



PLANTING IN THE EASTERN UNITED STATES.

Handwritten initials "H" and "C" with a flourish.

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INTRODUCTION.

Due to the great quantity of material available on this subject, I have left out the entire phase of nursery planting. My subject also is limited to the eastern part of the United States including the Rockies.

I am not going into a lengthy discussion of the technique of planting trees, but to cover more or less the entire field of planting. There is little advantage in trying to cover a lot of experimental plantings which include in a way the plantings in the various regions but which are not practical.

It will be quite evident as I proceed in my discussion that the age of the species used in the various regions is directly proportional to the severity of the planting site.

I am first going to give a general description of the regions, climate, soil, rainfall, and any other advantageous or disadvantageous factors. You will readily see that in each case the choice of species is based upon its ability to survive best under adverse conditions and still be of the highest use value, whether for protection, for lumber or for recreation.

Each region will be discussed separately. This paper is not original, but is a compiled group of facts obtained from the following sources: U.S.D.A. Bulletins; Journal of Forestry; "Elements of Forestry" by Moon & Brown; and personal letters received from technical men in the field of forestry in the various regions. There are many publications which have the latest discoveries and practices, but due to the present economic program they have not been printed.

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SOUTHERN PINE REGION

The Southern Pine Region is one of our most important regions for the growth of pine, because of the rapid growth of timber due to the warm climate, the ease of reproduction, ease of logging and log transportation conditions, and the fact that 40 to 50% of the area is unsuited to any other purpose but the production of timber.

Some of the general characteristics of this region are its flat or rolling topography and its warm, humid climate, combined with a sandy soil, which is largely responsible for the slow growth of the pine.

The length of the growing season is equalled only by that of California. Practically all the land in this forest region is in the hands of large private owners, while in other regions there is at least partial state or federal control.

The forests are being rapidly cut off, and because of fires, practice of broadcast brush burning, heavy turpentineing, and light burning practice, many areas have become barren, sandy wastes, which are rapidly giving way to erosion. In order to secure reproduction it is necessary to eliminate entirely the practice of broadcast burning; to protect the area from grazing, especially of hogs, for at least ten years; to eliminate light burning; and to leave scattered seed trees to supply the seed for natural reproduction.

Today, since much of the area is denuded, it is necessary to rely on hand planting methods to bring the land once more into a productive state. The large timber holding concerns are now realizing the value of growing crops to supply their needs for timber in the future; and they have launched a determined effort to re-stock not only their own areas but to help and encourage the small woodlot owner to do likewise. These large timber holding companies figure that it will be to their benefit in the future, for as their own lands are logged off they will be able to buy stumpage from adjacent areas at a very reasonable figure. Here is a statement made by the Long-Bell Lumber Company: "Having reserves of virgin timber to supply our plants far into the future, we further aim, by careful logging, reforestation of cut-over areas, planting if necessary, and aggressive forest protection, to keep all our forest land areas fully stocked with growing timber to sustain a permanent lumber manufacturing enterprise."

These various timber companies have been experimenting with various planting species and planting methods on different sites for some time, and have finally come to a fairly satisfactory practical solution of their problem. They have found that the native trees are the most suitable for planting purposes, for they can forecast with reasonable accuracy the results which they will obtain.

The native species planted depends entirely on the site. If the waste tract is swamp we would use cypress or one of the gums, although very slow growers; while on the lower areas, in farmers' woodlots, hardwoods such as Cottonwood (*Populus deltoides*), Yellow poplar (*Liriodendron tulipifera*), Red oak (*Quercus rubra*), Black walnut (*Juglans nigra*) and White ash (*Fraxinus americana*). Other species of hardwood are grown there, but grow too slowly to be of any great importance in planting commercial species.

Of the pines which are commercially grown the Longleaf (*Pinus palustris*), Shortleaf (*Pinus echinata*), Slash pine (*Pinus caribaea*) and Loblolly pine (*Pinus taeda*) are recognized as the best, and each has its particular site in which it is known to grow best.

Longleaf pine grows best on sandy, gravelly soil where drainage is good. Loblolly pine for moist bottoms and swamp margins, as well as upon land where the soil is worn out and poor. Shortleaf pine for uplands throughout the south, and Cuban pine (*Pinus caribaea*) for poorly drained flats (crawfish swamps), also swamp margins.

The spacing of a species is very important, and one should try to space as many trees on an acre as will thrive to insure maximum height growth; also this will yield the best quality of timber.

In planting the woodlot, 1 to 2 year old seedlings are used, and are obtained either from State Forest nurs-

eries or from a group of timber owners who cooperate and maintain their own nurseries. Formerly the 1-1 stock was used, but due to extra expense in transplanting, space necessary for transplanting and shipping expense, they are gradually abandoning the 1-1 stock in favor of the smaller 1-0 and 2-0 stock. Since the climate is mild and humid these small plants give an average survival of 85% to 90%, depending on the care given in handling seedlings from the time they are dug from the nursery until they are finally planted. Upon arrival of the stock the roots are examined to see if they have been kept moist and fresh. The roots in each bundle are then wet with a thick mud, care being taken that none of the small rootlets are scarred in handling, and that a stream of water is never poured directly on them; they are then heeled in until ready for use.

The present furrow planting practice is to plow those areas which are particularly adapted to cultivation, which not only facilitates and insures a clean space for planting but also provides good fire protection for the first two or three years.

