Reforestation In The Lake States.

by

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Professor of Forestry
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Reforestation In The Lake States.

Introduction

Reforestation in the Lake States has become a very important factor in an attempt to rebuild that country back to a point where the timber resources will again provide a means of livelihood for the people of that region.

The Lake States is a region which at one time was well provided with timber resources. The most valuable and most used were the Norway pine and white pine. The conifers did not comprise all the valuable timber, because this area supported some very good stands of valuable hardwood. With the expansion and development of this country, these timber resources were soon eyed by the lumbermen as a good location for their mills. The region, being in the north central midwest, was ideally located for providing forest products to the expanding settlement of the United States.

Such a vast area of timber was available that the lumberman thought it inexhaustable. Due to this belief, they cut the timber with no idea as to conservation or future supply of forest products. High grading was practiced in the woods in which they only took the clear logs and logs with very little defect. This type of cutting not only gave poor utilization but soon had practically all of the virgin timber cut.

Through poor cutting practices and the neglect to control fires, the area was soon faced with a shortage of timber resources and the curtailment of numerous mill operations.
By this time the western forests presented another timber frontier so many of the lumbermen moved west, leaving the Lake States in a depleted condition.

It is estimated that Minn., Wisc. and Mich. comprise a total area of 20,000,000 acres of land better suited to the growing of forests than any other purpose and which because of repeated logging, burning, or both, now bears no valuable forest growth. Most of it must be planted before forests will grow upon it. The enormous size of this denuded area, about one-third of the total forest land of the region, is the strongest evidence of the necessity for reforestation.

What reforestation has as yet been done represents only a start in the right direction. Up to and including 1926, only 0.33% of the area had been planted. Even at the rate of 15,000 acres a year, the area planted in 1926, more than 1,300 years would be required to reforest the 20,000,000 acres. No region can afford to have so large an area idle for centuries. But to remedy this situation a large and continuing expansion of forest planting by all agencies in each of the States is essential.

The area in need of reforestation undoubtedly includes some lands on which more or less natural tree growth has already started. As the fire-protection work of the states and other organizations become more effective, the scattered seedling trees escaped destruction and had a chance to grow and increase in number. If those lands are protected for a
sufficient period, a large part of them undoubtedly will re-stock with trees naturally, although chiefly with inferior species of low value. Here better fire protection will help and is essential, but it can not be said to offer a solution for all these idle lands. The process of natural restocking would be so slow that the owners, whether public or private, could better afford to plant the lands than suffer the loss from holding them unproductive for so many years. Under present conditions any decrease in the area in need of planting as a result of natural reforestation tends to be equaled or exceeded by the areas cut over and burned annually.

This paper is being presented to show what has been done in the past to reforest this region and the procedure, followed in carrying on such a program. It will present to the person unfamiliar with reforestation in that region a good foundation as to what is really necessary to carry on such a worthy project.

The material in this thesis was obtained from manuals, pamphlets, bulletins and through my practical experience in such work on the Chippewa National Forest.

History Of Reforestation In The Lake States.

In the Lake States the purpose of forest planting has been to produce timber crops and has been carried on through the State and Federal Forest Service Agencies to the greatest extent. Most plantations have been made on public lands set apart as State and national forests. In carrying on this program the areas planted were segregated into solid blocks. These areas should provide a substantial supply of timber products for local or general industries when the trees reach
merchantable size. In addition to planting of State-owned lands, the States have furnished forest planting stock in large quantities for distribution at cost to companies and individuals for planting on private lands.

**Private Reforestation.**

Planting by private owners has usually been on a small scale, however, and in the nature of trials of feasibility rather than of serious attempts to provide a future supply of timber. The demand each year is increasing, but it comes mostly from farmers and small landowners who plant only a few hundred trees or at most a few acres. Although these plantings are small they are very desirable and are encouraged. The main trouble with the private planting is that it is not continued long enough or developed on a large enough scale to provide for future timber supplies for working units. The small private owner cannot see any advantage in a long time investment. His interests are based on a crop that will produce some return in a very short time.

Large paper and pulp mills which require a continued supply of timber for a long period of years have not yet undertaken forest planting operations for timber production. Their lack of interest in planting can be traced to the fact that that Canada, only a short distance away, can furnish them with pulp species at reasonable prices. As long as Canada can furnish this timber, the private companies have no desire to reforest any land they might have.
The first planting in the northern part of the Lake States was done in experimental plantations established in 1888 at Grayling and Oscoda, Michigan by the Michigan Agricultural College, and at Grand Rapids, Minn., in 1898, by the Minn. Agricultural College.\(^1\)

As early as 1903, a few private companies and individuals did a little forest planting.

**State Reforestation.**

State forests have taken an active part in reforestation as well as the national forests. They have not carried on such an extensive program as the national forests because of the lack of sufficient funds. Much of the private lands reverted back to the states through delinquent taxes, giving them suitable reforestation areas. Once the private owner had removed the valuable timber, his interests in the area were practically forgotten unless he could entice some innocent outsider to buy the land for agriculture. Many of these agriculturists became discouraged and abandoned the land. The states soon recognized the problem of holding a large acreage of land that was idle and non-productive. The area was suited for timber production and nothing else so by creating state forests and slowly reforesting the areas, they put the land back on a productive basis.

**Michigan Reforestation.**

Michigan has been reforesting her state lands since 1904, when some planting was done in the Higgins Lake State Forest.
Their planting has not been on a large scale but has planted some area each year except 1936. The following chart shows the plantings in the state forests by date and season:

**PLANTING ON STATE FORESTS TO DATE BY SEASONS INCLUDING FAILURES REPLANTED.**

<table>
<thead>
<tr>
<th>Season</th>
<th>Year</th>
<th>Acreage</th>
<th>Number of trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>1904-09</td>
<td>242</td>
<td>209,400</td>
</tr>
<tr>
<td>Spring</td>
<td>1910</td>
<td>117</td>
<td>126,700</td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>1911</td>
<td>108</td>
<td>215,400</td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>1912</td>
<td>96</td>
<td>200,000</td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td>71</td>
<td>147,000</td>
</tr>
<tr>
<td>Spring</td>
<td>1913</td>
<td>143</td>
<td>290,200</td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td>109</td>
<td>239,200</td>
</tr>
<tr>
<td>Spring</td>
<td>1914</td>
<td>361</td>
<td>467,700</td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td>370</td>
<td>570,500</td>
</tr>
<tr>
<td>Spring</td>
<td>1915</td>
<td>682</td>
<td>890,500</td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td>485</td>
<td>650,500</td>
</tr>
<tr>
<td>Spring</td>
<td>1916</td>
<td>862</td>
<td>1,536,000</td>
</tr>
<tr>
<td>Fall</td>
<td>1917</td>
<td>983</td>
<td>1,673,000</td>
</tr>
<tr>
<td>Spring</td>
<td>1917</td>
<td>718</td>
<td>1,255,800</td>
</tr>
<tr>
<td>Fall</td>
<td>1918</td>
<td>741</td>
<td>1,307,100</td>
</tr>
<tr>
<td>Spring</td>
<td>1918</td>
<td>83</td>
<td>1,466,700</td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>1919</td>
<td>1,135</td>
<td>1,866,400</td>
</tr>
<tr>
<td>Fall</td>
<td>1919</td>
<td>391</td>
<td>590,900</td>
</tr>
<tr>
<td>Spring</td>
<td>1920</td>
<td>778</td>
<td>1,304,100</td>
</tr>
<tr>
<td>Fall</td>
<td>1920</td>
<td>847</td>
<td>1,239,400</td>
</tr>
<tr>
<td>Spring</td>
<td>1921</td>
<td>1,552</td>
<td>2,351,500</td>
</tr>
<tr>
<td>Fall</td>
<td>1921</td>
<td>854</td>
<td>1,096,800</td>
</tr>
<tr>
<td>Spring</td>
<td>1922</td>
<td>812</td>
<td>933,200</td>
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<tr>
<td>Fall</td>
<td>1922</td>
<td>1,072</td>
<td>1,196,400</td>
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<tr>
<td>Spring</td>
<td>1923</td>
<td>904</td>
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<tr>
<td>Fall</td>
<td>1923</td>
<td>238</td>
<td>355,400</td>
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<td>Spring</td>
<td>1924</td>
<td>3,213</td>
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<td>1924</td>
<td>2,478</td>
<td>2,882,500</td>
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<tr>
<td>Spring</td>
<td>1925</td>
<td>2,970</td>
<td>2,086,800</td>
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<tr>
<td>Fall</td>
<td>1925</td>
<td>3,175</td>
<td>3,516,500</td>
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<tr>
<td>Spring</td>
<td>1926</td>
<td>2,394</td>
<td>2,615,400</td>
</tr>
<tr>
<td>Fall</td>
<td>1926</td>
<td>4,551</td>
<td>5,163,600</td>
</tr>
<tr>
<td>Spring</td>
<td>1927</td>
<td>2,393</td>
<td>2,567,100</td>
</tr>
<tr>
<td>Fall</td>
<td>1927</td>
<td>5,007</td>
<td>4,482,400</td>
</tr>
<tr>
<td>Spring</td>
<td>1928</td>
<td>6,112</td>
<td>6,232,600</td>
</tr>
<tr>
<td>Fall</td>
<td>1928</td>
<td>6,915</td>
<td>5,069,700</td>
</tr>
<tr>
<td>Spring</td>
<td>1929</td>
<td>8,558</td>
<td>3,652,400</td>
</tr>
<tr>
<td>Fall</td>
<td>1929</td>
<td>8,646</td>
<td>4,990,100</td>
</tr>
<tr>
<td>Season</td>
<td>Year</td>
<td>Acreage</td>
<td>Number of trees.</td>
</tr>
<tr>
<td>--------</td>
<td>------</td>
<td>---------</td>
<td>------------------</td>
</tr>
<tr>
<td>Spring</td>
<td>1930</td>
<td>15,519</td>
<td>9,649,200.</td>
</tr>
<tr>
<td>Fall</td>
<td>1930</td>
<td>10,963</td>
<td>7,176,000.</td>
</tr>
<tr>
<td>Spring</td>
<td>1931</td>
<td>11,726</td>
<td>6,910,500.</td>
</tr>
<tr>
<td>Fall</td>
<td>1931</td>
<td>20,311</td>
<td>14,506,100.</td>
</tr>
<tr>
<td>Spring</td>
<td>1932</td>
<td>638</td>
<td>502,400.</td>
</tr>
<tr>
<td>Fall</td>
<td>1932</td>
<td>9,993</td>
<td>6,660,900.</td>
</tr>
<tr>
<td>Fall</td>
<td>1933</td>
<td>5,369</td>
<td>3,784,800.</td>
</tr>
<tr>
<td>Spring</td>
<td>1934</td>
<td>5,320</td>
<td>3,228,900.</td>
</tr>
<tr>
<td>Fall</td>
<td>1934</td>
<td>14,777</td>
<td>9,119,800.</td>
</tr>
<tr>
<td>Fall</td>
<td>1935</td>
<td>8,023</td>
<td>5,785,400.</td>
</tr>
<tr>
<td>Spring</td>
<td>1936</td>
<td>3,667</td>
<td>2,891,500.</td>
</tr>
<tr>
<td>Fall</td>
<td>1937</td>
<td>11,491</td>
<td>9,141,400.</td>
</tr>
<tr>
<td>Spring</td>
<td>1938</td>
<td>12,289</td>
<td>8,634,200.</td>
</tr>
</tbody>
</table>

