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CONNECTICUT AGRICULTURAL EXPERIMENT STATION

NEW HAVEN, CONN.

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CHESTNUT IN CONNECTICUT

AND

THE IMPROVEMENT OF THE WOODLOT

BY

AUSTIN F. HAWES, M.F.
State and Station Forester

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to others as far as the editions permit.

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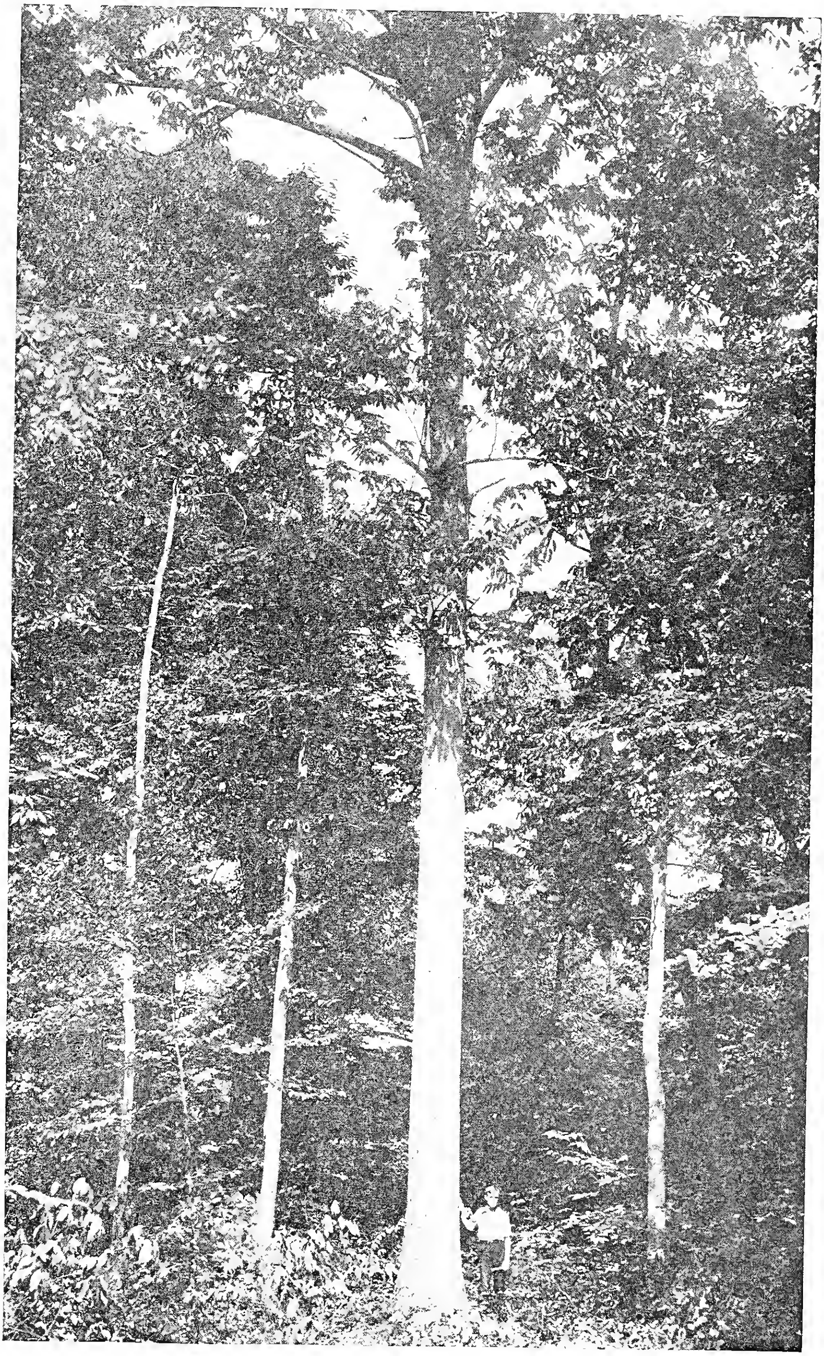
PLATE I.



A chestnut tree grown from seed, Hampton, Conn. This tree was 83 feet high, 27 inches in diameter and 103 years old. It sawed into 662 board feet of lumber. It occupied 900 square feet, so that it would be possible to have 48 such trees to the acre, or 30,000 feet of lumber.

CHESTNUT IN CONNECTICUT

AND

THE IMPROVEMENT OF THE WOODLOT.

By AUSTIN F. HAWES, M.F., *State and Station Forester.*

CONTENTS.

PREFACE.

The woodland of Connecticut is largely of two types: pine forest covering abandoned farms, especially in the northeastern part of the State; and young sprout forests of hardwoods such as the various oaks, birches, hickories or so-called walnuts, maples, chestnut and other species. This latter class of forest covers by far the greater part of the wooded area of the State, and the most important tree of this type is the chestnut, which, it is estimated, constitutes fully one-half of the timber of the State. The State is naturally fortunate in being the home of two such trees as the white pine and chestnut, which are among the most rapid growing and valuable trees of the country.

Unfortunately the woodlands of the State have been very sadly maltreated, so that their productive capacity has been considerably impaired. Practically all of the virgin timber of Southern New England was cut off before the Revolutionary war. From that time on there was a period of over fifty years when fuel was the chief product of our forests. The woods sprouted vigorously and were cut on a short rotation, often not over fifteen years.

Following the great development of manufactures in Connecticut and the consequent drift of population to the cities, the more inaccessible portions of farms were allowed to grow up to brush or forest. With the introduction of coal for fuel and the transportation facilities of railroads the demand for wood steadily diminished, so that to-day, except in the vicinity of large towns or brass factories, the market is poor. The railroads, which were in a great part responsible for this decline in the value of fuel, brought about a demand for railroad ties, a forest product requiring a longer rotation than fuel. With the growth of telegraph and telephone lines the supply of poles has become one of the chief uses of our forests. While the manufacture of lumber itself by small saw mills has been carried on in a small way in all parts of the State, the main lumber supplies are imported, only very local regions being supplied with native material.

The fact that the forest area of Connecticut has steadily increased, owing to the abandonment of farm land, added to the good sprouting ability of most of our trees, naturally led land owners to look upon woodlands as property which would care for itself.

Intensive farming has become necessary in Connecticut and is made possible by the application of science to agriculture. Every acre must be given the treatment which will yield the best financial results. Less than one-half the area of the State, however, is devoted to food production. It is therefore a very important matter that the million and a half acres not thus used, a large portion of it owned by farmers, should be producing the crop for which they are best suited, namely, forests; and also that care and knowledge should be devoted to securing the largest and best production of timber from these forests. The rapidly increasing price of our best forest products is sufficient reason for early action. While the price of our own chestnut and oak lumber has been practically at a standstill for thirty or more years, it will undoubtedly rise when the virgin supplies of timber in other parts of the country become exhausted, as they bid fair to at the present rate of cutting.

The purpose of this bulletin is to serve as a guide for the better management of our woodlots, a management which will produce a greater income in a definite period, or an equal income in a shorter time, than is produced under the present careless method.

Since chestnut is such an important factor in the Connecticut woodlot, the treatment of the lot must in most cases conform more or less closely to the demands of this species.

The tobacco grower has developed his industry by a careful attention to every characteristic and every need of the tobacco plant, and the successful farmer well understands the best methods of growing and handling his special crops. In the same way, the raising of good timber crops requires an intimate knowledge of the trees which make up the forest; therefore, as a basis for the management of the woodlot, this bulletin aims to furnish definite data on the character of chestnut.

In Europe precise studies have been carried on during the past century, resulting in tables of growth and yield for the various important species. In this country the securing of accurate information of this character has been confined to the past decade, and it is still very incomplete. White pine has been the subject of considerable study in different sections of the country, and a bulletin has been published by the United States Bureau of Forestry on Chestnut in Southern Maryland. The growth of chestnut in Connecticut has not been studied in detail, and conditions are so different from those of Southern Maryland that a study of the species in Connecticut is published here. The tables given in this bulletin are the results of "stem analyses" of over four hundred chestnut trees grown in the following towns of Connecticut: Portland, Windsor, Scotland, Washington, Morris, Bethlehem and Litchfield. The object in obtaining the data in such a variety of localities is, of course, that they may be representative of the whole State. The elevations of the localities vary from 100 feet to 1,000 feet or over above sea level.

A "stem analysis" includes the measurement of the total height of the tree, the diameter at the stump, and (in this case) at every eight feet, the age of the tree, and an accurate measurement of the radial growth for ten-year periods. From these figures are computed the cubical contents of the tree, as well as its rate of growth. Unless otherwise stated, the diameter of a tree in forestry publications refers to the diameter at breast height, 4.5 feet from the ground.

The author wishes to acknowledge the valuable assistance rendered by Prof. Henry S. Graves, Director of the Yale Forest School, and by the United States Forest Service, in securing the data which form the basis of this bulletin. The Forest Service has undertaken, during the past few years, the establishment of permanent sample plots in various parts of the East. These sample plots are to enable continuous observation and study of definite forest problems, along lines which have been practiced in Europe. Through the efforts of Prof. Graves a scheme of coöperation was devised whereby the author directed the establishment of a considerable number of these plots in the State forest at Portland, Conn. The Forest Service on its side furnished two assistants, who aided not only in the establishment of these sample plots, but also in obtaining the data for this study. Without this coöperation the study

would have been impossible, as there is no State appropriation available for research in forestry matters.

NATURAL HISTORY OF A WOODLOT.

The treatment of the woodlot is of course a more complicated matter than the treatment of individual trees. Because thrifty chestnut trees continue to grow remuneratively up to seventy-five years of age, as is shown on page 33, it does not follow that this is the best rotation on which to manage woodlots. As the trees grow older and larger they crowd more and more, so that a severe struggle for existence ensues. Trees derive their food materials through the roots from the soil in the form of mineral solutions. These are passed up into the crown of the tree and distributed through the leaves. The leaves take in carbon dioxide from the air, and by the action of sunlight on the chlorophyl of the leaves carbon products are formed which go to make the wood. These substances are carried down the tree and deposited in the form of an annual ring. The width of these rings, or the rate of diameter growth of a tree, depends then upon the fertility of the soil and upon the size of the crown which can be acted upon by sunlight. In other words, the growth of a tree, like that of an animal, depends upon its food and its digestive apparatus. So a tree in the open grows faster than one closely surrounded by other trees. This is very well illustrated on page 39 by a seedling which produced three ties in 26 years, requiring 800 square feet of room, as compared to many trees of the same age with only 100 square feet of crown which produce but one tie. On the other hand, trees grown in the open are apt to assume an apple tree shape, which is of little value for lumber. Their logs are not only short, but they are usually very limby. In order to have clear straight logs it is necessary that in youth, at least, trees stand close together. While the consequent struggle for existence results in less diameter growth, height growth is stimulated, as the trees are all striving for the light above and the lower branches, being cut off from light, die and fall off. On page 37 there is a discussion of the sprouting capacity of chestnut. When one considers that there may be from one to one hundred or more sprouts from each stump of the two or three hundred trees cut per acre, the immense number of sprouts per acre is evident. Yet after twenty years there are seldom over six or eight trees in a clump, and oftener there are only four or five. In the struggle for existence during that period the number has been reduced from several thousand on an acre to as many hundred. The trees which have survived are still far too numerous to form a mature forest, and they are of all grades of excellence, from the straight clear pole with ample top for best development to the spindling-topped, crooked tree which is being rapidly crowded out. In nature this struggle for existence goes on indefinitely. The great waste through such a struggle is apparent. This waste is not alone due to the fact that these innumerable trees die, fall to the ground and rot; but even more to the fact that by their fight for existence they interfere with the growth of the better trees which are to make the final harvest, and which should be straight poles to produce the most profit.