The practice of planting two species so as to have a tolerant suppressed understory which comes into vigorous growth as soon as the dominant species is removed has the advantage of providing an even utilization of the soil nutrients and keeping the soil protected from natural destructive agencies.

This^{is} actually practiced by the small land owners, but the large private holder cannot see his way clear to intensive forestry practice, and plants only the species which is best adapted to the site.

The "slit" method of planting is practiced as standard, the hold being made with a "dibble" which has a wedge-shaped steel blade nine inches long, $3\frac{1}{4}$ inches wide and $7/8$ inch thick at the top, tapering to a thin edge. At the top of the blade a step projects to facilitate forcing the blade into the ground. The handle is made of $7/8$ inch round iron. This instrument is used for making the hole, closing it and tamping it. A spade or mattock is also used to advantage.

Experienced planters working in pairs can plant 2000 to 2,800 seedlings per day. January is the best time to plant in most parts of the south. The plants are dormant only a short time then, and plenty of mild rain assures immediate response to the first warm days of spring. Plants should never be put in after March first if a good survival is expected, because of the dryness after that time.

Protection is now the big factor. Determined watchfulness must be maintained to control all fires; stock should be grazed only moderately after a period of five years and hogs after ten years. As a rule insects do not attack young pine, but in case they do a government entomologist should be consulted. Any degree of weeding or

thinning will depend upon the wishes of the owner.

APPALACHIAN REGION

The Appalachian region, just north of the Southern Pine region, consists of two long and rugged mountain systems surrounded and penetrated by well populated plateaus and valleys. The mountains are mostly forest land, and are adapted by climate and soil for the growth of commercial forest products in a variety unequalled outside the tropics. After many years of logging the original supply of timber for this region is nearing its end. Its replacement has been hindered by repeated cullings which removed most of the useable timber and left that which was poorest. Fifty-nine per cent of the total land area is in forest, and only 3% of this area is in National forests; 95% is privately owned. In the mountains we find the large-scale private owners, while in the valleys and on the plateaus we find the smaller woodlot owners. The forest problem, therefore, is one of privately owned tracts, large and small.

The elevation of the regions varies from 1000 feet to 6000 feet, and the average rainfall varies from 30 inches to 42 inches. The soil is sandy clay, and the growing season is moderately long.

Since the area has such a variety of species, both conifers and hardwoods, when the area was logged the val-

uable species were taken off first, and the ones of less value have taken their place. In many instances the species which were considered inferior when the area was cut over the first time, have later come into their own, and the region has again been cut over.

At present there is little private planting being done and statistics on this have not yet been compiled. The work done by the Forest Service in the region must therefore be taken as a guide. Of the total acreage in National Forests 12% is in need of some planting program. The main species planted are Norway spruce (*Picea excelsa*) Red spruce (*Picea rubra*), Ash (*Fraxinus americana*), White pine (*Pinus strobus*) and Yellow poplar (*Liriodendron tulipifera*). There is a tendency to mix the species, the reason being that it will lessen the danger of attacks by insects and fungi which are common to this region, and will also lessen the fire danger.

The age of the planting species varies from 2-1, 2-2 stock, with a present tendency to plant 3-0 root-pruned stock. The method of planting is not standardized, but the slit method is most commonly used. The spacing varies for the various species, ranging from 5'6" to 8'8". The percentage of survival varies, depending much upon the seasonal rains, from 65% to 80%; the cost of planting is about \$8.84 per thousand. This cost ^{was} ~~is~~ figured from the

planting of 1400 acres during the 1931 seasons. The season for planting varies, both fall and spring planting giving good results.

THE NORTH EAST REGION.

North of the Appalachian region lies a large area known as the North East Region. This includes the states of New York, Pennsylvania, Vermont, Maine and New Hampshire. Practically all of this region was covered with ice during the glacial era, and as a consequence the soil, topography and drainage are decidedly irregular. Vast outwash plains of nearly pure sand may alternate with heavier clay, especially in New York and Maine. The topography as a rule is very rugged. Due to all these factors we find a wide variation in types of forest in this region. The annual precipitation varies from 20 inches to 50 inches, and the elevation varies from 200 feet to 6000 feet, the bulk being at from 1000 feet to 2000 feet.

In the higher elevations we find the coniferous types, which include red, white and black spruce, red and white pine, balsam fir, hemlock, tamarack, white cedar, with a smattering of hardwood; but in the lower elevations, on the gentle slopes where the soil is deeper and the site is less severe, we find principally hardwoods, which in-

clude Hard maple (*Acer saccharum*), Yellow and Paper birch (*Betula lutea*, *papyrifera*),^{with} Beech (*Fagus atropunicea*), Aspen (*Populus tremuloides*), in possession of the burns.

There are few National Forests in this region, and in recent years the states have taken upon themselves the task of buying up and planting denuded areas, thus creating state-owned forests. The outstanding facts that point to a future for this area are first; ~~that~~ the center of population is only a few miles west of its margin, with splendid markets and transportation already developed; and second, with so vast an area suited to timber production better than to agriculture we can readily see that intensive forestry can be practiced. For these reasons we see the states of the Northeast taking the lead today in buying up abandoned farm areas and putting them under intensive management plans whereby they can assure themselves of a continuous supply of timber for the future, ~~for~~ protection, for grazing and for recreation, all of which are becoming more and more important, particularly recreation.