Totals........201,545 159,052,400.

The following information gives the State Forests in Michigan and the acreage of plantation on each forest.

Higgins Lake Forest, which was the first to be established (1903) now takes in a total gross area of 203,019 acres. A total of 15,080 acres have been planted.

Houghton Lake Forest embraces an area of 195,420 acres gross, of which 39 percent or 76,734 acres is controlled by the State. 20,247 acres have been restocked by planting.

Fife Lake Forest covers a total of 341,110 acres and the State holds title to 88,412 acres. Plantations total 22,993 acres.

Ogemaw Forest contains 347,448 acres within its boundaries of which 188,433 acres are held by the State. Plantations total 20,464 acres.

Presque Isle Forest contains 89,427 acres and of this it owns 57,764 acres. 20,652 acres have been planted to native pine.
Alpena Forest contains 30,616 acres gross with the state ownership claiming 19,023 acres. 4,667 acres have been reforested.

Pigeon River Forest contains 119,417 acres of which the State owns 84,875 acres. Plantation occupy 15,793 acres.

Hardwood Forest consists of 74,680 acres of which 48,600 acres is owned by the state. This is the only State forest containing any appreciable amount of hardwood soil. This area was obtained in 1925, and up to this time only cut-over pine lands were included in State forests. This tract is practically all hardwoods. The plantations cover 11,325 acres.

Block Lake Forest covers a territory of 92,440 acres with the State holding comprising 51,792 acres. 12,521 acres have been put into plantations.

Lake Superior Forest has a gross area of 223,745 acres. Of this 114,249 acres is under State control. Plantations established cover 9,222 acres.

Mackinac Forest contains 189,092 acres of which 116,181 acres are State land. Plantations have been established on 10,613 acres.

Au Sable Forest, the latest to be brought under administration, contains 334,745 acres and of this the State holds title to 131,622 acres. A total of 12,748 acres have been planted.
Planting stock is provided from two nurseries, the Higgins Lake and Hardwood. The Higgins nursery contains 25 acres and furnishes conifer stock. The output for the biennium 1936-38 was 25,550,800 pine trees. Of this amount 81 percent was used in reforestation on State forests. Higgins nursery is located on the Higgins Lake Forest.

Hardwood nursery is located on the Hardwood State Forest. This nursery site is particularly adapted to growth of hardwood species. Construction was started in 1935, enclosing forty acres. 20 acres are now under production. During the period from fall 1936 to fall 1937, the stock output was 699,925. Practically the entire amount produced was distributed to other Divisions of the Department for planting on State administered projects. This nursery also produces some conifer species.

The net acreage that has been restocked in all forests, which is arrived at by deducting the acreage that has been replanted because of failure from the total plantings made, is now 176,325 acres of which 11 percent is white, 70 percent red, 16 percent white and red mixed and three percent jack pine, Scotch pine and other species.

Ground preparation has been mostly furrowing or by hand. This will be taken up later as the same principles are used over the region.
Forest plantations have a definite place on the Michigan farm that is managed with the object of making the most economical use of each acre of land. Many Michigan farms include some land that is undesirable for the production of agricultural crops, and it is unprofitable to use it for that purpose. Sandy soils, very strong soils and lands with steep sloping surface are of this class. There are also odd corners of better soil that cannot be managed conveniently with modern farm machinery, which, therefore, might well be eliminated from cultivation.\(^2\)

Since farm crops must be harvested annually, lands of low productive capacity are a special liability during periods when the price of farm products are depressed. If the expenditures on poor lands, in labor, seed, and fertilizer exceed the average gross income for depression and prosperous years, such lands might better be put to some other use. These lands will usually yield acceptable crops of trees, producing cellulose and encouraging a larger crop of game animals and birds.

Trees planted on the farms are used for windbreaks, Christmas tree production and yield fence posts and fuelwood while they stand is young and lumber later.

Planting supervision and instructions are furnished the farmers through the cooperative agricultural extension work provided by the Michigan State College with the U.S.D.A. Cooperating.

Michigan has gone a long way toward placing here idle lands back into a timber producing status. It can be said that Michigan was the first state in the Lake States to realize the dire need of reforesting her denuded areas.
Wisconsin Reforestation.

The original forests in Wisconsin played a major part in the development of the state. They gave seasonal employment to thousands of farmers; they provided low cost building material; they made possible the development of a large wood using industry and the building of railroads which now serve them.

The new forests in Wisconsin may likewise play an equally important part in developing the state, in providing employment and in using lands not needed or not suited for other purposes. (3)

Some of the first land acquired by the state, for the purpose of growing timber, was by gift. Part of this land was contributed by a lumber company in 1907, and part by the federal government in 1903. (3) Very little development in forestry was evident at this time.

Many years were required to overcome a certain indifference to state forests. The illusion, particularly in the northern part of the state, was that there was no room for state forests. The people looked forward to the forest lands of yesterday to be agricultural lands of tomorrow. Time has proved this belief to be wrong. There is ample room in northern Wisconsin for both private farms and state forests.

Wisconsin state forests include a gross average of 350,000 acres of which the state of Wisconsin owns approximately 183,000 acres, the balance belonging to several counties and private owners. (3) Additional areas are to be purchased so solid blocking of state owned property will enable a more economical administration of the forests.
The conservation department of Wisconsin operates three nurseries for the production of forest planting stock. The original nursery at Trent Lake in Vilas county has been expanded and new nurseries at Wisconsin Rapids and at Gordon have come into production.

The first plantation was established in Vilas county in 1913, and was called the Star Lake Plantation. The planting stock came from the Trent Lake nursery and is now large enough to be cut for pulp wood. Within the next ten years merchantable material can be removed. The state forest planting program has been expanded so that there are now being planted on state land about five million trees annually.

With the challenging need for tree planting on much of the state owned land, or which it may soon own, appears also to offer a solution to a great social problem of the state. Crowded prison conditions and mounting costs to the state for prison maintenance have focused attention on the possibility of reducing this acute social problem by placing selected prisoners on state lands, and use their labor to protect and reforest. At the present three such camps are in operation.

The planting program has expanded since the CCC movement has been inaugurated. Camps on the state forests provide labor and technical advice for carrying on their reforestation program.
In 1938 there was planted on state forests 2,340,000 trees or approximately 2,340 acres. Stock was furnished from the state nurseries. (4)

County forests are of special importance in Wisconsin due to the fact that large areas of cut-over land, which are primarily more valuable for forestry than other purposes, are being dropped by the owners through non-payment of taxes. Many counties are among the largest land owners in the state.