THE IMPROVEMENT THINNING.

When the trees of a woodlot have attained their main height growth, and the lower limbs have been pruned off in their struggle for light, the forester makes an "improvement thinning" in order to accelerate as much as possible the diameter growth. The principle of such a thinning is to substitute for nature's wasteful struggle a systematic removal of the weaker and inferior trees, leaving as many of the good trees as can develop without retardation for a given period, say ten years. As these thinnings are seldom made before the trees are twenty years old, the wood removed has, in most cases, a sale value sufficient to pay the expense of the operation. This is especially true where there is a good admixture of hardwoods, and where the farmer makes his own thinning.

In practice it is customary to blaze the trees which are to be removed. This marking process requires considerable judgment and experience, special attention being given the trees which are to remain rather than those which are to be cut. Several factors determine which trees are to remain and which are to be cut out. In the first place, of course, the most valuable and rapid growing species have precedence. Where there is a question which of two species shall be left, the following list may serve as a guide, although it is by no means invariable:

Species specially favored: Chestnut, white pine, oak, hickory, white ash.

Species of less value: Maple, black birch, pitch pine, butternut, tulip, pepperidge, beech, basswood, hemlock, elm.

Species usually removed: Gray birch and red cedar, ironwood, sassafras, poplar.

More important usually than the species is the character of the tree. Straight, tall trees, with well developed thrifty tops, are left in preference to spindling, weak-topped trees, or crooked or unsound trees. Trees affected by fungus diseases are invariably removed to prevent the spread of the disease to other trees.

In a group of equally good trees it is often best to remove one or more, as the remaining trees will then produce a larger money income than would all of them had they been left.

Trees are conveniently divided into four classes: Dominant, intermediate, suppressed and dead. Dominant trees are those whose crowns are entirely open to sunlight. Intermediate trees receive sunlight from above, but are shaded on the sides, and are liable to become suppressed. Suppressed trees are those which are entirely overtopped by other trees, and are slowly dying. Dominant trees are seldom removed unless by so doing a number of thrifty trees can be assisted. Suppressed and dead trees are removed whenever their wood will pay for their removal, but they have ceased to be a factor in the growth of the stand, and need not be cut as far as the other trees are concerned. Neither is there any profit in cutting underbrush, as is often supposed. The intermediate trees furnish the class in which most of the thinning is done. It is in this class that the struggle for existence is most severe, and where greatest economy of energy can be effected by thinning. It is much better to make light thinnings at frequent intervals than to take out too many trees at once, for this opens up large patches of ground which dry out on being exposed to wind and sun, and thus deteriorate and permit the growth of undesirable underbrush. No rule can be laid down as to the proportion of the number of trees which should be removed, or of the amount of wood, but the following actual case may serve as an example:

TABLE SHOWING THE NUMBER OF TREES LEFT AND THE NUMBER CUT ON A QUARTER ACRE IN FARMINGTON, CONN.

Species.	Number of trees left.	Number of trees cut.
Chestnut,	36	18
Red Oak,	15	1
White Oak,	4	..
Red Maple,	32	5
Black Birch,	18	22
Ash,	9	3
Hickory,	7	1
Beech,	1	..
Slippery Elm,	..	1
Sassafras,	..	6
Basswood,	3	1
Total Number,	125	58

From a total number of 183 trees, 58, or 32 per cent., were cut. The total volume of the wood on the quarter acre was at the rate of 30 cords per acre, while that removed was at the rate of 6.4 cords per acre, or 21 per cent. of the total volume.

Special warning should be given to those contemplating improvement thinnings that these thinnings must always follow the judgment of the operator, and cannot be made along hard and fast rules. It is not safe, for example, to say that a birch must always be cut to make room for an oak, or that in clumps of five sprouts one or any definite number should be removed. The following illustrations may also show something of the points considered and the method of improvement cutting.

EXPLANATION OF THE FOLLOWING PLATES AND DIAGRAMS.

Each pair of plates shows two views of a group of sprouts about twenty-five years old in the State forest at Portland, Conn. The view on the left shows the group as it grew without any treatment. The view on the right is taken from the same point after the group had been properly thinned. The numbers and letters on the trees make it possible to locate them in the other view and in the diagram.

The diagram accompanying each set of plates shows the relative position and size of the crowns of the various trees. They are drawn to a scale of ten feet to the inch. The shaded areas are the crowns of the trees that were removed before the second photograph was taken. The "camera" indicates the point from which the photographs were taken, and the dots with *small* numbers show the positions of the trunks. For example, Plate II shows the trees from left to right in the following order:: Y, 78, 79, X, 77, 80, 81, Z, which is the order in which straight lines drawn from these trees to the camera would lie.

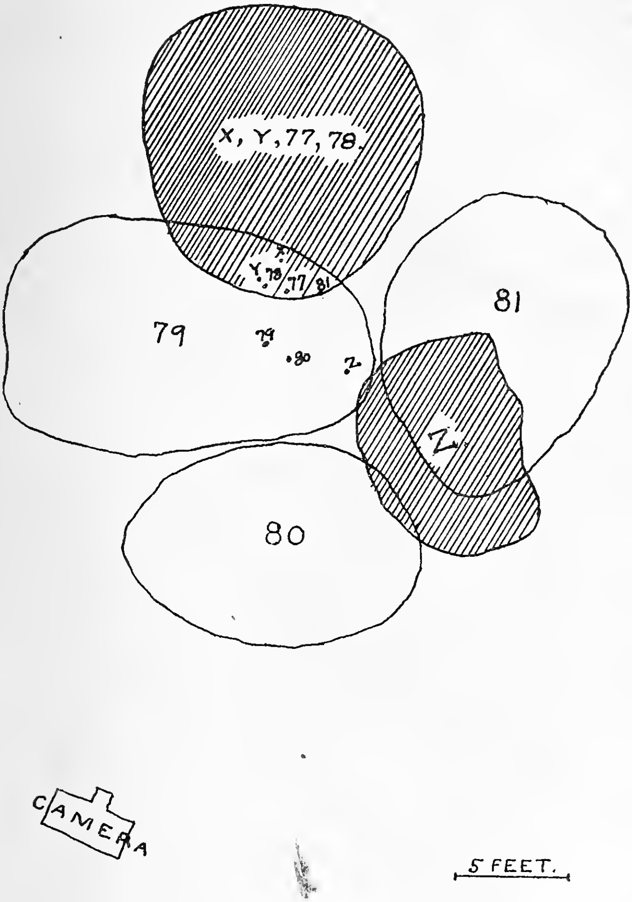


Diagram I, referring to Plates II and III.

In this group of sprouts trees 79, 80, 81 are straight, thrifty trees with diameters 5 to 7 inches and heights 40 to 43 feet. Tree Z as shown by the diagram is almost suppressed, being only 30 feet high. Its removal will admit more light for 80 and 81. The crowns of X, Y, 77 and 78 form one mass of foliage, the removal of which will help 79 and 81. The photographs show the relatively small size of the trees X, Y, and Z, which are nearly suppressed. The unnumbered crooked trees are already too much suppressed to affect the development of the large trees.

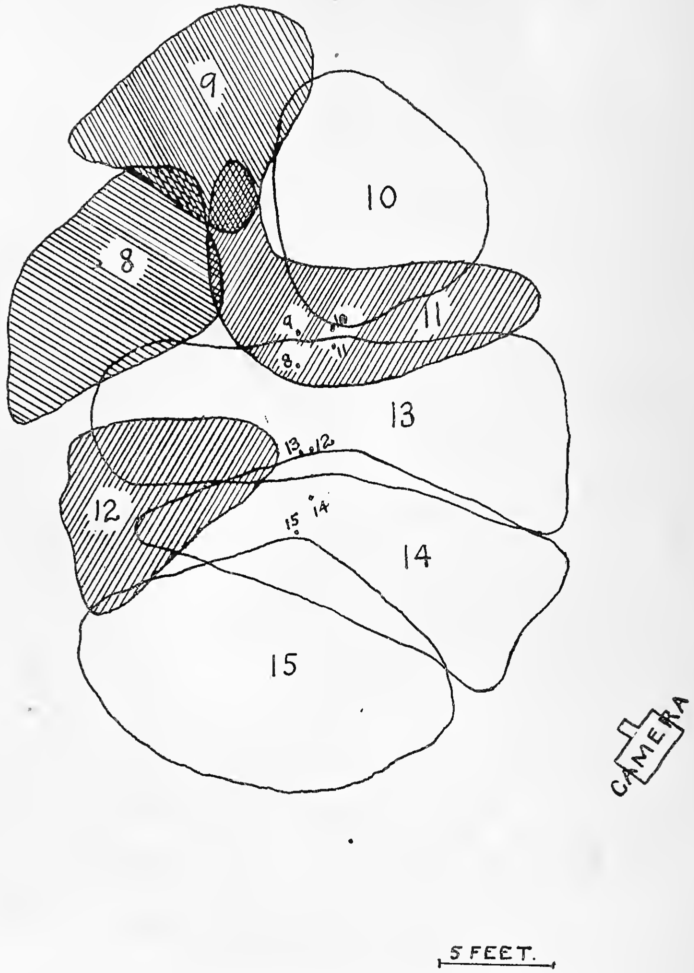
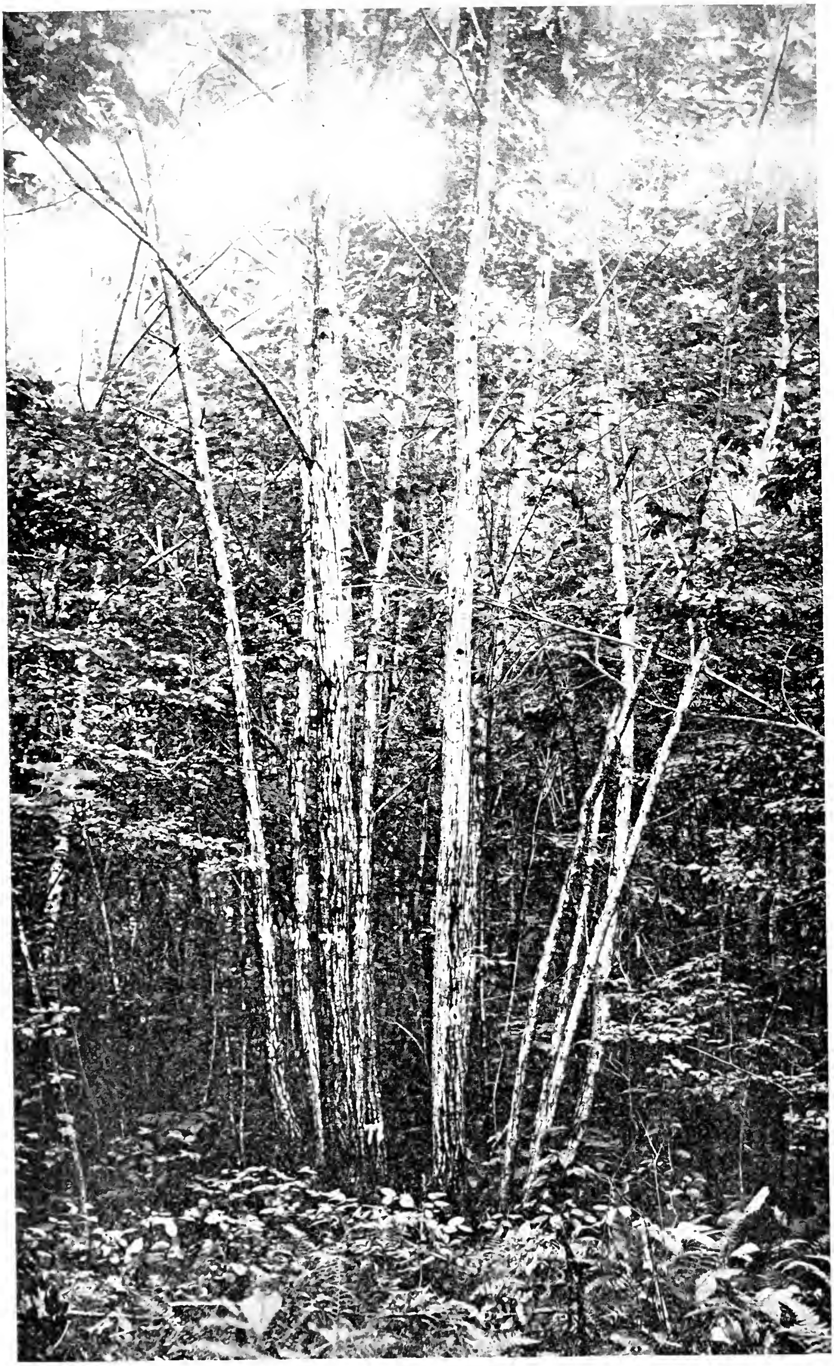