In the Northeast Region five acres of farm land are abandoned for each acre planted; ~~and~~ under present practices and favorable circumstances it costs from ten to twenty dollars per acre to plant. New York has put on a program whereby in the next fifteen years it will attempt to recover 7,187,000 acres of farm land which have been abandoned in the last fifty years. The forest planting

practiced at present is insignificant as compared to the job ahead.

There are 4,000,000 acres of sub-marginal farm land in New York. The state's appropriation of \$20,000,000 to be spent between 1929 and 1944 allows for state purchase of this land in parcels of not less than 500 acres and in communities where the areas may be expanded. The state is divided into five districts with a district forester appointed as the head of each district. A fire warden is appointed, and during the fire hazard season a fire patrol is employed. A system of fire alarms is also built by plowing six furrows with a large breaker plow pulled by a tractor along all roads running through each area, and in other parts of the interior where it seems necessary. Fire-line costs average \$22.00 per mile.

Where White pine is planted, precautionary measures are taken to prevent infection by White pine blister rust. Ribes are eradicated at approximately fifty cents per acre. This is all land which was once farmed. The land is rolling and between elevations of 1500-2500 feet. Soils are loams, some being stonier than others.

Ninety-five per cent of the stock now planted is coniferous, composed of White pine (*Pinus strobus*), Norway and Scotch pine (*Pinus resinosa*, *sylvestris*), and Norway and White spruce (*Picea abies*, *glauca*); one per cent is hardwood, three and four year old transplant. Planting stock is used, although 2-3 year old seedlings are cheaper.

The tendency is toward wider spacing and early pruning.

The ordinary grub hoe is the standard planting tool used, trees being planted by the slit method, with or without removal of the top sod depending on the size of the planting stock and the vegetation upon the ground. The average number of trees planted per day when the sod is removed is 2,000. Several sizes of planting stock are used, of different species, ranging from 2-4 year seedlings, and transplants ranging from 2-1 stock to 2-2 stock, being best suited for general planting.

It is now recommended that 2-0 year seedlings with root pruning could be grown which would be suitable. The average cost of planting for 6,500,000 trees, with the grub hoe, hand planting method, varies from \$4.17 to \$7.59 per thousand; an average cost of \$5.91 per thousand on brushy areas, etc. In planting seedling stock it is necessary to remove the sod to allow the best planting bed possible, one that will be free from vegetable competition until growth is well established.

A new planting machine has been invented by Mr. H.R. Walling, of the Champion Sheet Metal Company, Cortland, N.Y. The Champion Simplex Reforesting machine plants a single row, and is operated by two men and a team of horses. The Champion Duplex Reforesting machine plants two rows at a time, requires three men ^{to operate it} and is tractor drawn. The method of planting is practically the same in either type.

The plow in these machines is narrow and sharp pointed and has a horizontal shoe at the base, so as the machine is drawn forward this plow cuts a vertical slit in the ground with a horizontal cut at the bottom. The object is to make the ground on both sides of the vertical slit fall back tight about the stem and the roots of the plant after the plow has passed.

Simplex planting speed is 1200 per hour. The Duplex speed is 2500 per hour. The average cost with Simplex, including all expenses, is \$3.13 per thousand. The average cost with Duplex is \$2.40 per thousand. The three-year old transplants are best adapted for planting, with an 80% survival of 75,000 trees in spite of dry seasons.

The machine will work on steep slopes, rough ground and areas with scattered brush. This machine, by reducing planting costs has become a great incentive to increased planting activities.

THE LAKE STATE REGIONS.

A thousand miles west of the Northeast Region lies an area whose origin is similar to that of the Northeast Region. It is comprised of three states -- Minnesota, Wisconsin and Michigan. The 20,000,000 acres of land, denuded by repeated logging and burning, are suited to no other purpose but the growing of trees. This area is one-third of the total area of the three states. Up

to 1926 only 33 per cent of the area had been reforested.

The climate, topography and soil vary locally, but as a whole are comparatively uniform. The rainfall of the region varies from 25 to 35 inches a year. The snow fall is considerably heavier in the farther north, varying from 44 inches to 117 inches, and the temperature of the region often falls as low as 30 degrees below zero.

The forest belt consists of three zones -- the spruce-fir forest of the north; the Maple-basswood-hemlock and the Norway pine-jack pine forests of the central zone; and the White pine-oak-maple forests of the southern zone. The greater part of the region is covered with glacial deposits which form an array of hills, valleys, plains, ridges, swamps and lakes which are characteristic of the region.

The differences in the soil, which range from droughty dune, beach and outwash sands, to old lake beds, muck and peat of the swamps, form the underlying differences in the forest growth, and are of equal importance in forest planting.

The species principally planted are Norway pine, 60%, White pine 25%, Jack pine 7%, Scotch pine 5%, Norway and White spruce 1%, and all other species 1%. Seventy per cent of the planting so far has been done on sandy soil which has been repeatedly burned and of which erosion has taken its toll.

The basis of planting technique is a thorough knowledge of the species, understanding of the size and age of the trees to be planted and of the best methods of planting, how to space between the trees, number of trees to the acre, and what species should be planted together.

In selecting a species we must consider planting site, use to which the wood will be put, the rate of growth, value of the wood products, susceptibility to damage by insects, disease and other causes. Here may be mentioned the types of soil and the trees which are recommended to be planted thereon:

1. Dry, sandy land, with Norway and Jack pines.
2. Better sandy, moist soils, Norway pine, Northern white pine, White spruce and Red Oak, (Quercus borealis).