County forests may be regarded as auxiliary state forests. There is a working partnership, with the county furnishing the lands and local supervision, while the state contributes funds and technical supervision, both share in the income. By April, 1939, 25 counties had 1,902,900 acres of county forests. The first forest was established November 6, 1929. (3)

Reforestation has been a major part of the county forest development from the establishment of the first county forest. There are thousands of acres of land upon which artificial established forests are the only hope of restoring the timber resources. At the close of 1938, a total of 51,200,000 trees had been planted through the combined efforts of the counties, Conservation Department and the Civilian Conservation Corps camps. Some areas had to be replanted because of the losses caused by drought and heat. Combined work programs between counties, state, and the C.C.C. are creating value on lands once considered not worth the taxes. The establishing of plantations on idle lands underlie these new values.
Because of the rate of forest planting in Wisconsin, it is erroneous to state just the exact acreage planted to date. By the end of 1938, nearly 250,000 acres had been planted by the federal state, county, and private owners. With the average of 1200 trees per acre, this will total over 300 million trees planted within the past 15 years. (4)

The State of Wisconsin realizes the major part the forest resources played in their early development and are now directing their efforts to revert the state lands back into their original productive capacity of forest products.

**Minnesota Reforestation.**

Minnesota, like Wisconsin and Michigan, has seen its forest resources ruthlessly removed by the lumberman. Timber played an important part in the development of the state. Originally Minnesota was covered with thirty-one and half million acres of forests (62 percent of the area of the state). Today only two thirds of this area is forest land and much of it has very little timber. (5)

The timber of the state has mostly been cut by the lumberman. Very little has been removed by settlers for the purpose of establishing agricultural land.

First sawmill in the state was built in 1821 at St. Anthony Falls and many mills were established until 1899 at which time production started to decline. To illustrate the increase in mills, the following figures will help: In 1843 the cut was one and one-half million board feet and in 1899 it had reached the enormous figures of 2,341,719,000 bd. ft.
Between 1837 to 1927 over 75,000,000,000 board feet of pine were taken from the North Woods. (11)

During this period the loggers slashed down the forests without any regard for a future supply of timber. They said, "There is more timber here than the country can ever use; lumber is needed for home building and industry which will bring progress and a higher standard of living; therefore, it is only practical to supply the demand." (11) This prophesy was erroneous and has been so recognized by the people of the state. of the state.

Now that their timber resources have practically vanished, they find their lumber yards stocked with Pacific Coast Douglas fir and Southern pine. At the same time, much of the forest lands are idle and abandoned. The people now realize what the depletion of their forests is costing them and will continue to until they again grow their own timber supply.

Many of the pine lands are being reforested through natural reproduction and planting. On the area that was cut-over and burned is reproducing inferior species such as aspen and jack pine, or has no reproduction other than brush. It is these areas that must be planted before timber production will again provide a livelihood for the inhabitants of the area.

There are thousands of acres of cut-over land in the northern forest region which cannot produce a timber crop unaided for many decades. In addition to these forest lands there are several million acres of potential farm land which will not be brought under cultivation for a long time to come.
There is no need to allow these lands to remain idle when they are suitable for timber production. This northern part of the state is not really suitable for agriculture anyway. Poor agricultural soils and short growing seasons make it undesirable for even marginal farming.

There are between five and six million acres of forest lands needing reforestation in the state.

The first plantation in the state was established at Grand Rapids, Minnesota, in 1898 by the Minn. Agricultural College. This was an experimental plantation, but was a beginning in the right direction. Reforestation did not gain much headway until 1933 when the establishment of C.C.C. camps provided labor for such work. Total area planted up to and including 1926 was 2,000 acres. In 1931 the first state nursery was authorized and established on the Badora State Forest. This nursery supplies 5,000,000 trees annually. Under present state nursery laws this stock can only be used for planting state lands.

Green Side Lake, Park Rapids, Finland, and Owen Lake nurseries have been established since.

The acreage planted on state land since 1936 totals approximately 37,175 acres. The lack of available planting stock prevented further planting projects.

Minnesota has been slow to start her reforestation, but now a program of planting is underway to include state and county highways, county, townships, school and municipal forests, state forests, state parks and drainage and water
projects as well as game refuges. This work will be carried on by the Division of Forestry, C.C.C. N.Y.A., W.P.A., State Highway Department, American Legion, and Boy Scouts. (6)

National Forest Reforestation.

Reforestation on the national forests dates back to 1910 and 1911 when the federal government began planting operations in Michigan and Minnesota. Up to and including 1926, there had been 27,000 acres planted on Michigan and Minnesota National Forests. (1) Since 1926 to the present day there has been increasing activities in reforestation. The reforestation program has been the most active since the existence of the C.C.C. organization and other emergency agencies.

Approximately 670,000 acres have been planted on National Forests of the Lake States Region. Of this amount approximately 430,000 acres have survived. (10)

Acquisition of addition lands has broadened the planting program. With such a large planting program to be carried on, the government was not prepared to say which methods, species, etc, would produce the best results. A great deal of their planting has been in the experimental stage, which probably accounts for the failure of some plantations. In the last six years many studies have been made and now better success is evident.

The Lake States areas affords such a large reforestation program that all these agencies state, Federal and private must work individually and cooperatively to accomplish their aim.
The reforestation procedure followed by the various agencies is approximately the same so will present the following material as it is carried on in the National Forests in the Region.

**Planting Objectives Of The Lake States Region.**

"The primary objective of the planting in the North Central Region is to get every acre of true forest soil into production of a Forest crop, at a cost that will allow liquidation of the investment, plus the carrying charges. However on areas having a particularly high value for other purposes, such as recreation or wild life, this objective will be considered subsidiary to the higher use.

The general planting policy is to make every acre serve the highest economic and social uses. As a general practice, however land bearing any species of tree growth, regardless of age, which is merchantable or gives promise of producing a merchantable crop at the end of its rotation age, will not be planted unless the area is at present less than 60% stocked. The presence of 60% or better stocking with desirable coniferous or hardwood species will automatically place the land outside the area requiring planting under the normal planting program."(7) Because the quality of aspen varies considerably with site, careful study should be made for indications of defect or breakdown before it reaches a merchantable size. Many stands especially on poorer sites will never become merchantable and hence should be listed as areas requiring planting.
Areas now 60% or better stocked with commercial species may be considered for planting or direct seeding, using acorns or nuts to increase the proportion of valuable species. Percentage of stocking will be determined in the basis of milacre plots:

1. Which support one or more established trees of a commercial species of seedling size. A seedling will not be considered established unless it is at least 5" high and of such thrift that it can be "brought through" by justifiable stand improvement operations.

2. Which support sapling growth of a commercial species at the rate of one sapling for two milacre plots properly spaced.

3. Which support poles at the rate of one pole to form or five milacre plots properly spaced and depending upon the size of the poles.

4. Which supports tree growth 10" and over d.b.h. at the rate of one tree to 15 milacre plots.

This means that 60% stocking will require 600 seedlings, 300 sapling, 120 poles or 42 trees 10" and over per acre. Un-even aged stands will be figured on the percentage bases. (7)

Planting should be defined in areas which it is expected will reseed naturally within a 5 year period if the area is readily accessibly or within 15 to 20 years if more or less inaccessible.
Plating Surveys.

In formulating plans for any work there must be made some preliminary surveys that will furnish information needed to successfully carry out the work. In forest planting it is necessary to make planting surveys before any planning can be done for ground preparation or the actual planting.

Extensive Survey.

An extensive planting survey is just made that will serve to outline areas which are not fully productive. This data is compiled by sections and townships that require planting. The survey can be done with very little field work by simply referring to the acquisition, timber or inventory survey reports. From these reports a general picture of areas reading reforstation can be secured. No great expense is gone to in making this survey, because the intensive survey furnishes the data that determines the actual planting areas.

Intensive Survey.

Intensive planting surveys are made in order that accurate data may be attained on areas requiring planting. Species to be planted, the age classes of stock to be used, and all conditions affecting a planting job are obtained from this survey.

Survey is usually run by two or three men, depending on the topography of the area. When pacing is sufficient, two men can easily do the survey. Equipment needed: pocket compass, chain, short handle, round nose spade, cruising axe, a number of small paper bags for soil samples and a knapsack for carrying lunch and soil samples.

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A great deal of time can be saved in making this survey if old maps are used as basis for determining type lines. Of course the accuracy of these maps must be checked in the field during the survey. Two strips are run through each forty. Timber types are checked and corrected on old maps, or if no maps are available, it is necessary for the mapper to make a type map. All drainage, swamps, old roads, ridges or any other topographic features are put on the map. Present ground cover, both high and low, are studied and recorded. This factor is important in determining age classes to be planted and probable release work required after plantation is established.

Determination of proper ground preparation is made during the survey. Furrowing should be used to greatest possible extent where it is most economical. Scalping should supplement when furrowing is impracticable. The most logical direction of furrows is determined from the topographic features and windfalls. Standard legends are used to show furrowing and scalping areas.

One of the most important factors in making this survey is to determine the species to be planted. To do this a soil survey is made during the intensive survey. Soil samples are taken each time the timber type or soil changes, or if there is any doubt, a check can be made every few chains to be sure the soil types will be accurately made. To get a representative soil sample, samples are taken at 6", 12", 18", 24", 30", and 36" depths.
A small sample from each depth is placed in a small paper sack and kept for testing in the office. Testing in the office is much faster and eliminates the necessity of carrying additional field equipment.

The age class of stock to be used will be based on previous experience on the forest.

Presence of Ribes on a proposed white pine area must be recorded. Also any grubs found should be indicated. In the Lake States the Snowshoe rabbit is an enemy of the plantations so their presence on the area needs to be noted in the report.