DIAGRAM II, REFERRING TO PLATES IV AND V.

In this double group of sprouts there are four especially promising poles: 10, 13, 14, 15, with diameters from 5 to 7 inches, and heights 40 to 47 feet. The crown of tree 11 is crowded in between 10 and 13, and seriously interferes with their development. No. 12, although 47 feet high, has a crown too small to supply it with food. Its diameter is only 4.7 inches. By its removal the other three of the group, which are all over six inches, will obtain more light and increase their diameter rapidly. The removal of trees 8 and 9 affect respectively 13 and 10.

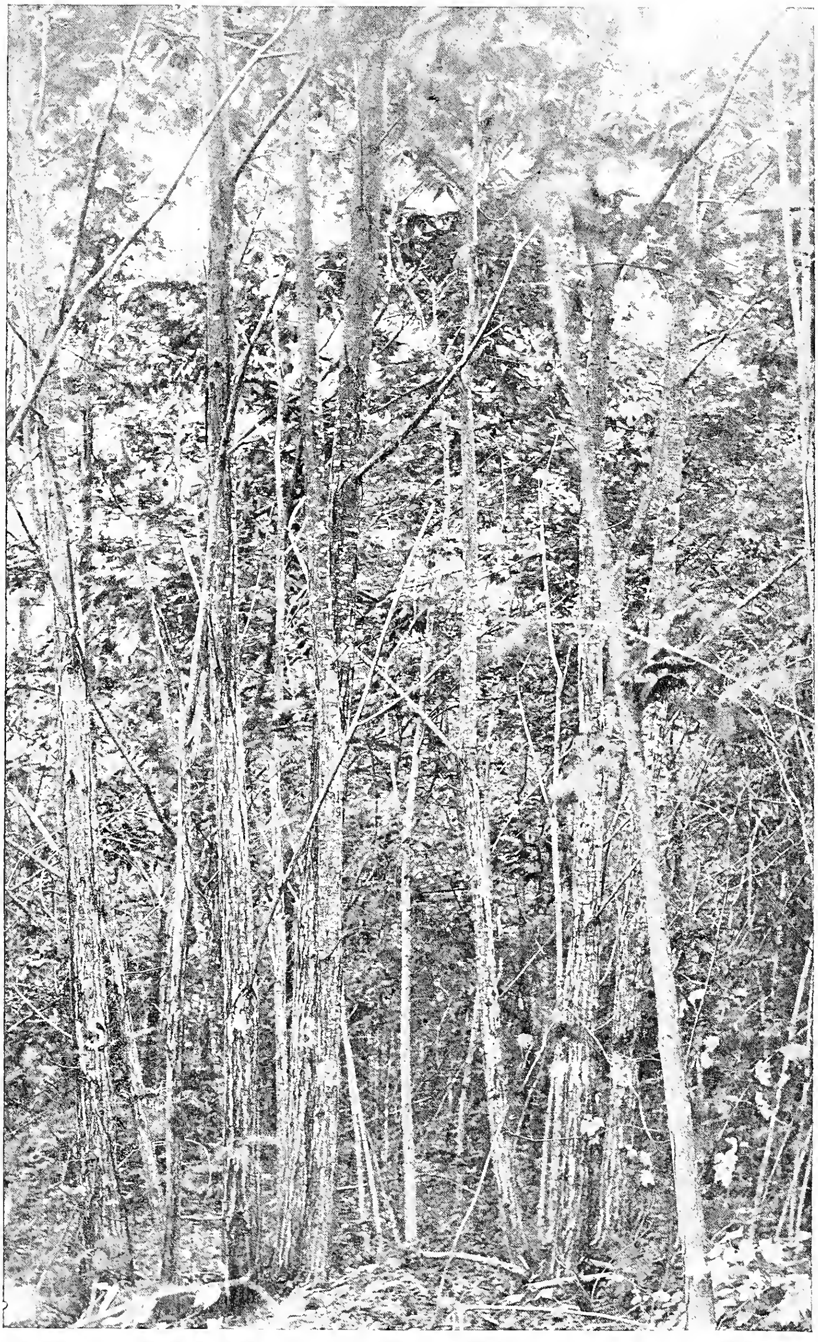
PLATE II.



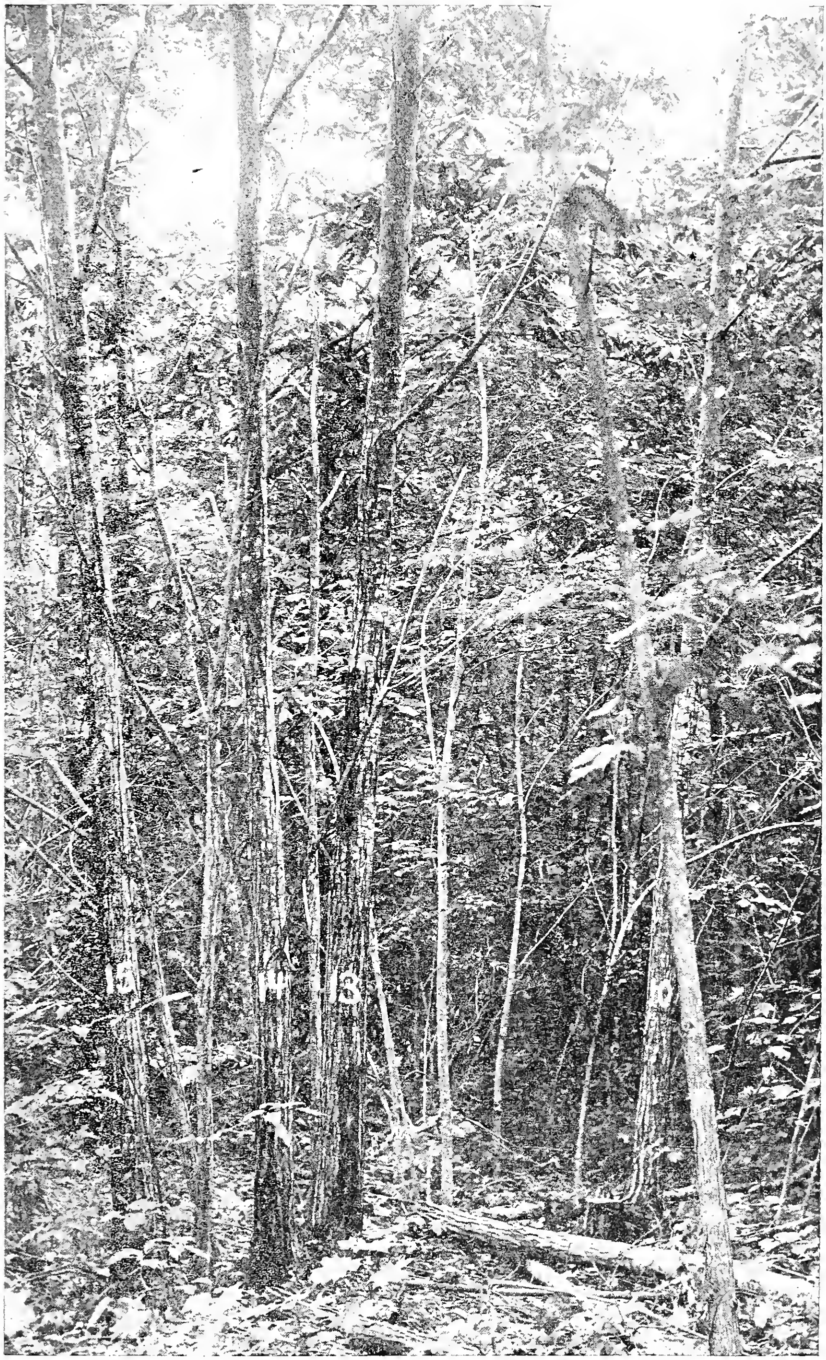
Group of chestnut sprouts, twenty-five years old, before thinning.

The same group, after thinning.

PLATE IV.