The original species should be planted back if possible.

The planting season may be either spring or fall, for large quantities have been planted in both seasons with excellent results. The size and age of planting stock of Norway pine 2-0 and 2-1 stock is recommended for brushy sites. For Northern White pine 2-1 transplants or 3-0 seedlings are recommended; while for White spruce 2-1 and 2-2 transplants are suggested. For Jack pine (*Pinus banksiana*) and White ash, one year seedlings, and for Cottonwood one year rooted cuttings are found the most satisfactory.

We can see here that there is a tendency to plant small, young stock even though the site may be considered unfavorable. The reason is that young stock is more easily adapted to new conditions of planting site, is cheaper to raise or buy, is planted more quickly and more cheaply since unskilled labor is used with good success, and finally, a larger return can be expected from the investment.

Different hole, slit and furrow methods of planting, and combinations of all of them, have been tried in an effort to establish plantations at a minimum cost without sacrificing survival or favorable development of the trees. All have given satisfactory results when practiced by reasonably competent crews under good supervision. The hole method is adapted to all species and all sites, since the mattock and grub hoe can be used on both rocky situations and sandy areas.

In the furrow method it can be combined with the hole or slit method, ~~the furrow~~^{thus} eliminating the time spent in clearing away the sod. In the direct furrow method the roots are spread out in the bottom of the furrow while the stem is held against the side of the furrow. Loose soil is then pulled over the roots and firmed by hand or foot, and a layer of loose soil is added on top by plowing another furrow against it. Where it can be applied it is quick, cheap, and easily practised by unskilled labor.

In the slit method a planting bar, spade or mattock is used. The planting bar consists of a steel wedge eight inches by twelve inches long, three inches by four inches wide, and three-eighths of an inch thick at the top, on a galvanized iron bar with or without a grip handle, and with a step attachment. The bar is driven vertically into the soil with a single stroke to the depth required, pushed forward to an angle of forty-five degrees, slipped slightly downward to get a new hold at the bottom of the hole, and finally brought back to a nearly perpendicular position. This forms a rectangular hole into which the roots of the tree are lowered. The roots are shaken out, and the slit is closed by another thrust of the bar behind the plant. The planter then closes this last hole, to prevent excessive drying near the roots, by a thrust of his heel as he steps forward.

The method has been criticized because the roots are all placed in the same plane , but investigation shows that the roots grow out evenly in all directions in the sand soon after planting. It is adapted to loose soil better than to heavy, sticky soils. It is also better adapted to small stock than to larger stock with bushy roots. It is a cheap and a fast method of planting.

Growth and survival of the trees should be weighed with the cost in the choice of a planting method. Slit

planting is the least expensive. Plowing the furrows adds little to the cost because it is largely compensated by the reduction in the time for actual planting. The hole methods are slower and much more expensive, and are justified only in extremely bushy or rough sites. The trees should be planted in furrows wherever plowing is possible.

By the slit method a man will plant 1000 to 2000 trees per day, and the cost will be from \$4.00 to \$4.50 per thousand. By the slit furrow method a man will plant 1500 to 2000 trees per day at a cost of \$2.50 to \$3.00 per thousand trees. By the dug hole method a man will plant 400 to 600 trees per day at a cost of \$8.00 to \$11.00 per thousand trees. Six by six spacing can be recommended for most species planted. The percent of survival ranges from 80% to 95% depending upon the method of planting used and the favorableness of the season.

The cost of planting stock 1-0 Jack pine is from \$.75 to \$1.00 per thousand trees. For Norway pine 2-0 the cost is \$1.50 to \$2.50 per thousand trees; for White spruce 2-1 or 2-2 the cost is \$3.50 to \$10.00 per thousand trees and for Northern white pine 2-1 or 2-0 the cost is \$3.50 to \$10.00 per thousand trees. Thus we can readily see that seedling stock is much cheaper than the transplanted older stock.

The age of merchantability for Norway pine is sixty to eighty years and the yield is from ten thousand to twenty-five thousand board feet per acre. The age of

merchantability for Northern white pine is sixty to eighty years and the yield is ten thousand to twenty-five thousand board feet per acre. White spruce is merchantable at fifty to seventy years and yields twenty to forty cords per acre. Jack pine is merchantable at thirty-five to fifty years and yields twenty to thirty-five cords per acre.

For this region we have the most complete set of practical information obtainable and it is based on actual experience and field data.

NORTHERN ROCKY MOUNTAIN DISTRICT.

Again we go 1,000 miles west of the Lake States Region and ^{we} find a forest region which occupies the mountain slopes above 5,000 feet to timber line at 9,000 feet to 11,000 feet. The topography is uniformly rugged and steep. The precipitation varies from 12 inches to 20 inches per year, and the climate may be classified as severe, giving a short growing season for tree growth. The greater portion of the forested area has been set aside by the government for National Forests, and the private timber holdings are somewhat small in extent and have little effect on the national timber supply.

The forest is largely composed of Ponderosa pine (*Pinus ponderosa*), Lodgepole pine, and small quantities of Douglas fir (*Pseudotsuga taxifolia*), Engelmann spruce

(*Picea engelmanni*) and White pine (*Pinus monticola*).

There are vast areas of pure Lodgepole pine; above the timber line the forest is of a broken nature, and at high elevations are found open parks.