In other words the intensive survey is made with the idea of collecting all the data available for determining the planting program. With the field work completed there remains the office work to complete the survey.

The office work consists of completing the soil survey and preparing the final map and report.

Office Soil Test.

The soil texture is determined by the hydrometer field test. The soil is forced through a 18 mesh sieve to separate the gravel and other coarse material. 40 grams of the sieved soil is measured by a spoon and placed in a 125 cc. wide neck bottle, adding approximately 1 gram of dispersing agent. The bottle is then filled to the 100 cc. mark with water and a stopper inserted. The bottle is shaken vigorously for one minute, and then allowed to settle for 1 minute. This solution is then poured into another specified cylinder, filling it to the 60 cc. mark.
The hydrometer is immediately floated in the solution and reading recorded. The following classification is used in the reforestation practices.

<table>
<thead>
<tr>
<th>Percentage of fine material found by test</th>
<th>Soil class.</th>
<th>Reforestation Possibilities.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5</td>
<td>Coarse sand</td>
<td>No profitable reforestation.</td>
</tr>
<tr>
<td>5 to 10</td>
<td>Medium sand</td>
<td>High light demanding pines or other pioneer species with low requirements for moisture and nutrients.</td>
</tr>
<tr>
<td>10 to 15</td>
<td>Fine sand</td>
<td>All pines except shade tolerant species.</td>
</tr>
<tr>
<td>15 to 25</td>
<td>Sandy loam</td>
<td>All pines.</td>
</tr>
<tr>
<td>24 to 35</td>
<td>Light loam</td>
<td>Hardwoods and conifers with lesser requirements for moisture and nutrients.</td>
</tr>
<tr>
<td>35 and more</td>
<td>Heavy loam</td>
<td>Shade tolerant conifers and hardwoods with high requirements for moisture and nutrients.</td>
</tr>
</tbody>
</table>

In making the soil test, it is also necessary to determine the soil acidity as it is valuable as a site indicator. The size and density of stumps on an area cannot be used as an indicator of the species to be planted because of the site deterioration due to repeated fires.
Professor S. A. Wilde of the Department of Soils at Madison, Wisconsin has made a thorough study of soils and has worked up a set of rules and a table combining the pH and colloid content percent. The rules and table follow: (7)

1. Neither mineral nor organic soils more than pH 3.7 support normally developed forest stands. Areas of this acidity are covered with low shrubs, Lichens or boy thickets.

2. Soils of pH 3.7 to 4.5 are usually correlated with acidophilous conifers such as Black Spruce, Tamarack, Hemlock, etc., or some light demanding hardwoods such as aspen, paper birch, etc.

3. Soils of pH 4.5 to 5.5 are well adapted to the majority of conifers and many of the hardwoods, with the exception of the better hardwoods such as white ash and basswood.

4. Soils of pH 5.5 to 6.9 support a vigorous activity of Micro-organisms, humifications and high availability of mineral nutrients, facable structure and good aeration. High yields of timber, especially the better hardwoods are found on these areas.

5. Soils of pH 7.1 to 8.0 support mainly stands of southern hardwoods. Conifers are generally unsatisfactory in this range.

6. Soils of pH 8.1 to 8.5 are toxic to all forest trees.

7. Soils of pH higher than 8.5 are absolutely unproductive from the forest standpoint.
### Planting Possibilities at Various Reactions and Colloid Contents of Soil

<table>
<thead>
<tr>
<th>Reaction</th>
<th>0-3</th>
<th>4-7</th>
<th>5-15</th>
<th>16-30</th>
<th>30-plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 4.5</td>
<td>None</td>
<td>None</td>
<td>None or Scotch pine</td>
<td>None or white pine</td>
<td>None</td>
</tr>
<tr>
<td>4.5 - 5.4</td>
<td>None</td>
<td>Scotch pine</td>
<td>Scotch pine</td>
<td>White pine</td>
<td>Yellow birch</td>
</tr>
<tr>
<td>5.5 - 6.9</td>
<td>None or Cottonwood</td>
<td>Jack pine</td>
<td>Norway pine</td>
<td>Norway pine</td>
<td>Spruce</td>
</tr>
<tr>
<td>7.0 - 7.9</td>
<td>None or Cottonwood</td>
<td>Jack pine</td>
<td>Jack pine</td>
<td>White pine</td>
<td>Hardwoods</td>
</tr>
<tr>
<td>8.0 and up</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

The soil pH or reaction test is made by placing a small portion of soil in a small container and adding a liquid chemical, making a paste. A chemical powder is shaken on this which causes the final reaction. The soil will change to various colors according to variation in reaction. A color chart is used to compare the colors and give the pH figure.

**Final Report.**

With the field work and soil tests completed, the final report must be completed. This report is very important to the planting program. A map of the proposed area is made with the proposed work designated by symbols. Site classification, year and season recommended for planting, species recommended, age of stock, ground preparation, accessibility and any special features of the area that might affect the planting.
This report is filed for future use not only for proposed plantings but to check the accuracy of the survey from actual results from the established plantations.

In region nine, intensive planting surveys have been made on 508,514 acres. This region leads all other in planting surveys due to the necessity of reforestation in that area. The 5 year average planting program was only 102,209 acres, making the intensive surveys five years in advance of the planting.(8)

Many times the intensive surveys are made years ahead of the actual ground preparation and planting. Material changes in site conditions are possible during this period so to correct for these changes a intensive reconnaissance is made of the area when it is to be planted during the current year.

Planting surveys are a very important phase of the reforestation program. Trees planted on areas not suited for them can not assure good survival or success of the plantation.

**Ground Preparation**

With the surveys completed and the areas determined that are to be used, ground preparation must be considered. Reliable data from the intensive survey will indicate the types of ground preparation to use on the various areas.
Furrowing.

Past experience indicates that furrowing results in better conditions for growth and survival, and has greatly reduced the cost of ground preparation. Due to these reasons furrowing is used when possible. Judgement must be used in furrowing to eliminate areas which are too rocky or which contain too many logs and stumps. Too steep a topography will also limit the use of furrowing. Tractors, which are fully armored to give protection against rocks and stumps, are used. "35" Cletrees or similar size Crawler type tractors handle the work well. The plows used in the past have been of the Kilifer make and have gone through many stages of improvement. The plow is constructed on the same lines as the Kilifer fire plow but is made of much heavier material and reinforced to stand hard usage. The wings on the mollers are constructed so they slide up and down with the movement of the plow. These wings catch the sod and throws it from the furrow. This is important because if the sod falls back, planting is slowed down and many times plantable area is lost.

Depth of the furrow must be kept at a minimum necessary to remove the sod and shrub roots; this rarely exceeds four inches. Spacing between furrows will vary with the species to be planted. Usually the furrows are the greater distance apart and trees planted the shorter distances.
Furrowing is best adapted to the lighter, sandy soils. It is used in heavier soils only when contour furrowing is done. In heavier soils subject to erosion, it should not be used.

In furrowing an area which has a stand of timber, especially a poor aspen stand, attention must be taken of the respective tree sizes and stocking. If the stand is too heavily stocked with trees over two to three inches d.b.h., consideration must be made to determine the feasibility of furrowing. In a stand of this type a poor job of furrowing is done and excessive breakdowns are had. This is not advisable.

Three or four furrowing units working together makes a satisfactory set-up. This facilitates better supervision and maintenance. Close supervision is needed to insure good work. With the units working together, it is much easier to service the tractors and transport the men too and from the job.

Consideration must be made to the lengths of furrows. The longer the furrows the more accomplishment and less wear and tear on machinery. Excessive turning around takes time and is hard on the equipment.

Furrowing should be planned so there is at least a month to six weeks for the soil to become stabilized. Ordinarily, only sufficient furrowing should be done to provide area for the stock to be planted. If too long a time elapses before planting, vegetation will become established.
In the Lake States a good unit consists of a tractor operator and one man to scout ahead of the unit to point out stumps, rocks and the desirable reproduction which is to be saved.

Accomplishments are governed by the furrowing chance, condition of equipment, ability of crew and weather conditions. One unit can furrow four to six acres per day on a good chances. A five year average of $4.31 per acre for ground preparation has been made in Region 9.

**Scalping.**

Scalping was used to a great extent before the tractors came into use. It is now used on areas where rocks, windfalls, brush, or weed tree growth makes furrowing impracticable. It is also used in conjunction with furrowing. Where large or small areas are missed in furrowing, scalps are used to fill-in such areas. Scalping has the purpose of preparing a spot large enough and deep enough to remove competing vegetation and surface roots. Scalps should not be less than 18" square up to 24" square where vegetation is dense. Spacing of scalps will be governed by the species to be planted. No scalps are made within six feet of any established reproduction of commercial value or within six feet of the crown spread of a tree of pole size, 4.5" to 9.5" in diameter.

Crews to not exceed 15 men are satisfactory for scalping. Each crew is under a foreman to keep them in line and properly space the scalps. Guide lines can be used, but a crew will usually get to the point where no guide lines are needed.
If the crew keeps in alignment, there is no reason for irregular scalps.

Scalping is done with a mattock or grub hoe, or with the so-called Finn hoe. The Finn hoe is nothing more than a shovel head mounted on a handle so it can be used as a hoe. In areas where it can be used, it produces better accomplishments and requires less effort.