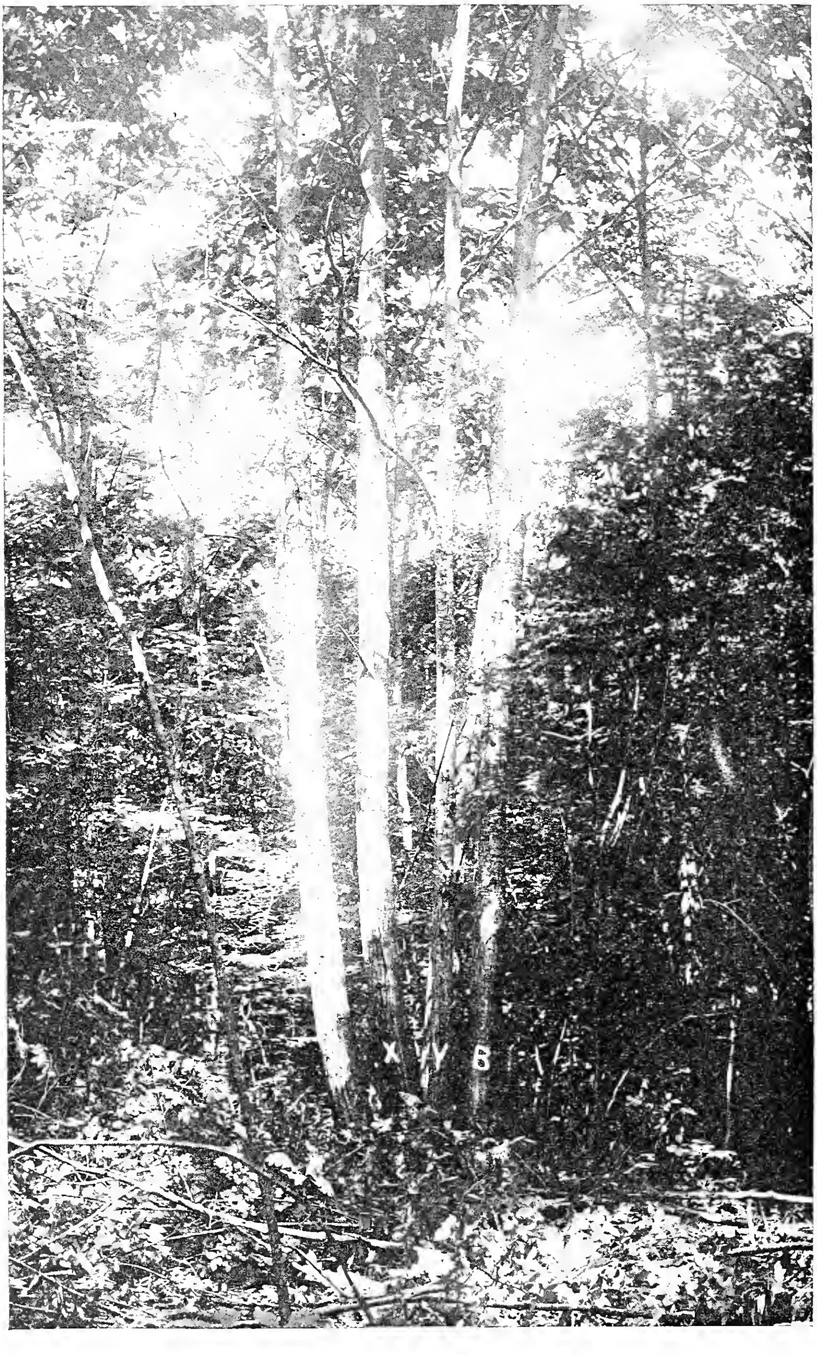


Group of chestnut sprouts, before thinning.

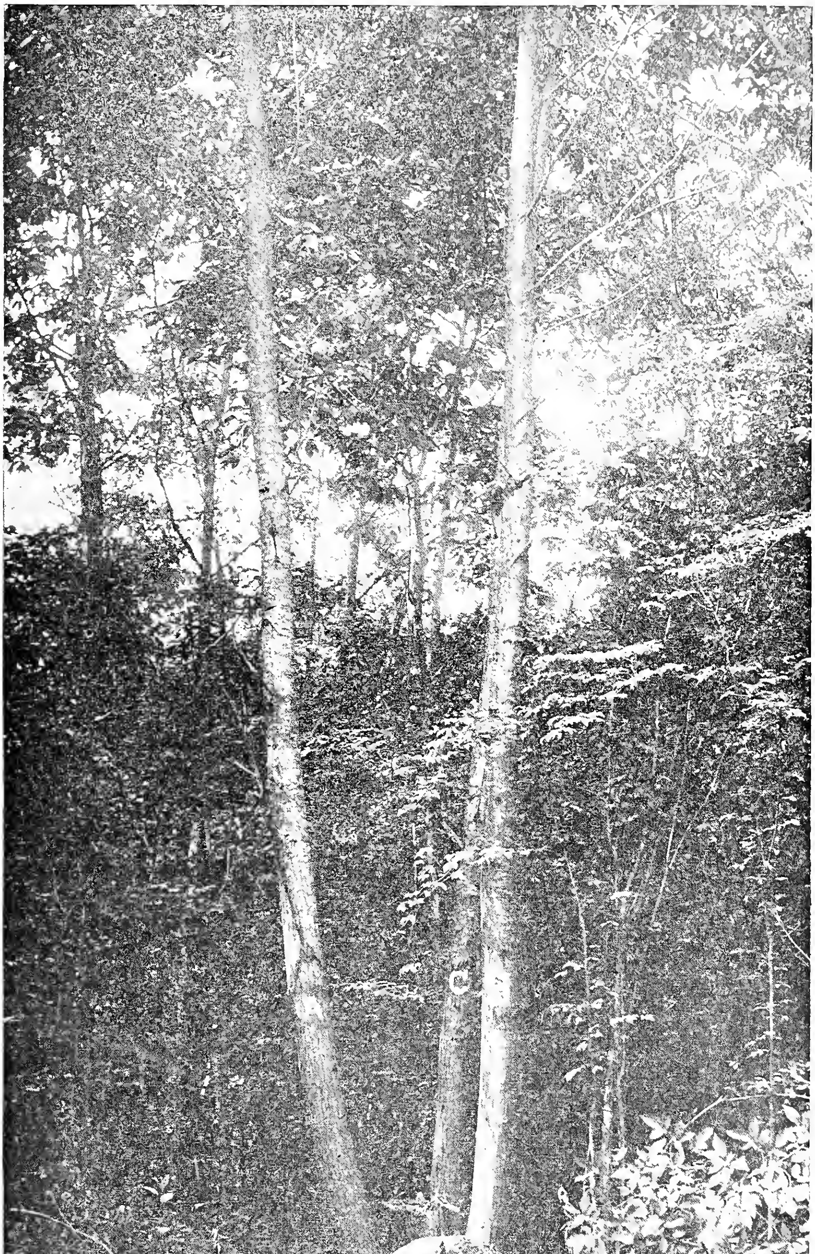


The same group after thinning.

PLATE VI.



Group of chestnut sprouts, before thinning.



The same group after thinning.

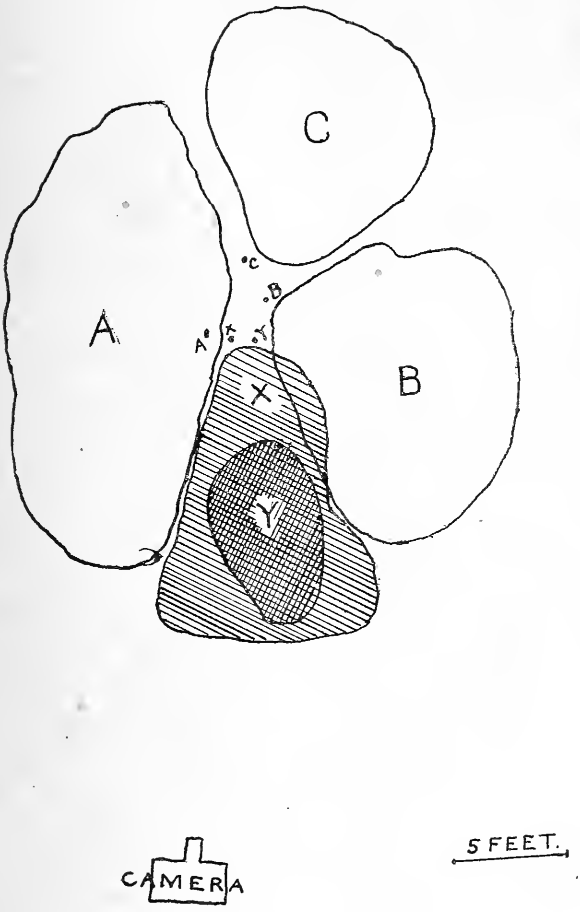


DIAGRAM III, REFERRING TO PLATES VI AND VII.

Trees A, B and C are fine specimens of chestnut poles,—diameters 7 to 9 inches, heights 55 to 60 feet. In Plate VI C is nearly concealed by Y. A is the tree furthest to the left. Y is a suppressed tree only 5 inches in diameter and 42 feet high, wholly overtopped by X. It is removed for use rather than for any influence on the remaining trees. X, on the other hand, is an intermediate tree 57 feet high, fully as good as the rest. It is believed that the increased growth of A, B, and C will more than compensate for its removal.

THE RESULTS OF IMPROVEMENT THINNING.

One of the main results of a thinning is that a greater number of perfect trees, and therefore better lumber, is produced. In the following pages the relatively greater profit from chestnut poles over other chestnut products is plainly brought out. Obviously very many more trees are crooked and therefore unfit for poles in a natural forest than in one which has been properly thinned. The table on page 31 shows the stumpage value for chestnut trees of different sizes. In an 18 inch tree there is from 20 cents to $2.00 more profit cut as a pole than for lumber. It will readily be seen that the profit per acre may be greatly increased by producing poles instead of lumber. If in a clump of a dozen trees the struggle for existence is so severe that only three survive, the forester does well if by abating this struggle he can produce five thrifty trees. By wise selection the whole area can be made productive up to its maximum capacity. Reference is made on page 39 to a sprout which produced two ties in 21 years by means of its 254 square feet of crown. This would permit 171 such trees per acre, or 342 ties. The frontispiece (Plate I) shows a chestnut seedling 103 years old which produced 662 board feet with a crown space of 900 square feet. These figures emphasize the large crops which can be secured by judiciously thinning so as to permit crown development of this kind. By the increased growth timber will become in a given time larger than would have been the case under nature's treatment. A greater and more profitable crop can therefore be raised in a definite period, or, in other words, the period for producing a definite amount of wood can be reduced.

Measurements of the wood crop on a tract of three hundred acres showed 7,900 cords standing, with an average age of 48 years. The average growth had therefore been about one-half a cord per acre per annum. Good land will produce a cord an acre in a year, and by proper thinnings most land can be brought up to this standard. On land which can be purchased at $10.00 an acre it makes a difference of five per cent. on the investment whether one-half a cord or a full cord is grown annually, considering wood worth $1.00 a cord standing.

Forestry has not been practiced long enough in this country to have demonstrated the value of thinnings, but in Europe their efficiency has long been recognized.

Plates VIII and IX, following page 16, show admirably the effect of increased light upon diameter growth.

FINAL HARVEST OF THE WOODLOT.

The preceding chapter on improvement thinnings is particularly intended for the even-aged sprout lots so common in the State. The first thinning should be made from the twentieth to the twenty-fifth year, and the second about ten years later. The former of these is the more important for its effect upon the growth of the timber. In the latter the suppressed and dead trees are removed, thus preventing waste and influencing somewhat the growth during the remainder of the woodlot's life. Another important result of this thinning is the seedling reproduction which almost invariably comes up in openings, and which will be in good condition to take advantage of the full light of the final harvest, which should usually be when the trees are about fifty years old. It is essential for the permanent welfare of Connecticut woodland that some seedlings are started with each generation of sprouts. Otherwise the woods of the State would perpetually deteriorate.

The age for the final harvest, set here at about fifty years, is, of course, variable. Lots which have suffered from fire or are seriously affected by rot should be cut earlier, while those composed largely of chestnut seedlings or of other longer lived trees can more profitably be left for a longer time.

Public opinion in regard to forestry is still very much at sea. One of the most common delusions held by the public on the subject is that, according to the doctrines of forestry, woodlands should never be cut clean, but that individual trees should be removed here and there as they mature. This is the so-called "selection system," and is perfectly sound for some forms of forest, especially conifers, which reproduce wholly from seed. A large proportion of the chestnut of Connecticut comes from sprouts, this ability of the species for sprouting being discussed on page 37. Chestnut sprouts do not grow well under shade, and for this reason a selection system of removing occasional trees, as in coniferous forests, is not advisable in chestnut stands. As the main reproduction must always be by sprouts, it is better to practice a modified form of the present clear cutting system, when a woodlot is ready to cut. Since most of our woodlots contain longer-lived and slower growing trees, such as the white oak and hickory, it is often advisable to leave a few such trees per acre to grow into large dimension lumber; but these should be left in clumps, not individually. Solitary trees thus left are liable to windfall and windshake.