Owing to the large number and size of the burns in this region planting must be resorted to if certain areas are to be restocked. The northerly climate, the low rainfall, the high altitudes and the short growing season all combine to make the season's growth a short one, and the rotation ranges from 80 years to 120 years.

In this region there have been no recent changes in planting technique. The slit method is the one most commonly used. The species which are being recommended for planting, depending on the site, are White pine, Ponderosa pine and Engelman spruce. Transplant stock is used principally; 1-2 and sometimes 2-2. Very little seedling stock is used at present owing to the better survival of the larger stock on severe sites.

The planting is divided about equally between spring and fall. Spring planting is somewhat favored, but there are administrative reasons for an equal amount of planting being done in the fall. Many of the sites are not accessible in the spring when planting spruce and White pine on the high north slopes. So the work is divided about equally between the two seasons; since either season is short at best, ~~and~~ the work can be handled more efficiently

in this manner. The average cost is approximately \$8.00 per acre using the standard spacing -- 8'x8' (680 trees to the acre.)

There have been many large experiments carried on, but no definite reports have been collected.

SOUTHERN ROCKY MOUNTAIN FOREST.

This region occupies the southern portion of the continental divide, with its associated high plateaus and ranges..

There is no distinct line of demarcation between this region and the Northern Rocky Mountain Forest, but they are separated because of the preponderance of *Ponderosa* pine, which comprises about 90% of all the merchantable timber in the Southern Rocky Mountain Region.

The region is characterized by relatively high elevations, broad desert plateaus between mountain ranges, hot, dry climate and rainfall exceedingly low (from 5 to 20 inches per annum).

The principal industry of the region is grazing, with the lumber industry on the increase. Most of the forested areas are in the National Forest, as is the case in all Western areas. The government is paying special attention to stream protection, and to the permanent upkeep of the sheep and cattle ranges, as well as to the timber production.

Characteristics of the forest are: practically no forest growth below the elevation of 5,000 feet; exceedingly slow growth; dominance of ^{Ponderosa} Yellow pine; difficulty of reproduction; and the fact that the principal forest growth is limited to the higher elevations and northerly aspects.

The bulk of the merchantable species of Yellow pine is found between elevations of 6,000 to 8,500 feet, yielding 3000 to 5000 board feet per acre. Trees average 18 inches in diameter and 70 feet in height.

Due to the hot, dry summers and the comparatively low rainfall, reproduction in this region is exceedingly difficult, and it takes a rotation of 160 to 200 years to produce a saw log of merchantable size. For this reason this forest region will never be as important in the sense of being a large producing center and a source of the nation's timber supply as some of the others. It will be important locally because of its close association with the grazing, mining and agriculture of the region.

For the last fifteen years there has been very little planting, because there are other regions in which growth is more rapid and the planting of trees much more profitable. This region, therefore, has done little in developing new methods; ~~and~~ new ideas on the subject come principally from the other regions, where much planting work is being done. In this region approximately 25,000 trees per year are being

planted, and this is largely experimental, and is being done on many areas by the regularly employed Forest Personnel. Planting small areas brings the cost per acre to a very high figure, averaging from seven to fifteen dollars. In this work quality of planting rather than quantity is stressed. The goal is the making of observations on various sites which will enable the service to state definitely which areas can be planted with expectation of success, and which will not pay for planting.

The question of species must be settled by an examination of the area, determining the species which are natural to that locality, conditions of soil, site, exposure, etc. Exotic species have not proven desirable in this region. The question of age varies with the species and locality, and can be determined accurately by experimental plantings. The following are recommended on the basis of planting and cost: Ponderosa pine 2-1; Douglas fir 3-0; Engelman spruce 3-1; Limber pine (*Pinus flexilis*) 2-1; Brittlecone pine (*Pinus aristata*) 2-1. The age of these species holds true to the fact that on the more severe sites better results are obtained by planting larger stock. The stocking is approximately seven hundred to the acre.

The two methods of planting used are the "slit" method, in which the dirt is forced aside and forced together again about the roots of the tree; and the "dug hole" method, which makes a hole by removing the soil, which is replaced by hand around the roots of the tree.

The dug hole is used in heavy soils or dry locations where the soil has a tendency to bake and conditions are more severe. The slit method is used in most places where conditions warrant, because greater speed is accomplished in planting. In either planting method the planter carries his own canvas planting bag, digs his own holes, and plants the trees. The average number planted per day per man is 500 to 600 transplants with the deep hole method; with the slit method a thousand per day can be planted.

Planting seasons ordinarily begin the early part of April, depending upon the elevation of the areas to be planted and upon weather conditions. April and May furnish the moisture to carry the trees through the usual dry June days before the midsummer rains; therefore, planting should ordinarily be done only in the months of April and May. The per cent of survival varies from 60% to 80%, depending on the species. It is the practice to consider an area supporting 250 trees per acre as being fully stocked. It is also accepted in this region that an area supporting 100 trees or more per acre does not need planting.

CONCLUSION.

Throughout all the literature which I have consulted there has been recorded a tendency to plant only those regions which are most suitable for the growing of trees.

The species recommended for planting was in all cases that which grew naturally in the region rather than an imported one.

There is little planting being done at present by private concerns, owing to economic conditions.

Wherever the region will warrant there is a tendency to consider in the planting of seedlings:

1. Expense of growing
2. Freight charges
3. Handling facilities
4. Planting speed per day per man.

The comparison is based on the percentage of survival for every dollar expended.