Accomplishments vary with the sites but an average man should be able to make approximately 600 scalps per day. This is based on C.C.C. manday of six hours.

Scalping is expensive and does not give the satisfactory results of furrowing, so its use is limited.

**Field Planting.**

**Source of Stock.**

In the Lake States area each National Forest has a nursery or is developing one, except the Clark and Shawnee. Each nursery will be able to supply the required planting stock for the individual Forest. Seeding in the nurseries will be on the basis of definite areas to be planted.

State nurseries have been established that furnish stock to private owners, County, municipal and State forests. The chart on the following page gives the stock costs.
Total cost of commonly used planting stock on National Forests, in Region 9.

<table>
<thead>
<tr>
<th>Species</th>
<th>Age class</th>
<th>Average cost per M 1938</th>
<th>5 yr. ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pinus Strobus</em></td>
<td>2-0</td>
<td>$4.33</td>
<td>1.62</td>
</tr>
<tr>
<td></td>
<td>3-0</td>
<td>2.60</td>
<td>1.81</td>
</tr>
<tr>
<td></td>
<td>1-2</td>
<td>4.92</td>
<td>4.65</td>
</tr>
<tr>
<td></td>
<td>2-1</td>
<td>6.10</td>
<td>3.11</td>
</tr>
<tr>
<td></td>
<td>2-2</td>
<td>4.32</td>
<td></td>
</tr>
<tr>
<td><em>Pinus Resinosa</em></td>
<td>2-0</td>
<td>$3.07</td>
<td>1.03</td>
</tr>
<tr>
<td></td>
<td>3-0</td>
<td>2.60</td>
<td>2.09</td>
</tr>
<tr>
<td></td>
<td>1-2</td>
<td>11.96</td>
<td>5.18</td>
</tr>
<tr>
<td></td>
<td>2-1</td>
<td>5.97</td>
<td>4.85</td>
</tr>
<tr>
<td></td>
<td>2-2</td>
<td>8.22</td>
<td></td>
</tr>
<tr>
<td><em>Pinus Banksiana</em></td>
<td>1-0</td>
<td>$2.78</td>
<td>.75</td>
</tr>
<tr>
<td></td>
<td>2-0</td>
<td>3.45</td>
<td>1.72</td>
</tr>
<tr>
<td></td>
<td>1-1</td>
<td>6.17</td>
<td></td>
</tr>
<tr>
<td><em>Picea Mariona</em></td>
<td>2-1</td>
<td>$6.53</td>
<td>3.04</td>
</tr>
<tr>
<td>&quot; Glauca&quot;</td>
<td>3-0</td>
<td>6.51</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-1</td>
<td>5.45</td>
<td>6.70</td>
</tr>
<tr>
<td></td>
<td>2-2</td>
<td>5.97</td>
<td>8.20</td>
</tr>
<tr>
<td></td>
<td>3-1</td>
<td>9.72</td>
<td></td>
</tr>
<tr>
<td><em>L. Laricina</em></td>
<td>2-1</td>
<td>$6.53</td>
<td></td>
</tr>
<tr>
<td><em>T. Occidentalis</em></td>
<td>3-0</td>
<td>2.87</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-1</td>
<td>13.85</td>
<td></td>
</tr>
</tbody>
</table>

Seasons of Planting.

There are two planting seasons in this region, fall planting and spring planting.

Fall planting must be on light soils to prevent frost heaving. Planting can start early in September, providing there has been sufficient rains to provide good soil moisture conditions and properly hardened stock is available. White and Norway pine have usually hardened off as early as first week of September. This means that planting can start early in September and continue to near the end of October. The duration of the season is based on the acreage to be planted,
availability of stock, weather conditions and available labor. In this region the fall snows start in late October or early November and freezing temperatures make planting impracticable.

Spring planting season usually opens around the first of May. This season is shorter than the fall season and less accomplishment is had due to the early fire season interrupting the planting program. The frost must have left the ground before planting starts. Soil moisture conditions are usually good due to the moisture from the winter snow. One difficulty encountered in spring planting is the accessibility to the planting sites. Even the best roads become very soft and make traveling slow. Spring planting sites should be selected with accessibility in mind.

It must be remembered that if anytime during these planting seasons, the conditions are unfavorable, the planting should be discontinued until conditions are favorable again. This will prevent excessive losses and increased expenses of the program.

Although planting comprises a number of simple but important operations, it is one of the most technical in the profession. Each season some minor changes are noted, so to place capable men in the field it is necessary to hold training schools for the personnel. This school presents all changes in policies, methods, and plans for the region or area and gives each foreman a chance to actually plant some trees.
After he has planted trees himself, he is in a better position to demonstrate the procedure to his crews. These schools are held before each planting season.

**Stock Delivery and Care in Packing and Planting.**

Before each planting season starts, the daily planting budget is made. This will specify the species, age, and number needed per day. Stock will be secured from the nursery so there is no more than 48 hours elapse between receipt of stock and the planting of it. This means that regular trips are made to the nursery every other day.

The stock is all graded in the nursery and ready for planting when received. Upon receipt of stock it should be inspected for heating and moulding. Stock can be rejected anytime it is unsatisfactory. Each shipment is accompanied by an inspection report which must be filled out by the receiver and returned to the nursery superintendent. Bales or crates of trees must be stacked so the air can circulate freely. Stock must be kept moist at all times. Heating and moulding must be watched for. Moulding is produced when moist air at a temperature of 45°F or higher is had. Cooling systems must be had that will maintain a temperature below 45°F at all times. Ice can be used for this purpose as this country is well provided with ice. Spring planting stock is usually subjected to moulding more than fall.
In the fall precautions must be taken to protect stock against freezing. This can be done by making a small underground cellar. By leaving the door open at night and closing early in the morning, air circulation is had and a low temperature is maintained throughout the day.

Through experience it has been found that having packing crews in the field has minimized the confusion of each planter pack his stock. Packing crews go to work early in the mornings and have the planting trays packed for the planters. Actual count of stock going to the field is obtained as each tray is packed with the same number, depending on size of stock. Shelters are provided for packers and each tray is waters and placed in the shade ready for the field.

The location of this packing shed should be as close to the planting site as possible and near a good supply of water.

Deliveries from the shed to planting crews are made by truck and again placed under cover for protection.

Care must be taken to pack the old stock before the new. This will prevent stock loss and allow the newer stock to be held for the required 48 hours.

Each evening the stock not planted in the field is returned to the packing shed. These trays are repacked in the morning and sent out first.

The packing crew should water the stock before leaving each night and see that it is protected against hear or cold.
The care of the stock does not stop with the packers but must be continued in the field. Stock must be well covered with wet moss at all times. No roots are allowed to be uncovered. The planter must be careful to not tear the roots or skin them when taking the tree from the tray. The trees are separated as they are packed, making it possible to take individual trees from the tray.

No grading is done by the planter. All stock in the tray should be planted. If any questionable stock is found, the foreman should be the judge.

Proper care and handling of stock is essential to an efficient planting operation.

**Methods of Planting.**

In all planting work, regardless of the method used, there are some cardinal points to follow. They are: (1) location of a spot to plant the tree. In furrows set equidistant from either side and in scalps set as close to center as possible. (2) The size and depth of hole. (3) Depth of planting. Trees are usually planted slightly deeper than they grew in the nursery. Never plant tree so green or dead needles are covered, nor so high as to expose lateral roots. Leeway in 1-0 and 2-0 stock is seldom more than \( \frac{1}{4} \) inch.

Planting methods selected must be adapted to the soil, species and size or age of stock. The following methods are used.

**Center or Square Hole Method.**

Used on heavier soils with stock having large spreading root system and where no previous ground preparation has
been done. Mattock or grub hoe is used and the planting box or tray. Planter carries planting tray in left hand and a mattock in the right. The sets are: (1) Set tray down to the left and slightly ahead of the proposed hole. (2) When necessary, chop off top sod and litter for a space of 18" - 24" square, with three to five strokes of the mattock. Remove as little soil as possible with the sod. (3) Sink blade of hoe to full depth near center of bare spot. Blade should be nearly perpendicular to surface of the ground. (4) Lift up and pull back and slightly to the right on handle, removing soil from the planting hole. Soil is deposited to right near edge of the hole. (5) Repeat No. 3 and 4 to enlarge hole. Hole should be 8" to 10" deep and 6" to 8" wide, large enough to contain all the roots without bending. (6) At completion of last stroke, drop hoe to right with handle to rear. Bend over or preferably drop on right knee. (7) Select trees from tray with left hand using right to hold remaining trees in tray and keep moss on roots. (8) Grasp tree firmly between thumb and forefinger of left hand just above collar, and hold in center of hole, with root collar just below the soil surface, and hold until it is tamped. Spread roots with right hand. (9) Scoop in a few handfuls of soil, using right hand to place soil carefully around roots. (10) Tamp this with doubled fist. From these to five tamps are sufficient. (11) Continue holding tree erect in center of hole and scoop in the remaining dirt. (12) Holding tightly to top of stem, raise to semi-erect position, placing both feet on earth, which has been filled in and pack dirt firmly around roots. (13) Test tree by pulling gently on upper needles.
This method can also be used in furrows and scalps. The main difficulty with this method is getting the holes deep. Shallow holes cause the roots to be bunched or curled up, thus causing poor survival.