The preceding instructions for the improvement of the woodlot can only be applied to those still engaged in the struggle for existence. Very many of the Connecticut woodlots are past this age. They are irregular in appearance, with a few good trees and many crooked and diseased trees which have "lost out" in the struggle. An improvement thinning cannot increase the growth of the remaining timber very much; but a "reproduction cutting" can be made, preparatory to the final harvest. This is similar to the second thinning described above, and consists in removing all the inferior trees, thus making room for seedling reproduction to form part of the next forest generation, when the whole lot is cut after about ten years.

Illustrations of this are given on Plates X and XI.

TIMBER ESTIMATING.

One of the most important subjects which can be presented to the farmer along forestry lines is timber estimating. Through long years of experience in cutting hay and harvesting corn he has acquired an ability to estimate, in many cases, very accurately the amount of hay or corn standing in the field. By similar training in buying and cutting lumber the lumberman has acquired the ability to estimate fairly closely the amount of timber standing in the woodlot. While the farmer can sell his standing hay to good advantage, he usually makes a poor bargain when he sells his woodlot to the lumberman, because the latter knows better its actual value.

The farmer has no time to acquire this training in lumber estimating, and should therefore appreciate any ready-made methods such as the forester employs. The application of these methods requires more time than does that of the lumberman, who usually only walks through the lot; but when carefully applied, the forester's estimates are more accurate than those of any man relying on experience alone.

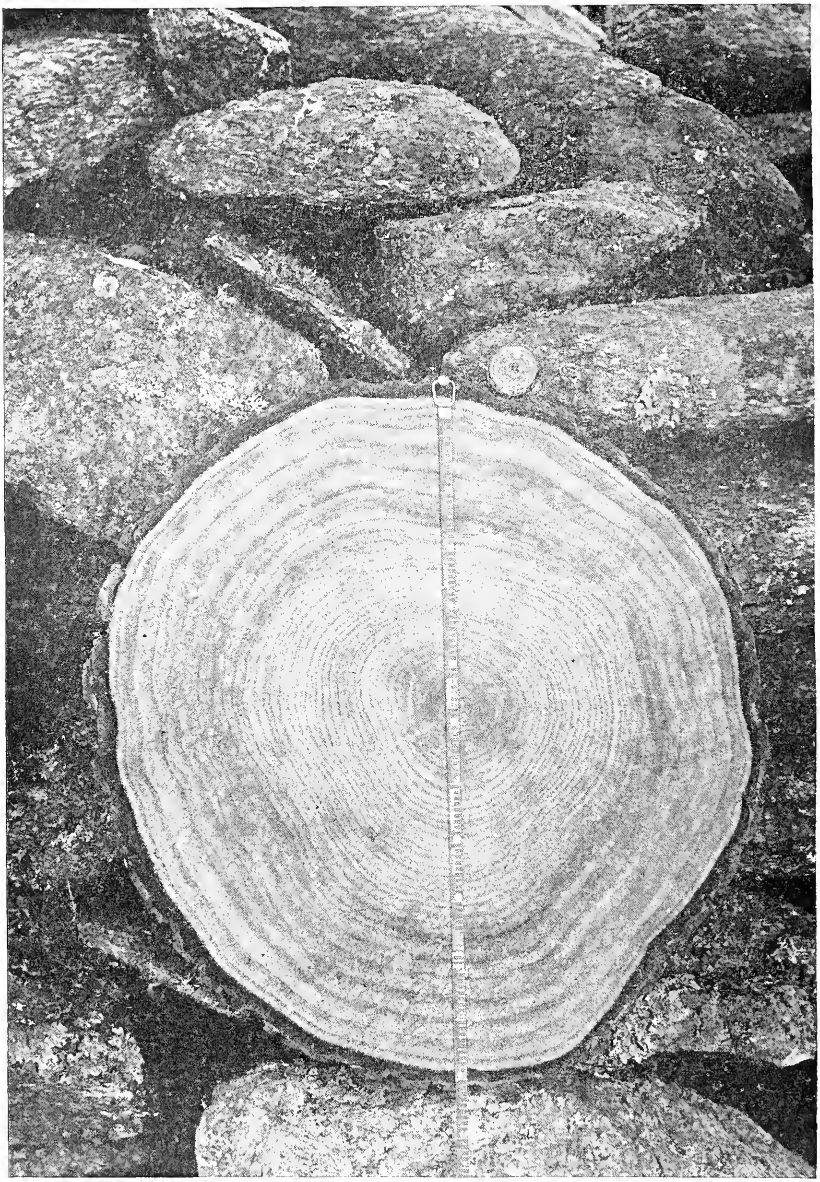


Plate VIII shows the cross section of a chestnut sprout which grew in a clump of three. The other two were cut for ties eight years ago, according to the farmer's account, which was verified by the small sprout which had come from them and which appears in the picture. At that time this tree was 34 years old, had a diameter of 8.5 inches, and was therefore too small to cut for ties. During the eight years of unlimited light the diameter grew to 14 inches, an increase of six inches in eight years. The tree, 42 years old, now furnishes three ties.

The measure, seen in the picture, is divided into feet, tenths and hundredths.

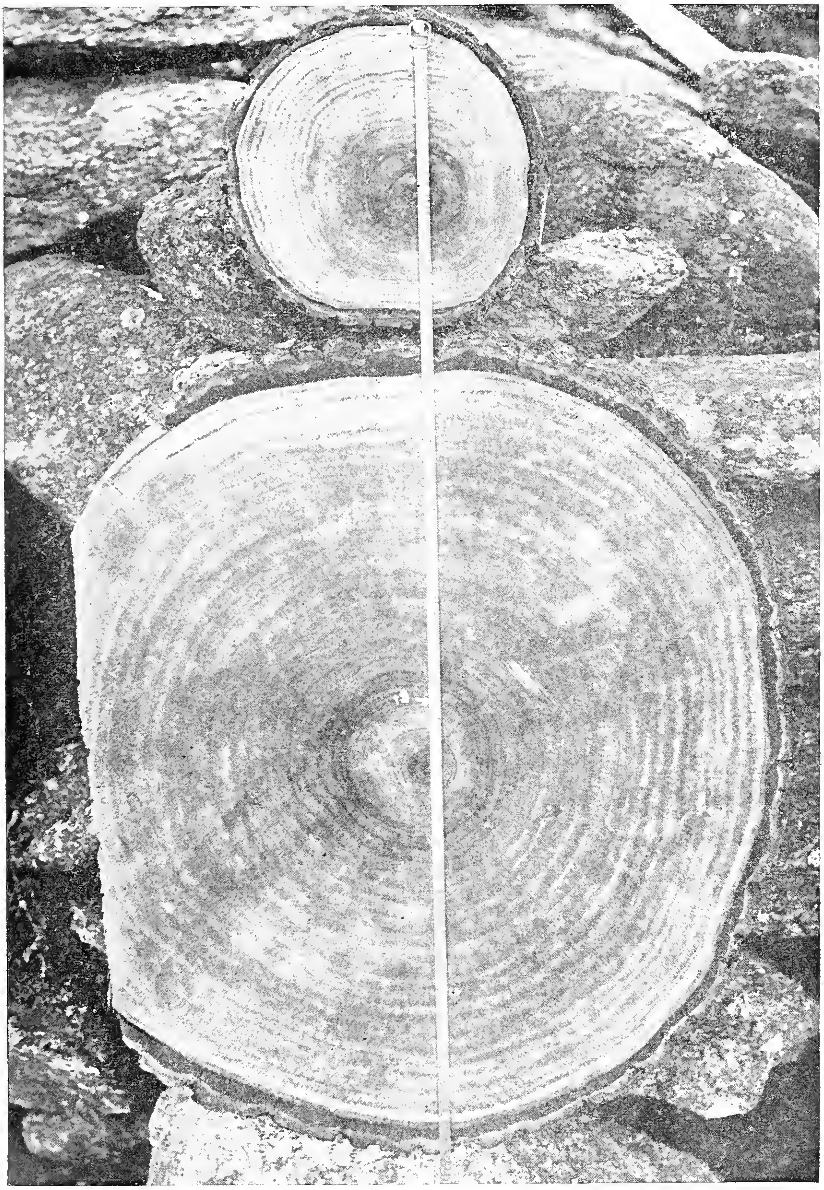
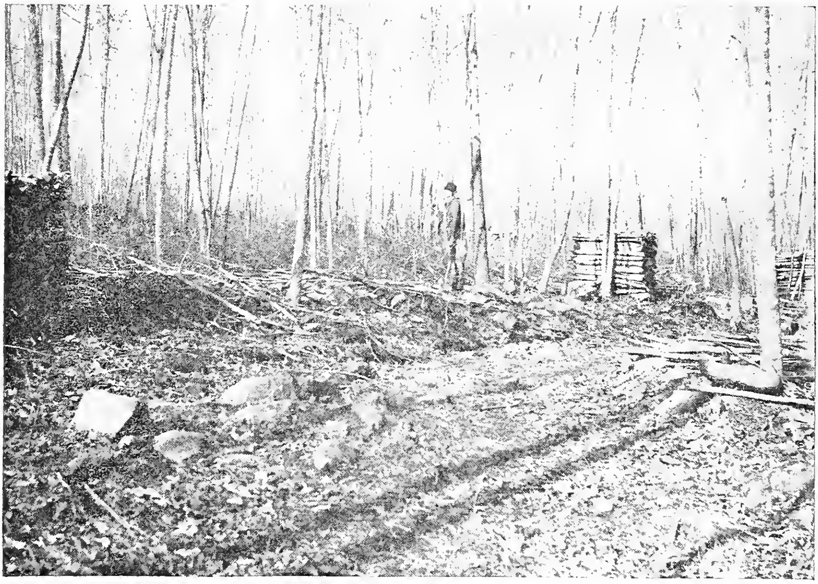


PLATE IX shows below the cross section of a chestnut seedling, 42 years old, which was only two inches in diameter at the age of 18 years, when the wood was cut off in 1881. During the 24 years of unlimited light the tree grew to thirteen inches.

The time of cutting given by the farmer was again verified by the age of the sprouts forming the present stand. The smaller section, shown above, is from one of these sprouts, and is 24 years old.

PLATE X.



A. A woodlot where a light improvement thinning has been made: State Forest, Portland, Conn. This land was bought by the State for $2.00 an acre.

B. A woodlot which should be thinned: Farmington, Conn. Of the 35 cords per acre, 7 cords should be cut, or 20 per cent. This will leave 72 chestnuts, 192 hickories, 52 oaks, and 6 ash per acre.

A. An open stand in which a thrifty reproduction of hemlock has come up under worthless butternut. The latter should be cut to allow better growth of the hemlock, and a chance for reproduction of other species before the final harvest.

B. A mixture of white and pitch pine, red cedar and chestnut. The cedars are mostly suppressed and should be removed along with some of the pitch pine to make room for the reproduction of white pine before the final harvest.

VOLUME TABLES.