The age class planted is directly proportional to the severity of the planting site.

The planting period is as a rule indirectly proportional to the length of the growing season. The longer the growing season the shorter the planting period, as for instance in the south the period of dormancy is approximately one month -- January, while in the Northern Rockies the growing period is short and the planting period is from four to five months, depending on physical conditions such

as snow, frozen ground, inaccessibility, etc. The planting cost also varies with the severity of the planting site.

There are two new developments in tree planting. One is the plowed furrow method described in the chapter on the Lake State Region, and the other is the Champion Tree Planter. The latter is discussed in the article on the North East Region. These two methods are both fast and economical, but their use is very limited.

A number of the states (Pennsylvania and New York) are now buying up denuded land and creating state forests. The public is gradually coming to recognize the necessity of growing its own forests. Private capital is still evading Forestry as a business. Much literature has been gathered for publication, but owing to the new economic program it has not been published.

Out of the new Forest Conservation program may come aid to the many areas in the east which need reforesting. Even now it is conceded that private forestry is gradually giving way under the present economic order, and that many areas will of necessity become State or National Forests.

REFERENCES CONSULTED.

SOUTHERN PINE REGION:

1. U.S.D.A. Leaflet No. 32
Planting Southern Pine.
2. Louisiana State U. Bul. Vol. 21, May '29, No. 3
Survival and Early Growth of Southern Pine.
3. R. A. Long, Long-Bell Lbr. Co. Kansas City, Mo.
Personal Letter.
4. Long-Bell Lbr. Co., Kansas City, Mo.
Farmers' Manual of Woodland Planting.
5. U.S.D.A. Farmers' Bulletin Nos. 1256, 1517, 1671.
U.S.D.A. Departmental Bulletin No. 1061.

APPALACHIAN REGION:

1. Planting & Nursery Report of Region No 7 1931.
2. Joseph C. Kirchner, Regional Forester, Washington D.C.
Personal Letter.
3. H. C. Foster, Pack Demonstration Forest, Warrenburg,
Personal Letter. N.Y.

NORTHEASTERN REGION:

1. C. E. Behre, Journal of Forestry, 30: 162 E '32.
Aspect of the Forest Planting Situation in the
Northeast.
2. Journal of Forestry 29; 1215-D '31
New York Reforestration Program Progress.
3. Journal of Forestry 28; 1009-N '31
Tree Planting Machine Cuts Planting Costs in Half.
4. D. G. Rankin, Journal of Forestry 29; 334 Mar. '31
Reforestration of Farm Land.
5. Vermont Forest Service, Montpelier, Pub. (35) 11. '30
Planting Forest Trees in Vermont.
6. H. J. Macaloney, Asst. Forester, New Haven, Conn.
Personal Letter.

LAKE STATE REGION:

1. U.S.D.A. Bulletin 1497
Forest Planting in the Lake States.
2. Journal of Forestry 19:131-138
Forest Planting in Southern Michigan.
3. Journal of Forestry 23:95-96
Forest Planting with a Plow.
4. R. N. Cunningham, Forest Economist, Lake States
Exp. Station, St. Paul, Minn.
Personal Letter.
5. E. W. Tinker, Regional Forester, Milwaukee, Wis.
Personal Letter.

NORTHERN ROCKY MOUNTAIN REGION:

1. W. G. Wahlenberg, Journal of Agri. Res. Vol.36
No. 12, June, 1928
Forest Planting in Northern Rocky Mountains.
2. D. S. Olson, Chief of Planting, Missoula, Mont.
Personal Letter.

SOUTHERN ROCKY MOUNTAIN REGION:

1. Planting Instructions Followed in Pike National
Forest, Colorado Springs, Colo.
2. H. A. Pearson, Director Southern Forest Experi-
ment Station, Tucson, Arizona.
Personal Letter.
3. Frank C. Pooler, Regional Forester, Albuquerque,
Personal Letter. N.M.
4. Earl C. Sanford, Asst. Regional Forester, Ogden,
Personal Letter. Utah



**BOARD OF COMMISSIONERS
OF
AGRICULTURE AND FORESTRY
TERRITORY OF HAWAII**

1428 KING STREET
HONOLULU, T.H.

March 6, 1933

Mr. Herman Dill,
215 N. 26 St.,
Corvallis, Oregon.

Dear Sir:

I had hoped to give you the information requested in your letter of December 1, 1932, sooner, but have been so busily engaged in writing reports and with field work that I have been unable to give your request an attention until now. And even now, I feel that I cannot give adequately all of the information you want, but here goes. We have practically nothing new in print which I can send to you but I am enclosing copies of some special information which may work in with what you want.

As you perhaps already know we cannot use the bare root method of out-planting here because of our drying winds and sun. All planting is with a ball of earth around the roots and this naturally brings up the expense. I lack figures of any value on costs and regret that I cannot send them to you. As for success of planting, however, I think that Hawaii stands quite high and on this subject I refer you to pages 44-46 and page 63 of the enclosed Biennial Report for 1929 and 1930.

This lists the species used and these are quite numerous because we have planting sites from sea level to 6,000 feet elevation and rainfall from 20 to over 240 inches per year. Practically all of our plants are under 1 year of age having been transplanted once in the nursery from flats when they are about three months old to other flats or to individual tins which are discarded at the pineapple canneries and are available free of charge.

We plant throughout the year whenever the showers make the soil moist enough and growth of the plants is continuous in these islands.