**The Mattock Split Method.**

Method used for top-rooted species. Same equipment is used as for the center hole method. This method is faster than the center hole method, especially where smaller stock is used. The steps are as follows: (1) Set tray down to left and slightly ahead of place for slit. (2) Sink blade full depth and as nearly perpendicular to the surface as possible. (3) Pull back on handle raising it not more than 3" above the ground, opening the slit. (4) Drop to right knee and with right hand grasp handle near blade. Take tree from tray with left hand. (5) Grasp tree between thumb and forefinger at root collar, insert roots in slit, pushing well down below the ground level to insure getting roots to the bottom of slit. (6) Raise tree so that root collar is at ground level. Remove mattock, laying to right of slit. (7) Partially close slit by tamping with right fist. Transfer grip of left hand to tip of stem, straighten up and complete closing of slit with vigorous thrust of heel of right foot applied in a downward and forward direction three inches from root of tree. (8) Test tree for firmness, grasp hoe with right hand, tray or box with left and step off distance to next planting spot.
This method was used in early planting practices, especially with 1-0 or 2-0 stock. Carelessness in depth of hole and curling of roots made survival poor. This method was fast with a man planting 500-600 or more trees in a six hour day. Method was used when quantity rather than quality planting was stressed.

**The Bar Split Method.**

This method is used on sandy soils where 1-0 or 2-0 stock is used. It is well adapted to scalps and furrows. Tools used are the Huron bar or Michigan planting bar and planting tray. The steps are as follows: (1) With the right foot on the ground, left reaching forward, thrust bar perpendicular into the ground full length of blade. (2) As left foot hits the ground, push bar forward with stiff arm to a 35 degree angle. At the same time place planting tray to left and slightly ahead of spot to plant. (3) Slide right hand halfway down the handle and force blade two or three inches into soil before bringing bar into perpendicular position. The downward thrust of the blade produces a new fulcrum from the point of the bar. This step is necessary to secure a rectangular hole three to four inches wide and 8" to 10" deep. (4) Select tree from planting box with left hand, holding between the first and second finger. Put roots in hole so they are all hanging straight down. Back of hand will be resting on the ground at left of hole. (5) While in this position and holding the tree erect, remove bar and thrust it perpendicular into the soil 3 or 4" back of the tree.
(6) Pull handle back about 6" to close bottom, then thrust in forward to fill top. Test tree by pulling on 3 or 4 needles.

(7) In moving forward, thrust right foot forward to close hole created by packing movement. Firm the tree slightly with foot but do not stamp. Step off to next planting spot.

Planting with this method is very fast in sandy soils with some men planting 1000 trees in six hours. A fair average through would be around 500-600. Technique is important with this method because any lost motion increases time required to plant a tree. This method was used extensively in the Lake States in the sandy areas and where large stock could not be secured. It can be said that this method sacrificed quality for quantity. Depth of hole and carelessness in doubling roots gave trouble with this method.

**Inverted "V" or Saddle Method.**

This method can be used in any of the soil types in the region. Works best in sandy loam. Large stock with good roots systems is used. This method has been very appropriate for transplant stock. Can be used in furrows or scalps, preferable furrows.

Since 1936 this method has been used more and more and has been established as a very successful method. Tools used are the usual planting box or tray and a mattock. The follow instructions give the steps in planting: (1) Hold planting box in left hand and mattock in right, near the head for easier carrying.
(2) Place the planting box on the left side of furrow and slightly ahead of position tree is to be planted. Drive mattock into ground as deep as possible, preferably having the handle parallel to ground. Draw mattock from ground with a slight motion toward the planter, placing the dirt eight inches from the hole. It may take two strikes of the mattock to get the hole deep enough. With the first hole completed the mattock is again driven into the ground just so the mattock blade strikes the slope nearest the planter about an inch below the ground level. Then the mattock is drawn out placing the dirt directly behind the hole. One or two strokes of the mattock may be needed but the fewer the better. In drawing the mattock out, care must be taken to keep the handle parallel to the ground level. This prevents the breaking of the inverted "V" or saddle down. (3) Place mattock in right of furrow with blade away from planter. Kneel with right knee to the left of the pile of dirt. (4) With left hand take tree from box, using right to keep moss in contact. Spread roots with right hand and place over saddle. Roots should not be bunched or turned up. Tree in center of saddle. Tree is held between the first and second fingers with the root collar just below the back of fingers. Back of left hand should be flat on the ground and held so the tree root collar will be just a little below the ground level.
(5) With the tree in position place the right hand behind the pile of dirt and push forward carrying the dirt by the right of the tree. In so doing allow dirt to go in first hole and second hole. As this motion is completed, double the first and tamp front hole with one tamp and then back hole. Then scrap in remainder of dirt, keeping left hand in same position as given in step 4. (6) Come to your feet and place left foot about one inch from tree and at right angle to furrow. Same for the right on opposite side of tree. The ball of the foot is so placed that when the weight is shifted to the ball of the foot the ground is packed. The left hand can now be moved to the top of the tree and the feet are both move away from tree and soil packed again. This packs all the loose soil placed around tree. Test tree for height and solidness. (7) With left hand reach behind and get planting box and right hand pick up mattock near head. Turn to left and step to next tree position.

Accomplishments are not so very high with this method, but the trees as a whole are better planted and give better survival. In my experience with the method, C.C.C. labor will plant on the average from 300-400 trees per six hour day. The accomplishment is governed by soil conditions, size of stock, and ability of the planters. Some planters just fall naturally into the method and can plant 500 to 600 per day. Close check must be made on the planting to insure good work. The main points that have to be watched are the depth of holes, flatness of hole, peak of saddle below ground level, spreading of roots on saddle and correct packing of soil. With a well trained crew quality planting is easily had.
All of the above methods have been used in the Lake States. With the methods explained it might be interesting to know something of crew organization and training.

Crew Training.

In all planting projects, adequate training must be given the crews. The foreman should explain the procedure and then demonstrate sufficient times to insure it is understood. Then the crew can practice technique before planting. A study of training showed the following results: brief instructions gave 56% planting, 1 1/2 hours instruction and practice gave 65%, and 2 1/2 hours instruction and practice resulted in 76%. This shows the advantage in adequate training.

Experience has proven that crews of 10 to 15 men are the most practical. Each crew has to be under a subforeman and a foreman can supervise three or four subforemen. The crew should be organized so the fastest planter will be the lead man. He can be a pace setter and the man to keep tree count for the crew. The rest of the crew is placed according to speed also so the slow men will be on the outside. Help can be given the slower man by the faster, after they have finished their rows. It is not a good policy to allow the fast men to get too far ahead. When the crew gets spread out, supervision is difficult. At the end of the day the work should be spread off so the next day's work will be easily located.
Daily or semi-daily inspections should be made by the foreman of the crew planting. Ten trees should be checked and a grade recorded for the planter. Regular inspection forms are used and record kept. On the planting job you can expect periodic inspections from the ranger, supervisor or regional men. Planting holds a high priority among work projects so frequent inspection must be expected.

In planting, the measure of success is survival and growth of the planted trees. Quality of the planting job should be emphasized rather than acres planted. The development of technique and skill is followed by an adequate output. The following are planting costs for Region 9.

1935...............$10.54........This included ground preparation.
1936.................7.16......." " " " "
1937.................6.12.......Planting only.
1938.................6.23....... " " "

*Planting Quarterly......November 1, 1939.

**Plantation Marking.**

All plantations should be adequately marked for future inspections. In the past they were marked with white posts at each change in direction of the boundary. This method was too costly and unnecessary. The new method uses only two to four posts per plantation. A compass traverse is made of the plantation and posts are only placed at the main points where they can be found easily. The posts are usually made of cedar and have a flattened face on the side which extends down about 18 inches from the top.
This surface is used to scribe the plantation identity in.

**Plantation Examinations and Survival Counts.**

Plantation examinations have two purposes in mind. They should produce data which will accurately depict the degree of success of the planting effort for statistical purposes and to determine the percentage of stocking on all portions of the area, taking into consideration the natural reproduction of valuable species, as well as survival of planted trees.

Survival counts are governed by many conditions. After a good year following planting the survival will tend to be good requiring a less intensive survival count. With a poor year following planting, survival will usually be poor so making an intensive survey is unnecessary. With patchy survival, 30% to 60% is necessary to use a survey that will cover the entire area.

In the past survival counts were made for the first, third, fifth and tenth years. This required time and was expensive so now they only take first and fifth year counts and any subsequent ones needed due to droughts or other disasters.

First year survival counts are made on all plantations established for a year. A preliminary reconnaissance is made using the random sample method. Samples are required by cover type, exposure, size of crew and any other factors that might affect the survival. 100 tree plots are taken and survival determined for the plantation.
Where survival is 60% or better or less than 30%, the reconnaissance will be final but between 30% and 60% a detailed line plot survey is required to determine the accurate survival and necessity or advisability of replanting. Subsequent years of drought or other disasters will require more reconnaissance surveys.

Fifth year and final survival counts can be made by the reconnaissance method where the first survival was 60% or better and where proper attention has been given the plantation. On areas which have not had care, a detailed line plot method should be used.

Plantations with survival between 30% to 60% will be sampled by one of the following methods.