One of the best methods of estimating timber is by means of volume tables. A volume table gives the average volume for trees of different diameters. Such volume tables have been made in Europe for practically all species of that continent, but tables of this class in America are still scarce. The volume tables below give the volume of chestnut trees in fuel, ties, piles, poles and lumber, and are practically the only published tables for the species except some obtained in Maryland, where conditions are quite different. They are made by averaging the results of the stem analyses mentioned on page 6.

TABLE I.—CHESTNUT VOLUME TABLE. SOLID CUBIC FEET, AND STACKED CORDS, AND THE GROSS VALUE DELIVERED.

Diameter Breast High (inches).	Volume in cubic feet (solid).	Volume* in cords (stacked).	Gross value delivered at $3.00 per cord.
3	0.7	....	....
4	2.0	.02	$ .06
5	3.5	.04	.12
6	5.2	.06	.18
7	7.2	.08	.24
8	10.	.11	.33
9	12.	.13	.39
10	15.	.17	.51
11	19.	.21	.63
12	23.	.26	.78
13	27.	.30	.90
14	31.	.34	1.02
15	37.	.41	1.23
16	42.	.47	1.41
17	48.	.53	1.59
18	55.	.61	1.83
19	62.	.70	2.10
20	69.	.77	2.31
21	77.	.86	2.58
22	85.	.95	2.85
23	93.	1.04	3.12
24	102.	1.14	3.44
25	112.	1.25	3.75
26	122.	1.36	4.08
27	132.	1.47	4.41
28	143.	1.60	4.80
29	154.	1.72	5.16
30	164.	1.86	5.58
31	175.	2.00	6.00

* It is customary to convert cubic feet into stacked cords by dividing by 89.6, on the principle that a cord of wood contains on an average 70 per cent. of solid wood.

Table I gives the average volume in cubic feet for trees of different diameters, and the same reduced to fractions of cords, with the gross value for the same delivered at $3.00 a cord.

APPLICATION OF VOLUME TABLES.

The purpose of a volume table is for wide application and not for limited use. It is an expression of average figures. That is, it might be difficult to find a chestnut tree 23 inches in diameter which would stack up just a cord, yet the average volume of several trees of this diameter in Connecticut is this amount. The value of such a table is apparent to any woodland owner or prospective purchaser. A simple way of computing the stand of wood on a lot is by measuring the diameters of the trees on the whole lot or a part of it, and multiplying the volumes for different diameters by the number of trees in the diameter class. It is seldom necessary to measure the trees on a whole lot, for sample plots can usually be selected fairly representative of the whole. The volume of wood on the whole lot is, of course, computed by multiplying that of the sample plot by the number of such plots which could be obtained in the whole piece. These sample plots should be carefully selected to represent an average stand and may be square, circular, or any convenient shape. They are usually either one acre, one-half, one-quarter, one-eighth, or one-sixteenth of an acre in size. One method considerably used is to lay out a circle with a radius of sixty feet. This includes practically one-quarter acre. A square acre has 208 feet on a side, a quarter acre 104 feet, an eighth acre 74 feet, and a sixteenth acre 52 feet. Half acres are usually made rectangular, 208 × 104 feet.

The application of this method of estimating wood is given in Table II, the result from a quarter acre plot on the Mountain Spring farm in Farmington, Conn.

TABLE II.—NUMBER OF TREES ON ONE QUARTER ACRE, FARMINGTON, CONN.

Diameter Breast High (inches).	Chest-nut.	Red Oak.	Beech.	Black Birch.	Rock Oak.	Hem-lock.	Hickory.	Maple.
1	..	..	..	..	..	..	..	..
2	..	..	6	1	..	1	4	2
3	..	3	6	7	10	2	1	3
4	..	..	4	2	4	2	4	2
5	..	2	6	..	6	1	3	1
6	4	1	4	1	2	..	..	1
7	5	..	3	..	4	1	1	1
8	5	..	4	..	3	..	1	..
9	8	2	..	..	3	..	1	..
10	5	1	..	..	..	..	..	..
11	1	..	..	..	..	..	..	..
12	2	..	..	..	..	..	..	..
13	3	..	..	..	..	..	..	..
14	2	..	..	..	..	..	..	..
15	..	..	..	..	..	..	..	..
Total,	35	9	33	11	32	7	15	10

By using Table I it is a simple matter to compute the number of cords of chestnut on the quarter acre. The method of working is shown in Table III.

TABLE III.—NUMBER OF CORDS OF CHESTNUT WOOD ON THE QUARTER ACRE GIVEN IN TABLE II.

Diameter Breast High (inches).	Volume in cords (stacked per tree).	Number of trees.	Total volume in cords (stacked).
6	.06	4	.24
7	.08	5	.40
8	.11	5	.55
9	.13	8	1.04
10	.17	5	.85
11	.21	1	.21
12	.26	2	.52
13	.30	3	.90
14	.34	2	.68

Total number of cords 5.39
Number of cords per acre 21.56

Where there are no volume tables, as in the case of most of our trees, it is possible to estimate the yield per acre by some modification of the so-called "sample tree method." After the number of trees of each diameter has been secured, the average diameter is computed. One or more of these average trees are cut down and their volumes measured. The average volume of these sample trees multiplied by the number of trees of the species gives the total volume of wood of this species. This, however, is a more cumbersome method than the average land owner is willing to use. It is therefore advisable that volume tables of all our species be prepared as soon as possible. The way of using the sample tree method may be illustrated by the red oak in Table II. The average diameter of these nine red oaks was 6.4 inches and the volume of the sample tree of this diameter was 7.83 cubic feet. The total volume of red oak is therefore $9 \times 7.83 = 70.47$ solid cubic feet, which is equivalent to 0.8 of a cord or 3.2 cords per acre. The volumes of the other species in Table II were computed in this way, and the total yield was 10.2 cords, or 40.8 cords per acre, of which a little over half was chestnut. The volume of the chestnut for this quarter acre, computed by this sample tree method, came out exactly the same as by the use of the volume table; in each case 5.39 cords. Such close results by the two methods, however, are seldom obtained.

Chestnut Fuel and Ties.

Except for special industries, chestnut fuel has little demand and brings a low price. In the vicinity of brick yards and brass factories there is a good market for it at fair prices. In general, however, the woodland owner in this State either sells his lot outright or cuts it for ties and poles and lumber, getting what he can out of the cord wood as a sort of extra crop. It is therefore more important to know the amount of such materials than of cord wood. Table IV is a volume table for chestnut, expressed in ties, plus cord wood cut from the tops and limbs; and the money value of the same.

TABLE IV.—CHESTNUT VOLUME TABLE. TIES AND FUEL AND GROSS VALUE DELIVERED.

Diameter Breast High (inches).	Number of 1st class ties.	Number of 2d class ties.	Cords of stacked wood in tops.	Gross value delivered.
6	..	..	..	..
7	..	..	..	..
8	..	1.2	.03	$ .45
9	..	1.2	.03	.45
10	1.2	1.1	.03	.92
11	1.9	1.1	.04	1.25
12	2.4	1.	.05	1.45
13	3.	1.	.05	1.71
14	3.6	.9	.06	1.96
15	4.3	.8	.06	2.22
16	4.9	.8	.07	2.51
17	5.5	.7	.08	2.76
18	6.2	.7	.09	3.08
19	7.	.6	.09	3.39
20	7.8	.6	.10	3.76
21	8.8	.5	.10	4.15
22	9.9	.5	.11	4.64
23	11.2	.4	.12	5.18
24	12.6	.4	.13	5.80
25	14.1	.3	.14	6.43
26	15.9	.3	.15	7.22
27	17.5	.2	.16	7.89

We must again remember that this table is an expression of averages. It would, of course, be to no purpose to pick out a 12 inch tree and say that it contains 2.4 first class ties and one second class tie, plus .05 of a cord in the tops. The idea is that in a woodlot where there are, for example, ten trees 12 inches in diameter, these would yield 24 first class ties, ten second class ties, plus .5 cords of wood. The values given in the last column are for gross price at point of delivery. It will be noticed that as the number of first class ties increases a diminishing amount of wood goes into second class ties. This is because, for the purpose of this table, logs are always considered as sawed into first class ties in preference to seconds.

Table V. shows the basis for this previous table, and is the result of an inspection of a portable saw mill which sawed all the chestnut logs into ties.

TABLE V.—VOLUME OF CHESTNUT LOGS 8 FEET LONG.

Diameter outside bark at small end (inches).	Number of ties.	Class.	Diameter outside bark at small end (inches).	Number of ties.	Class.
7	1	II	16	2	I
8	1	II	17	2	I
9	1	I	18	3	I
10	1	I	19	3	I
11	1	I	20	4	I
12	1	I	21	4	I
13	1	I	22	5	I
14	2	I	23	6	I
15	2	I	24	7	I

There are, of course, cases where it is possible to realize more by cutting logs into seconds than firsts. For example, some logs 17 inches at the top may be sawed into four seconds instead of two firsts, having a gross value of $1.20 instead of $0.84. Since these cases are rare, for the purpose of uniformity they were omitted in preparing these tables. It is one of the faults of the present prices offered by the railroad company that they thus encourage sawing into second class ties, while they are anxious to obtain the largest possible proportion of first class ties.

Chestnut Piles.

One of the greatest advantages of chestnut over the other trees of the State is that it has such varied uses. Important among these are the uses for poles for telegraph, telephone and electric light and trolley lines; and for piles. Inasmuch as pile sticks do not need to be as straight as poles, more trees can be utilized for this purpose, and the cutting of chestnut for these is especially profitable near water, where bridges, wharves, etc., require their use. One of the chief users of piles in Connecticut is the Hartford & New York Transportation Company. While specifications and prices for piles vary with different consumers, those of this company may serve as an example, and are therefore given below:—

No. 3 are piles 12 inches at butt, 6 inches at tip, ordinarily straight, peeled 20 feet from butt, 6 cents a linear foot.

No. 2 are piles 12 inches at 4 feet from butt, and other dimensions the same, 7 cents a linear foot.

No. 1 are piles 12 inches to 14 inches at 4 feet from butt, other dimensions the same, 8 cents a linear foot.

Extras are good straight sticks, 16 inches at 4 feet from butt, other dimensions the same, 9 cents a linear foot.

These prices are for piles delivered along the Connecticut River ready for rafting.

The class and value of piles which can be taken from chestnut of various diameters is shown in Table VI.

TABLE VI.—CHESTNUT VOLUME TABLE. LENGTH OF PILES AND GROSS VALUE DELIVERED.

Diameter Breast High (inches).	Length (feet).	Class.	Value.
10	29	3	$1.74
11	32	3	1.92
12	34	3	2.04
13	37	2	2.59
14	40	2	2.80
15	42	1	3.36
16	44	1	3.52
17	46	1	3.68
18	48	Extra	4.32
19	49	Extra	4.41
20	51	Extra	4.59
21	52	Extra	4.68
22	53	Extra	4.77
23	55	Extra	4.95

Of course many trees are too crooked or otherwise defective to be used for piles, so in estimating the value of a lot in piles a distinction is made in measuring the trees as to whether they are fit for piles or not.

Telegraph and Telephone Poles.