We are lately using more flats for our transplants rather than tins because less soil in this manner has to be carried into the field and costs are thus cheapened. This Division planted 320,253 trees on government lands in forest reserves in 1931 and 348,002 in 1932. This constitutes about one third of the total planting throughout the Territory.

If there is any other specific information you desire, please write to me again.

Very truly yours,

E. S. Judd

DIVISION OF FORESTRY

Territorial Forester

SCHOOL OF FORESTRY
OREGON STATE COLLEGE
CORVALLIS, OREGON



TERRITORY OF HAWAII

BOARD OF COMMISSIONERS OF AGRICULTURE AND FORESTRY

HONOLULU

September 20, 1932.

Tree Planting Policy

Mr. Bruce Cartwright
Chairman, Committee on Planting Policy
Honolulu, T. H.

Dear Sir:

In response to the request made of me at the meeting of the committee on Tree Planting Policy, held in Mr. Rice's office this morning, I have the honor to submit the following comments on the proposed report of the committee dated September 13, 1932:

1. Page 2 of Committee's report, paragraph 5. Concentrate watershed tree planting "more on the trees which have a greater secondary (timber) value", using more valuable timber trees than Silk Oak and Paperbark.

Tree planting on government lands in forest reserves is not the simple operation that it may seem offhand. It is a combination of a great many complex conditions which must be studied and worked out in harmony and of many obstacles which must be overcome, if successful results are to be obtained. For proof that the appropriations for tree planting in the past have been well spent and the tree planting in forest reserves has been a success, please see "Success of Tree Planting" as set forth on pages 44-46 of the printed biennial report of the Division of Forestry for the calendar years 1929 and 1930.

Some of the conditions which govern the choice of species in forest reserve plantings are as follows:

1. Availability of seed as to cost and abundance.
2. Germinating power of seed and ease of propagation.
3. Hardiness of transplants in outplanting operations.
4. Ability of transplant to take hold in planting site and put on satisfactory growth in spite of wind, drought, etc.
5. Value of species primarily for watershed cover and secondarily for timber.
6. Ability of species to reproduce itself naturally.

Some of the conditions surrounding planting operations in forest reserves are as follows:

1. Availability of transplants at nursery in quantity at time they are needed.
2. Proper soil moisture conditions at time of planting.
3. Availability of labor for setting out the transplants.
4. Accessibility of the planting site.

All of the above conditions must be harmonized if we are to have successful results in tree planting at reasonably low cost.

From our experience the SILK OAK TREE (Grevillea robusta) has met these requirements remarkably well. Not only have we been able to obtain sufficient seeds of this tree locally and at very low cost so that we have been able to raise it in abundance but the tree stands strong winds and drought remarkably well, produces a salch of leaves which add humus to the soil and increase water percolation, grows on almost any site which is well drained, throws a light seed which is easily wind borne and will germinate at distances of up to 5 miles from the mother tree, and produces a tough handsomely-grained wood which is useful for many purposes. Practically all of the flats now in use at the Makiki Nursery are made of silk oak wood. In my opinion it would be difficult soon to find a substitute tree which would hold up to all of the above specifications.

WHITE ASH seed is available in quantity in the late spring almost every year from old trees in Makiki Valley and is readily handled in the nursery, has a well-known high timber value, but can be grown successfully only in situations bearing a rich, moist soil. It is a waste of time and labor to set it out in certain dry sites where silk oak will thrive. We have therefore been compelled to restrict the planting of white ash to sites suitable for it.

PAPERBARK TREE seed is available in quantity at all times of the year from local trees but it prefers a wet site for favorable growth and our plantings of this species have been limited to such sites. Its high technical values are set forth on pages 349-353 in "The Hawaiian Planters' Record" July 1926, (Vol. XXX, No. 3) by an article on "Exotic Trees in Hawaii" by Dr. H. L. Lyon in which he points out the value of the Paperbark Tree for the production of Cajuput oil from leaves and twigs, of insulating material about refrigerators and steam pipes from the bark, and the production of a hard, close-grained wood almost imperishable in the ground, resisting termites, which is excellent for fence posts, wharf piles, ship building and various artisans' work.)

This Division would be glad to use in quantity trees of greater timber value than the three mentioned above which will stand up to the many specifications outlined above and has been working on the proposition

by experimenting with new species on the various planting sites encountered. In the meantime it has been compelled to use in quantity these three species of trees which have more or less met the exacting requirements involved in planting work.

The Division would like to use (Norfolk Island pine) more extensively. It is an excellent dual purpose tree but the seed supply is closely limited and (cannot be imported (because of low viability.)

Experiments made on various sites so far, and these experiments must necessarily cover a number of years for satisfactory results, show that the Brushbox and Turpentine trees are promising as dual purpose trees since both have a high timber value. Lack of a cheap seed supply has prevented more extensive use of these two trees thus far and the Brushbox will not withstand sites where the wind is severe.

In accordance with the suggested recommendation of the committee, however, I will be glad to have these experiments carried further so that if possible we can concentrate in our planting work on trees which have a greater timber value.

2. FOOD PRODUCING TREES.

This Division will be glad, as suggested, to give greater attention to the planting on government lands in forest reserves of trees having a food value. Whether 25% of the planting could be devoted to such trees is problematical because of the following limitations.