**Staked Row Method.**

Staked row method will be used in areas less than 40 acres. Trees will be staked to make a counting plot which will approximate the length of the longest dimension of the planted area.

On areas larger than 40 acres the stake row method can also be used with light trees per acre staked. These will be so located that they will make 25 tree groups. First tree in each group will be staked. Natural reproduction will supplement dead trees when they are within three feet when six foot spacing is used and four feet when eight foot spacing is used. The exposure, cover type, need for release and growth, will be recorded for each plot.
20 Tree Group Method.

20 tree-group line plots are used where plantations are located on two or more sections and the section lines are located. Four strips per forty are run by compass with four plots per strip. Tree groups are marked on the ground so they can be found again. At the designated point on the strip line, the observer steps to the nearest furrow to his left and counts five trees in counter-clockwise direction; then he steps to the left to another furrow and counts ten trees counter-clockwise; then step to left into original furrow and counts five trees which brings him back to the original starting point.

In tallying the 20 tree groups, a tally of natural seedlings, the same as for the staked row method will be made. Planted trees are classified as thrifty, unthrifty and dead. Growth data can also be secured and the cause of tree death recorded. This is not required but is valuable information if the increased cost is not too exorbitant. Exposure, cover type, and need for release is also recorded in the field.

A map is made in the field as the survival survey is made. A map sheet form 878 or similar form is used. If a four inches to mile scale is used, each small square will equal 2½ acres, and the plots can be made so they fall in the center of these squares. As the percentage of stocking is figured in the field, it is entered in the correct squares, thus denoting stocking in the field.
In making the map, the plotted data forms the main basis and visual inspection will help to determine areas according to stocking. Separating areas of unequal survival is not carried to an extreme refinement. Primary purpose of mapping is to locate the areas needing replanting.

Thrifty and unthrifty trees are combined in calculating percentage of survival. On plantations having a large proportion of unthrifty trees, special notice must be made so that the plantation can be watched to determine how many of the doubtful trees pull through or die.

The size of crew can be very small for this survey. A well qualified technical man should make the survey. Many times a one man crew is suffice. He can run his own compass and pace for distance. This is economic and gives results. In difficult chances, the crew can consist of two men. No one size crew can be designated because of the varying conditions. The criterion of the survey should be accurate work and results that will be usable in determining the success of your reforestation program. The following survival data is given for Region nine to December 31, 1938.

<table>
<thead>
<tr>
<th>Acres By Survival Classes</th>
<th>Percent By Survival Classes</th>
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<tbody>
<tr>
<td>Acreage</td>
<td>Trees per Acre</td>
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<tr>
<td>500</td>
<td>250-499</td>
</tr>
<tr>
<td>Plantation One And Two Years Old</td>
<td></td>
</tr>
<tr>
<td>135,618</td>
<td>10,986</td>
</tr>
<tr>
<td>Plantation Three And Older</td>
<td></td>
</tr>
<tr>
<td>237,198</td>
<td>84,707</td>
</tr>
</tbody>
</table>
Approximately 670,000 acres have been planted in the Lake States Region to 1940, and of this approximately 430,000 acres have a stand of 250 or more trees per acre. (10)

A survival experiment was carried on in the Ottawa National Forest to determine the survival of different age classes. Three different age classes of Red pine were used. Survival after one year was 3-0 79%, 2-0 85.2%, and 2-1 89.3%. This experiment fortifies the idea that the early plantings of 1-0 and 2-0 stock was not suited to give good survival. (9)

Factors Contributing to Poor Survival.

Once trees have been planted, you can not expect them to all survive but a larger percent would survive if it were not for a number of damaging factors.

Drought.

Since the large reforestation program started in 1933, the area has experienced one or two droughts. Trees must have moisture if they are to survive. A great deal of the area is of sandy soil which does not hold moisture very long. Coupled with the drought was the use of small planting stock which did not have sufficient root systems to reach out for moisture. Survival was very low on many plantations due to these factors. Drought cannot be controlled by man, but he can select areas which would afford more protection to the trees. The use of transplanting and 3-0 stock has helped to decrease mortality during dry seasons.
Grubs.

The white grub is a destructive invader of plantations. It works under-ground, eating the roots. No tree can survive with the root system damaged. It has been indicated that one or more grubs per square foot will cause a 25% loss in a plantation.\(^7\) When white grubs have been a factor in plantation failure, a grub survey is required. One foot square samples at one chain intervals on two stumps across a forty will constitute an intensive grub survey. On the map made, the location and number of grubs by genera are recorded. If any given tract of ten acres or more has one or more grubs per square foot in more than 50% of the sample holes, it should be withdrawn from planting during the current season. Areas of ten acres or less showing excessive grub population, should be planted with 25% more trees.

A great deal of care should be taken in making the intensive planting survey to try and determine grub population. This would save a great many trees and reduce the expense of planting areas infested with grubs.

Snowshoe Hare.

Snowshoe have caused a great deal of losses on plantations. It seems to be the nature of the animal to destroy. Many times I have seen ten or more trees nipped off and let lay. Of coarse after it snows the rabbits feed on the uncovered trees. Control has been tried by shooting and snaring, but nature does the best job of control. The hare seems to go by cycles. It is during the decline in hare population that the plantations get the best start.
Deer.

Deer are another intruder of the plantations. They work on the same principle as the hare but there is no definite means of control. Regulated deer seasons does help to reduce the deer population, but it soon builds up again.

Livestock.

Domestic stock cause some damage by trampling the small seedlings. No grazing restrictions are enforced so native stock goes at large. Plantations near local settlers suffers the most. This damage is small compared to the others.

Drought and severe winters as have been mentioned, are destructive factors of which we have no control.

Follow-up Work in Reforestation.

Releasing of Plantation.

Once a plantation has been established it is necessary to take care of it. In this region, the ground vegetation and brush is very dense. It is this type of cover that chokes the seedlings. All sunlight is obscured and root competition rob the planted threes of life giving materials. This low cover is much more damaging than high cover, because high cover does allow sunlight to filter through. Release of many plantations is required one year after establishment. The degree of release is governed by the density of overstory, exposure, species, age of stock and season of year. Good judgement is necessary to determine the varying releases due to varying conditions.
Many different tools have been used in this work. Scythe, brush knife, machete, and brush hook have been tried with the scythe proving superior.

Release crews of ten men have proven satisfactory. Each man is given a row to release. With the use of such tools as scythe, it is necessary to stress safety in the crew. The release walks up the row searching for trees by spreading the vegetation with his feet. Trees needing release are difficult to find if the crew gets careless. A good way to search for trees is by their spacing. Continual check must be made of the following points: (1) Trees not released, (2) Trees cut off, (3) Brush left laying on released trees, (4) Release too light, (5) Release too heavy. Cutting of trees seems to be the biggest fault. This is due to carelessness of the worker.

Release work has to be carried on each year until the trees get above the competing vegetation and brush. This may require two or three releases.

A release study was made in the Chippewa National Forest which showed that 470 acres were released by 890 C.C.C. man days, or an average of 1.9 man days per acre. Accomplishments will vary with the degree of release so no accurate average can be given.

Release has prevented many plantations from stagnation. Release is to reforestation what weeding is to gardening.
Replanting.

After the survival surveys have been completed, it is possible to determine the successful and failures by plantations. A plantation is considered a failure when less than 400 trees per acre survive. The failure areas are examined to analyze the likelihood of survival of the replant. Replanting is carried on the same as planting except only dead trees are replaced. Replanting is done with such a quality of stock and such a degree or technique as to insure against excessive loss due to controllable factors. All replant can not be expected to survive, but it does build the stocking up to the point where the area is more fully utilized.

**Disease and Insect Control.**

Disease and insect control must be carried on as is needed. It is important that they be recognized immediately to get effective control. White pine blister rust seems to be the most troublesome disease.

**Animal Damage Control.**

The Snowshoe hare control has been carried on in many plantations by snaring and shooting. This is rather expensive and has been curtailed since it has been determined that the hare multiple and decrease by cycles. Nature seems to supply the best control.
Deer damage control has not been solved due to the protection they are given. Annual hunting seasons would help to reduce the deer population.

Domestic livestock, although no serious factor, could be controlled by requiring the owners to keep their stock in fenced areas.

**Fire Control.**

Fire control must be had at all times to insure reforestation success. Parallel furrowing along all roads has proven a fire control measure. The furrows act as firebreaks. Public education plays a big part in controlling fire danger. Quick action on part of the district personnel is a valuable asset in fire control. As we all know, fire heads the priority list on any forest so adequate provisions for fire protection can be expected.

The preceding follow-up points are necessary to carry on a reforestation program and expect any degree of success. Once planting costs have been incurred, we should be broad-minded enough to see where additional cost is necessary to develop the plantations and advance reforestation.

**Summary.**

This thesis has been prepared as more of an instructional paper with the idea of enlightening any prospective forester of the duties ahead of him, should he secure work in the Lake States.
Reforestation has been neglected in this region, but the present trend is to return every acre of forest land to productivity.

To carry on any reforestation program it is necessary to formulate a definite plan and then follow it. Present plans are set up with an objective in mind and to accomplish it, very few deviations can be allowed.