The specifications of the various telegraph and telephone companies using poles vary considerably, and the prices paid depend largely upon the supply and demand. The table on page 24 is based on the specification of the Western Union Telegraph Company:

"For winter cut, second growth, white chestnut poles, full eight inches in diameter at the top, the following prices are paid F.O.B. New York, New Haven and Hartford Railroad:

25 feet	$1.70	45 feet	$ 5.75
30 "	2.65	50 "	8.00
35 "	3.65	55 "	10.00
40 "	4.65	60 "	13.00
		65 "	15.00

TABLE VII.—CHESTNUT VOLUME TABLE. LENGTH OF TELEGRAPH POLES AND GROSS VALUE DELIVERED.

Diameter Breast High (inches).	Length (feet).	Range of Values.
11	0–25	$ 1.70
12	25–30	1.70–2.65
13	25–35	1.70–2.65–3.65
14	30–40	2.65–3.65–4.65
15	35–40	3.65–4.65
16	35–45	3.65–4.65–5.75
17	40–45	4.65–5.75
18	40–50	4.65–5.75–8.00
19	40–50	4.65–5.75–8.00
20	45–50	5.75–8.00
21	45–55	5.75–8.00–10.00
22	50–60	8.00–10.00–13.00
23	50–60	8.00–10.00–13.00
24	55–60	10.00–13.00
25	55–60	10.00–13.00
26	55–60	10.00–13.00
27	55–60	10.00–13.00
28	55–60	10.00–13.00
29	55–60	10.00–13.00
30	55–65	10.00–13.00–15.00

Since poles are taken only in five foot length classes it is impracticable to give the average length, as in the case of piles, where odd lengths are used. Also, since the length of poles which can be secured from trees of different diameters varies a great deal with locality and condition of the tree, it is considered better to indicate the limits of pole lengths rather than one length. Thus from trees 21 inches in diameter, poles may be secured 45, 50 or 55 feet long, according to the height of the tree, with values of $5.75, $8.00 or $10.00. Only a comparatively small number of trees 11 inches in diameter yield poles, so this is expressed, 0–25 feet.

The largest consumer of poles in this State, especially of the smaller sizes, is the Southern New England Telephone Company. This company has no fixed price for poles, as it varies with supply and demand. The following are average prices given by the company:

$3.00	for poles	30	feet long
4.50	"	40	"
6.50	"	45	"
9.00	"	50	"

These prices are for poles delivered along telephone lines. The specifications of the company follow:

1. All poles shall be of the best quality, live, sound chestnut, reasonably straight, free from large knots, and well proportioned from butt to tip.

2. They shall be furnished peeled, squared off at both tip and butt, and all knots shall be trimmed close.

3. Their minimum dimensions shall be as follows:

Length.	Diameter at Tip.	Circumference at Tip.	Circumference 5 ft. from Butt.
25 feet	7 inches	22 inches	34½ inches
30 "	7 "	22 "	37½ "
35 "	7 "	22 "	41 "
40 "	7 "	22 "	44 "
45 "	7 "	22 "	47 "
50 "	7 "	22 "	50 "
55 "	7 "	22 "	53½ "
60 "	7 "	22 "	56½ "

4. Poles will be subject to inspection at point of shipment, or upon receipt as called for, and any poles failing to meet the requirements of this specification will be rejected.

5. The Southern New England Telephone Company will be the sole judge in questions regarding the interpretation of this specification.

It will be seen that the prices paid by the telegraph and telephone companies for small poles is practically the same, while the prices for 45 and 50 foot poles are higher in case of the telephone company. The difference of one inch in diameter at the tip is hardly enough to allow longer telephone poles from trees of given diameters, especially when the circumference at five feet from the ground is taken into consideration.

Trees must be pretty straight to yield poles, and the proportion of straight trees in a forest varies a good deal in different places.

Chestnut Lumber.

Still more difficult to estimate than any of the above is the amount of lumber on a lot. There are various log rules by which sawed lumber is measured. One of the most common of these is the Doyle Rule. This rule gives too small results for logs of small diameter. By comparing the amount of lumber shown by the rule with that actually cut, factors were obtained by which the rule numbers were multiplied for obtaining the results shown in Table VIII.

TABLE VIII.—CHESTNUT VOLUME TABLE. BOARD FEET AND GROSS VALUE DELIVERED AT $18.00 PER M.

Diameter Breast High (inches).	Board Feet.	Value delivered.	Diameter Breast High (inches).	Board, Feet.	Value delivered.
7.....	12	$ .22	20.....	266	$ 4.79
8.....	22	.40	21.....	298	5.36
9.....	35	.63	22.....	335	6.03
10.....	47	.85	23.....	372	6.70
11.....	60	1.08	24.....	411	7.40
12.....	75	1.35	25.....	451	8.12
13.....	91	1.64	26.....	495	8.91
14.....	110	1.98	27.....	541	9.73
15.....	131	2.36	28.....	587	10.57
16.....	155	2.79	29.....	637	11.47
17.....	180	3.24	30.....	688	12.38
18.....	206	3.71	31.....	741	13.34
19.....	235	4.23			

In Table III we showed the application of Volume Table I to a given forest area. The following table, IX, shows the application of Tables IV, VI, VII and VIII to the same area.

TABLE IX.—YIELD TABLE. ONE-QUARTER ACRE, FARMINGTON, CONN. See Tables II and III.

Diameter breast high (inches).	Total number of trees.	Number of trees good for ties.	Number of 1st class ties.	Number of 2d class ties.	Number of piles.	Total value delivered.	Number of poles.	Value delivered.	Number of trees good for lumber	Lumber board, feet.
6	4	-	----	----	--	----	--	----	-	----
7	5	-	----	----	--	----	--	----	4	48
8	5	4	----	4.8	--	----	--	----	3	66
9	8	6	----	7.2	--	----	--	----	7	245
10	5	5	6.0	5.5	4	$6.96	--	----	4	188
11	1	1	1.9	1.1	1	1.92	--	----	1	60
12	2	1	2.4	1.0	2	4.08	1	$2.65	2	150
13	3	3	9.0	3 0	3	7.77	2	5.30	3	273
14	2	2	7.2	1.8	1	2.80	1	3.65	1	110
Total	35	22	26.5+ 2.08 cords	24.4+	11= 2.74 cords	$23.53+	4 = 7 piles= 2.74 cords	$11.60+ 13.51+	25	1140+ 1.18 cords

To obtain the yield per acre of chestnut in this forest and the gross value of the same delivered, the above results are multiplied by four.

This acre yields:—

		Gross value delivered.
(cut entirely into cordwood) 21.56 cords (see Table III) of chestnut at $3.00		$ 64.68
(cut into ties and cordwood)		
106 first class ties at 42 cents	$44.52	
97.6 second class ties at 30 cents	29.28	
8.32 cords at $3.00	24.96	
		98.76
(cut into piles and cordwood)		
44 piles	$94.12	
10.96 cords	32.88	
		127.00
(cut into poles, piles and cordwood)		
16 poles	$46.40	
28 piles	54.04	
10.96 cords	32.88	
		133.32
(cut into lumber and cordwood)		
4,560 board feet at $18 per M	$82.08	
4.72 cords at $3.00	14.16	
		96.24

The above figures are given more to illustrate the use of volume tables than to show the relative values from cutting a lot into the various products mentioned. To do this it is necessary to take into consideration the expense of manufacturing these products. It must also be borne in mind that a greater gross receipt could be obtained than any here given by utilizing each tree for what it is best adapted, in which case we would have poles, piles, lumber, ties and cordwood from the same lot, provided there was a market for all these.

The use of volume tables does furnish an indication of what chestnut can be most profitably manufactured into. A comparison of Tables IV and VIII shows that a first class tie is equivalent to about 31 board feet of lumber, from the fact that a 25 inch tree yields 14.4 ties, equivalent to 541 board feet. Calculating 31 board feet to the tie allows 32 ties per one thousand board feet, while most lumbermen allow 33. Tables I and VIII show that 370 board feet of lumber will cut one cord of wood, as a 17 inch tree yields .53 cords, or 180 board feet; a 23 inch tree yields 1.04 cords, or 372 board feet, and a 31 inch tree yields two cords, or 741 board feet.

LUMBERING.

As there are no virgin forests in the State, and no large tracts of timber, there is no lumbering in the sense that the term is used in the north woods or other lumber regions of the country. Farmers cut off their own lots, in many cases, hewing some of the logs into ties, cutting some into poles and the rest into cordwood. If there are saw logs, they may haul these to a water mill, of which there are many scattered about the State in a more or less dilapidated condition. A few of these mills are operated steadily, but most of them only a few days in the year. These mills usually charge the farmer $4.00 a thousand feet for sawing soft woods (including chestnut) and $5.00 a thousand for hardwoods.

By far the greater part of the lumbering of the State is done with portable saw mills. These mills usually have a maximum capacity of about ten thousand feet daily. Most of them have circular saws, but there are one or two in the State fitted with band saw. Most of the lumbermen of the State let out the various operations to contractors. They either buy the woodlots outright from the farmers, or they buy the timber on the lot, paying usually a lump sum rather than a stumpage price per unit of volume, as is common in other sections. Some of the portable mills are owned and operated by the lumbermen, but many of them are owned by men who simply take contracts for sawing. Other contracts are made for cutting and logging, and for hauling the manufactured lumber. The cost of manufacture to the lumberman therefore depends somewhat on whether he operates his own mill or whether there is a middle man who is also dependent on a profit.

MAKING AND HAULING LUMBER.

Replies to questions sent to some of the largest lumbermen of the State indicate that the cost of cutting, logging and sawing chestnut lumber varies from $5.00 to $6.25 a thousand feet B. M. The latter figure, given by Ely Brothers of Terryville, is the sum of $1.25 for cutting, $2.00 for logging, and $3.00 for sawing. The average cost of the three operations together is $5.50. The cost is, of course, slightly more for small timber than for large. The cost of hauling dry chestnut lumber three miles is $1.50 per M.; and of green lumber, $2.00.

Some place the latter as high as $2.50. Three miles is a short haul, the distance of the average lot from the market being five to six miles, which enables only one trip a day, thus doubling the cost of hauling. So the cost of hauling dry lumber this distance would be $3.00, and of green lumber, $4.00. At this distance chestnut wood is worthless. It costs about $1.00 per M. to pile lumber.

SUMMARY.

Cost of cutting, logging and sawing 1,000 feet B.M.	$5.50
" hauling (green) six miles	4.00
" piling	1.00
	$10.50

The market price of chestnut lumber ranges in different parts of the State, and according to quality, from $15.00 to $24.00 per M. Probably $18.00, the price paid by the New York, New Haven and Hartford Railroad for switch ties this year, is an average price. This leaves a profit of $7.50 per M. over all operations, from which, however, cost of stumpage must be deducted in the case of a purchased lot.

MAKING AND HAULING TIES.

Sawing ties is slightly more expensive than hewing. The average cost of cutting, $0.04; logging, $0.05; sawing, $0.05,—brings the total cost up to $0.14 to $0.15 and an additional cent for peeling, making $0.16. The cost of hewing varies from $0.08 to $0.10 apiece. But even for small logs it pays better to meet the extra expense of sawing where there is a saw mill, because considerable lumber can be sawed from the sides of logs, which is wasted when the ties are hewn. The cost of hauling 32 sawed ties is practically the same as for 1,000 feet of lumber, i.e. about $0.06 apiece for three miles, or $0.10 to $0.12 for six miles, but for hewn ties a little more, probably $0.08 apiece for three miles, or $0.15 for six miles.

SUMMARY.