(The majority of planting sites on government lands in forest reserves are exposed, windswept ridges, often presenting a poor soil, where only the sturdiest trees can be planted and be expected to grow. Obviously, fruit trees are unsuited to such situations and it would be a sheer waste of money to set out fruit trees there.)

The planting of trees like the breadfruit, mango and kukui nut must be confined to rich alluvial soils which are constantly well moistened. Such sites are comparatively scarce on lands at our disposal. A glance at the map of Oahu will show that only at Waiahole and at Hauula are such sites available and these are limited to only a few acres. On account of the inland situation of our forest reserves, the planting of coconuts would be a waste of money. Such planting must be confined to littoral sites where the coconut tree will thrive but there are no such sites in the forest reserves with perhaps one exception, the Nanawale Forest Reserve in Puna, Hawaii.

(The breadfruit tree is about the most difficult tree to secure in quantity for planting because, having no seeds, it must be reproduced vegetatively, and to secure planting stock of sufficient size from roots

and slips requires an expensive layout of capital because the trees must be held from one to two years in the nursery before they are ready to plant out. This has been the reason for the standard price of \$5.00 for a young breadfruit tree. In addition to this, the trees when ready must be carried to the planting site in large containers and they will have to be cultivated until safely above the surrounding vegetation.)

The supply of material for breadfruit slips and roots at our disposal is limited but in accordance with the desire expressed by the Committee, this Division would be glad to make every effort to secure as much material as is available on all of the islands where we operate for the purpose, within our financial means, of producing as many young breadfruit trees as possible for planting on available sites in forest reserves. How many young breadfruit trees can be produced under the difficult circumstances it is impossible to tell and it would be unfair to promise the production of a fixed amount. The project, with your consent, will be started at once, however, and every effort made for its success. An offhand estimate, however, leads me to believe that the stock of young breadfruit trees which it will be humanly possible to produce will be in the hundreds rather than the thousands.

As brought out in the committee meeting, the planting of mango trees in forest reserves for food production is inadvisable because of the blight which almost invariably attacks the inflorescence and prevents fruiting. It is my observation that whenever there is any fruit on mango trees in forest reserves, which is rare, it either falls to the ground unused as food for humans and creates a breeding place for fruit flies or is eaten unripe by children with unwholesome results.

During the past calendar year the Division sprouted and distributed over 3,500 coconut trees in three of its nurseries. Of these 1,026 were planted experimentally at the Mokuapu Game Farm and 725 were planted in the Manawale reserve in Puna. To foster the more extensive planting of coconuts on private lands near the shore, it will be the aim of this Division to increase the output from our nurseries but there will necessarily be a limit to the amount because of the price of seed. Nuts for 10,000 coconuts would cost \$500. Large purchases like this are beyond our present means. The running expenses for the Division of Forestry, exclusive of automobile allowances amounting to \$311.87, for August 1932, were necessarily as low as \$418.41. It would therefore be out of the question to spend any large sums for purchasing coconuts for planting. An attempt will be made to meet the situation by contributions of ripe coconuts from private groves in order to foster coconut tree planting on private lands near the shore. An surplus stock of breadfruit trees could probably by arrangement be planted on private lands in favorable situations.

3. PLANTING PROGRAM.

In the past, I will admit that the Division of Forestry has felt its way rather than followed a definite, hidebound plan in carrying out its tree planting program. This has been more or less necessary for several reasons, dependant upon the amount of appropriations, the availability of labor near the planting sites, and the necessity of keeping on our payrolls men who have been employed for long terms of service, in addition to conditions concerning the selection of species for planting as set forth on the first pages of this letter.

I am now preparing a working plan for the management of all government lands and private lands under our control in all the forest reserves of the Territory which will show the work done to date in the way of tree planting and fencing exposed boundaries and the work needed to be done along these two lines and in eradicating destructive wild animals. It is my plan to have this working plan bring out the most essential work to be done during the next biennium and to base the appropriation budget estimate, which is due in October, on the needs as brought out by this plan, harmonising our present forest force as closely as possible to the situation. It is respectfully suggested that the Committee consider this forthcoming working plan as a substitute for the suggested planting program.

4. INDISCRIMINATE PLANTING.

(In all of our plantings, solid stands of trees of one certain species are now planted together and no mixed planting is undertaken. We do not yet know enough about the silvicultural requirements of the various species as to shade tolerance, root competition, etc. so as to be able to undertake any mixed or "indiscriminate" planting with assurance of success.)

The above information and suggestions are presented not in any spirit of protest but in the friendly effort to present a clear picture of the present complexities surrounding tree planting in the forest reserves.

In closing this lengthy letter, for which humble apologies are made, permit me to summarize the above discussion with the following suggestions:

1. In the effort to determine upon and use, in watershed planting, trees of greater secondary value than the silk oak, white ash, and paperbark, which will meet as well the exacting requirements of our planting sites and conditions of stock production, the present

experiments of the Division of Forestry with other more valuable species of trees should be continued.

2. The Division of Forestry will make every effort to produce young breadfruit trees in quantity for planting on suitable sites in forest reserves and on privately owned lands, will make special efforts to plant kukui nuts on all favorable sites in forest reserves, and increase within its means the production of young coconut trees for distribution to private land owners who will plant them in favorable sites near the shore.

3. The forthcoming working plan of the Division will include a planting program for the next biennium on which the new budget estimate will be based.

4. The present policy of planting in pure stands i.e. one species in a block will be continued.

Very truly yours,

C. S. Judd
Territorial Forester