Continual experiments have been carried on in reforestation in an attempt to better past results. A great deal of credit should be given the Lake States Experiment Station. All established plantations are studied for valuable information and data.

The interests of the federal, state, county, and municipal agencies are in getting the timber resources back.

One noticeable change in this region has been the public attitude toward reforestation. The ones that thought this area suitable for agriculture after the timber was cut can see where they prophesied wrong. With the depletion of the timber resources, there was also a reduction in their resources. Forests seems to be their only means of returning to a more economical sound livelihood. Reforestation aims at just this thing.

The reforestation program has received its criticisms as well as its praise. It may be true that some of the costs have been high, but think of the benefits that will be received by the coming generations.
Reforestation, although slow, is slowly reproducing the timber resources that the man ruthlessly destroyed. Let's hope that past experiences will open the eyes of the public to better forest management in the future.

**Bibliography.**

1. Forest Planting In The Lake States, USDA Bull. 1497.
3. Forestry In Wisconsin, Circular 294.
8. Planting Quarterly, November 1, 1939.
10. Letter from Chief, Division of Timber Management, Region 9.
11. Minnesota's Timber, Educational Pamphlet No. 5.
1. Project Name ______________________________ Date of Examination __________________

2. Legal Description - Forty __________________ Sec. ______ Twp. ______ R. ______

3. Year and season recommended for planting: Season: _____ Year: _____

4. Site Classification

   A. Open Area

   a. Light or sandy soil (4 to 20% colloidal content)

      1. Pure jack pine
      2. Pure red pine
      3. Patch planting - red pine and jack pine

   b. Heavy loams and clay soils (21 to 30+% colloidal content)

      1. Pure white spruce
      2. White spruce and jack pine (multiple strip)

   B. Covered Area

   I. Regular spacing (8 ft.) of furrows

      a. Light or sandy soils (4 to 20% colloidal content)

         1. Pure jack pine
         2. Red pine and jack pine (multiple strip)

      b. Heavy loams or clay soils (21 to 30+% colloidal content)

         1. Pure white pine
         2. White pine and jack pine (multiple strip)
         3. White spruce and jack pine (multiple strip)

   II. Irregular Spacing (3-20 ft.) of furrows - "Conversion"

      a. Light or sandy soils (4 to 20% colloidal content)

         1. Pure jack pine
         2. Red pine and jack pine (multiple strip)

      b. Heavy loams or clay soils (21 to 30+% colloidal content)

         1. Pure white pine (if eradication feasible)
         2. White pine and jack pine (multiple strip) (if ribes free or practically so)
         3. White spruce and jack pine (multiple strip)
5. Gross area covered ________ Acres  
   Plantable areas ________ Acres

6. Topography

7. Accessibility

8. Soil - Depth of top soil ________ Ph at 6" ________ Colloidal content 6" ________

   Soil Profile - - - - - - - - -

9. Scale - 4" equals 1 mile

   | S | Sand |
   | FS | Fine Sand |
   | CS | Course Sand |
   | L | Loam |
   | SL | Sandy Loam |
   | LS | Loamy Sand |
   | C | Clay |
   | CL | Clay Loam |
   | TS | Top Soil |
   | SS | Sub Soil |
   | PM | Parent Material |

10. Depth of water table ________

11. Surface drainage

12. Subsoil drainage

13. Ground cover

14. Rabbits (heavy, medium, light)

15. Number of bushes of ribes per acre if white pine site

16. Cost of survey per plantable acre

17. Remarks (Stumps, windfalls, rocks, etc. effecting furrowing)
Procedure in planting by the Slit method.
## PLANTATION SURVIVAL

### 25 Tree Group Tally

<table>
<thead>
<tr>
<th></th>
<th>First Year Count</th>
<th>Third Year Count</th>
<th>Fifth Year Count</th>
<th>10th Yr. Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>By</td>
<td>Date</td>
<td>By</td>
<td>Date</td>
</tr>
<tr>
<td>Species</td>
<td>Thrifty</td>
<td>Unthrift</td>
<td>Injured</td>
<td>Dead</td>
</tr>
<tr>
<td>Tree No.</td>
<td></td>
<td></td>
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</tbody>
</table>

### Ground Preparation:
- Furrows
- Scalp
- Width
- Depth

### Survival %

<table>
<thead>
<tr>
<th>Type of Release (check)</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Sod</td>
<td>Sand</td>
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</table>

<table>
<thead>
<tr>
<th>No. of Trees Needing Release</th>
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</thead>
<tbody>
<tr>
<td>Total Height</td>
</tr>
<tr>
<td>Current Height</td>
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</table>

Remarks- (11)
1. Fill in from Form 134 except ground preparation, check whether furrow or scalp, give dimensions at time of planting.

2. Use number shown on plantation map.

3. Groups are numbered consecutively from starting point.

4. Use Regional standard soil type symbol.

5. Use N, NE, E, SE, S, SW, W, NW, to designate direction of exposure.

6. Use standard compound cover type symbol, also note ground cover, e.g., heavy quack grass, heavy timothy, medium sweet fern, etc.

7. Write in species planted. Check mark to show species of each tree.

8. Give date of count, your name. Check the condition of each tree by a straight line from upper right to lower left of appropriate square. Use blank column under "Injured" or "Dead" only when you feel cause is of special significance, e.g., Abbots Sawfly, Hog Grazing, Deer, Frost Heave, etc. When release is needed mark the individual trees needing the release.

9. Total for each species and for both species if mixed plantation.

10. Show per cent survival by species. Show initials and species then total for all species. If release is necessary, check type of work, and give the number of trees needing release. Leaf smothering can be listed under "Sand".

11. Note here any important data not provided for elsewhere, as whether or not natural reproduction is taking over the site or will influence replanting.

12. When plantation is 10 years old, if counting plot stakes are still in place, make tally of living trees.

Summarize group sheets on counting plot summary sheet. File group sheets in plantation folder.

Every dead tree will be carefully dug up for examination as to cause of death. Leave open hole 10 inches deep to indicate location of dug trees to next examiner.

After first count, trees noted as dead in previous count will be checked under "Missing".
Form 134* (4/1/37)

GENERAL PLANTING OR SEEDING REPORT

National Forest  
State  
Whether Initial or Replant  
Project  
Date Work was Done  
Plantation Number  
Acres  

<table>
<thead>
<tr>
<th>T R E E S</th>
<th>DESCRIPTION OF STOCK</th>
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<tbody>
<tr>
<td>Sub-P No.</td>
<td>Acres</td>
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<td>-----------</td>
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Total

Methods of Mixture

<table>
<thead>
<tr>
<th>Contributed Time</th>
<th>Ground Preparation</th>
</tr>
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<tbody>
<tr>
<td>Hours</td>
<td>Value</td>
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</table>

Total

Per Acre

Per M

Source of Labor: For Planters Only

<table>
<thead>
<tr>
<th>No. Men</th>
<th>Man Days</th>
<th>Daily Wages or Wage Value</th>
<th>Total Wage Cost</th>
<th>Trees per Man Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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If planting camp (FS) is established give Avg. Cost of Sub. Per Meal $  

Approved  
(Forest Supervisor)  
Date  
Name  
Title  

*R-9 Revision of Printed Form 134.
WEATHER CONDITION DURING PLANTING SEASON

General weather conditions at opening of season

<table>
<thead>
<tr>
<th>Date</th>
<th>Bright</th>
<th>Cloudy</th>
<th>Humid</th>
<th>Light Showers</th>
<th>Heavy Rains</th>
<th>Windy</th>
<th>Date</th>
<th>Bright</th>
<th>Cldy</th>
<th>Humid</th>
<th>Lght. Heavy Sho. Rains</th>
<th>Wind</th>
</tr>
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Explain unusual costs, indicate cost per acre of intensive planting reconnaissance.

*Record daily weather conditions with a check mark in the appropriate column.
### PLANTATION SURVIVAL
**Summary Sheet**

(Forest)  
(District)  
(Project)  

Group Totals of Counting Plots  
Plantation No. P __ Acreage __

Planted: Season and Year __ Spacing __

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<tr>
<th>Species and Age Class</th>
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(8) Summary

(9) Total

(10) Total

(11) Original No of Trees Planted per Acre: By Species

(12) No of Thrifty Trees per Acre: By Species

(13) No of Unthrifty trees per Acre: By Species

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*Form 286 R-9*
Instructions for Filling Out the Form for Summarizing the Group Sheets.

This form will be filled in at the office and be used to summarize counts of 25 tree groups.

1. Information obtainable from Form 134 of each plantation.

2. Give counting plot number as shown on plantation map.

3. If more than one sheet is required for any counting plot, number the sheets consecutively and summarize on last sheet.

4. Enter number of each group from group tally sheet. Plantations of one species will allow 57 group tally sheets to be summarized on one group total sheet. Plantations of two species will allow 28 group tally sheets to be summarized and three species will allow 19 group tally sheets to be summarized.

5. Note species in place provided. Check mark proper column for each species.

6. Show number of trees needing release and condition making release necessary.

7. Total for each species.

8. Total for all species.


10. Give, for each species and for all species, total of all groups.

11. Determine for each cause using total loss as basis. ("Other" column may be split if necessary to recognize any special cause of distinct importance.)

12. Average total height by feet and inches and average current height in feet and inches.

13. Show species by initials and total for both if a mixed plantation.