Cost of cutting, logging, sawing ties	$0.15
Hauling six miles	.12
Total cost	$0.27
Cost of cutting and hewing ties	$0.10
Hauling six miles	.15
Total cost	$0.25

In both cases the profit depends upon the class of ties obtained. The New York, New Haven and Hartford Railroad pays 42 cents apiece for first class ties and 30 cents for seconds. The cost of manufacture and hauling are, of course, less for second class ties, but the figures given are average for both classes together, as they occur in Connecticut. If all ties cut were firsts, the net profit from 32, the equivalent of 1,000 board feet, would be $5.12. If they were all seconds, the profit would be only $1.28. In actual practice both classes are represented, and the profit is between these figures.

MAKING AND HAULING PILES AND POLES.

The cost of manufacturing poles and piles varies somewhat with the season, because they are more easily peeled in the spring than at other times. A common price for cutting and peeling poles is one cent a linear foot. Hauling is also a variable expense. For a three mile haul the following figures are given by a man who makes a business of furnishing poles:—

Length of pole (feet).	Cost of hauling.
25	$0.30–.40
30	.60–.75
35	.90–1.00
40	1.25
50	2.00
55–60	2.50
65	3.00

For a haul of six miles these figures would be about double.

SUMMARY.

Length of poles (feet), ...	25	30	35	40	45	50	55	60	65
Value delivered telegraph poles,	$1.70	2.65	3.65	4.65	5.75	8.00	10.00	13.00	15.00
Cost of cutting, peeling, hauling six miles	.85	1.50	2.15	2.90	3.50	4.50	5.00	5.60	6.65
Net profit ...	.85	1.15	1.50	1.75	2.25	3.50	5.00	7.40	8.35

MAKING AND HAULING CORDWOOD.

The cost of cutting cordwood varies with the kind and size of wood between 90 cents and $1.25 a cord. Hauling six miles costs about $1.50 to $2.00 a cord, so that the total expense of cutting and hauling amounts to between $2.40 and $3.25 a cord, and as chestnut wood rarely sells for over $3.00 a cord, it seldom pays to cut it at this distance from a market.

RELATIVE PROFIT FROM TIES, PILES, POLES AND LUMBER.

With the data at hand as to the quantity of various products which can be secured from chestnut trees of different sizes, and the cost of manufacturing the same, it is a simple matter to draw conclusions as to relative profit from ties, lumber, poles, piles and cordwood. It has already been shown that there is generally no profit in chestnut cordwood where the lot is over five miles from market. For a farmer owning a lot at this distance there should be a profit of $7.50 per thousand board feet where lumber sells for $18.00 per thousand. From 32 first class ties, the equivalent of 1,000 board feet, the profit is only $5.12. The relative profits from poles, lumber and ties can only be shown by comparison of different sized trees. The following table gives the average net profit from ties of various diameters standing in woodlots five or six miles from a market; in other words, the stumpage value,—when these trees are cut into ties, piles, poles and lumber. (See Tables IV, VI, VII, VIII.)

TABLE X.—CHESTNUT STUMPAGE VALUES AT SIX MILES FROM A MARKET.

Diameter Breast High (inches).	Stumpage value for ties.	Stumpage value for piles.	Stumpage value for telegraph poles.	Stumpage value for lumber at $18 delivered.
6	....	....	....	....
7	....	....	....	$0.09
8	$0.05	....	....	.16
9	.05	....	....	.26
10	.23	$0.37	....	.35
11	.35	.36	$0.85	.45
12	.42	.10	.85–$1.15	.56
13	.52	.00	.85– 1.15–$1.50	.68
14	.61	.00	1.15– 1.50– 1.75	.82
15	.72	.00	1.50– 1.75	.98
16	.81	.00	1.50– 1.75– 2.25	1.16
17	.91	.00	1.75– 2.25	1.35
18	1.02	.00	1.75– 2.25– 3.50	1.55
19	1.14	.00	1.75– 2.25– 3.50	1.76
20	1.26	.00	2.25– 3.50	2.00
21	1.42	.00	2.25– 3.50– 5.00	2.24
22	1.60	loss	3.50– 5.00– 7.40	2.51
23	1.80	loss	3.50– 5.00– 7.40	2.79
24	2.02	....	5.00– 7.40	3.08
25	2.26	....	5.00– 7.40	3.38
26	2.55	....	5.00– 7.40	3.71
27	2.80	....	5.00– 7.40	4.06
28	....	....	5.00– 7.40	4.40
29	....	....	5.00– 7.40	4.78
30	....	....	5.00– 7.40– 8.35	5.16
31	....	....	....	5.55

CONCLUSIONS AS TO RELATIVE VALUE OF DIFFERENT PRODUCTS.

Several important conclusions may be drawn from the preceding table. First of all is the fact that straight trees pay considerably better cut into poles than in any other way, while there is no profit in piles six miles from the market at the prices mentioned. Lumber, of course, pays better than ties. If this were more generally understood there would be no sawed ties on the market until prices are raised to correspond with those for lumber. Of course hewn ties are the most profitable utilization the farmer can make of his more crooked trees in the absence of a sawmill. They will always be one of the chief products of the improvement thinnings previously described. Stumpage values in the above table should be understood to mean the profit the farmer can derive if he acts as his own lumberman. He cannot expect to receive these prices for the stumpage from lumbermen, since they in turn must make their profit.

RATE OF GROWTH OF CHESTNUT.

In considering the rate of growth of the chestnut, it is necessary to bear in mind that chestnut has two methods of reproducing itself which materially affect the rate of growth. Trees grown from the nut make very little headway for the first few years, since they have to first develop a root system. Those which sprout from old stumps obtain their nourishment through the old root system, so that they often grow six feet high the first year. On the other hand, trees grown from nuts are longer lived and grow better in old age than do those coming from sprouts.

Height Growth.

It is often difficult, especially in the case of single trees, to distinguish nut grown trees (seedlings) from sprout grown (sprouts). In the following table, XI, the third and fifth columns show the number of trees belonging to each class which were measured for this study of growth. It will be noticed that practically no seedlings were measured less than forty years old, while the majority of the sprouts were less than sixty years old. This is no doubt largely due to the fact that the latter class do not live to an old age as do the first class. It may seem peculiar that the sprouts analyzed form themselves into two distinct age groups; one about 25 years old, and the other 45 to 55 years. This is probably not so much indicative of the age of chestnut through the State as of the fact that most of the analyses happened to be taken in even-aged stands of these ages. Up to the age of 55 the sprouts are considerably higher than the seedling trees, but from that age on, the latter have greater height. In both cases height growth is practically at a standstill after the age of seventy.

Table XI gives the average height of sprouts and seedlings of various ages from 20 to 105 years.

TABLE XI.—AGE-HEIGHT TABLE. CHESTNUT.

Age (years).	Trees grown from nuts. Height feet.	No. of trees measured.	Tree grown from sprouts. Height feet.	No. of trees measured.
20	..	..	36	5
25	..	1	45	75
30	..	..	52	6
35	48	1	57	5
40	54	3	62	8
45	60	11	65	25
50	64	16	67	27
55	68	9	69	20
60	71	11	70	2
65	73	9	71	3
70	75	7	72	9
75	76	2	73	2
80	77	4	74	..
85	78	7	75	2
90	79	6	75	5
95	79	2	76	1
100	79	6	77	2
105	79	12	77	2
		107		199

DIAMETER GROWTH.

Most of the difference in diameter growth between sprout and seedling chestnut occurs during the first decade. In the trees measured, varying from 20 to 105 years in age, little difference could be distinguished beyond this early period between the two classes. In fact, the increased growth of the seedlings seems to compensate for the early start of the sprouts.

The average age of chestnut for different diameters from 3 inches to 30 inches is given in Table XII.

TABLE XII.—CHESTNUT. AVERAGE AGE FOR TREES OF DIFFERENT DIAMETERS.

Diameter Breast High (inches).	Age (years).	Diameter Breast High (inches).	Age (years).
3.........	19	17.........	64
4.........	22	18.........	68
5.........	25	19.........	71
6.........	29	20.........	74
7.........	32	21.........	78
8.........	35	22.........	81
9.........	39	23.........	84
10.........	42	24.........	88
11.........	45	25.........	91
12.........	48	26.........	94
13.........	51	27.........	97
14.........	55	28.........	101
15.........	58	29.........	104
16.........	61	30.........	108

It will be seen from the above table that the average length of time required for chestnut to grow one inch in diameter is three years, and that this growth is fairly uniform up to thirty inches in diameter.

One must not make the mistake of thinking that this table can be turned about. The average diameter of trees 108 years old would not be 30 inches, etc.

A uniform diameter growth means a constantly increasing growth in volume and value, for a tree ten inches in diameter growing one-third of an inch a year produces much more wood than a tree five inches and growing at the same rate.

The following table shows, of course, that the greatest percentage of increase in growth is during the early life of the tree, while it is still small; and that this percentage falls off at a uniform rate until it gets as low as two per cent. For volume alone it would not pay to leave a chestnut tree after it reaches the diameter of 19 inches, when its rate of growth falls below four per cent. per annum compound interest. As a matter of fact, however, trees which will yield poles can profitably be left until they reach the diameter of 25 inches if they are in thrifty condition. The grade of material taken from large trees is so much higher than that taken from small trees that pole trees increase in value up to this size at the rate of six per cent. compound interest. This is not a steady increase, because the increase in price of poles is irregular.

TABLE XIII.—Increase in volume and value of chestnut, and the rate of increase at different periods.

Diameter Breast High (inches).	Volume in cu ft. (See Table I.)	Annual* percentage of increase in volume.	Stumpage value at 6 miles from market. (See Table X.)	Class of material.	Annual* percentage of increase in value.
3	.7	....	....	....	....
4	2.	42.2	....	....	....
5	3.5	19.4	....	....	....
6	5.2	14.1	....	....	....
7	7.2	11.4	.09	lumber	....
8	10.	11.3	.16	"	23.9
9	12.	6.2	.26	"	17.5
10	15.	7.7	.37	pile	12.4
11	19.	8.1	.85	pole	31.9
12	23.	6.5	1.15	"	10.5
13	27.	5.4	....	....	....
14	31.	4.7	1.50	pole	6.9
15	37.	6.08	....	....	....
16	42.	4.3	1.75	pole	2.5
17	48.	4.6	....	....	....
18	55.	4.5	2.25	pole	4.2
19	62.	4.07	....	....	....
20	69.	3.6	3.50	pole	7.6
21	77.	3.7	....	....	....
22	85.	3.3	5.00	pole	6.1
23	93.	3.04	....	....	....
24	102.	3.1	7.40	pole	6.7
25	112.	3.1	....	....	....
26	122.	2.9	....	pole	....
27	132.	2.6	....	....	....
28	143.	2.6	....	pole	....
29	154.	2.5	....	....	....
30	164.	2.1	8.35	pole	.69
31	175.	2.1	....	....	....

* Obtained from the formula: $l = ar^{n-1}$ where a = first term, l = last term, n = number of terms. Thus $2.0 = .7r^3$ (Table XII shows that it requires 3 years to grow one inch) $r = \sqrt[3]{\frac{20}{7}} = 42.2$.

These conclusions have practically nothing to do with determining when a woodlot should be cut. We have already stated that most sprout lots should be cut by the time they are fifty years old, but at that age there are few trees twenty inches in diameter. The reason for this conclusion is that the woodlot as a whole deteriorates after that age more than the individual trees increase. It may often be advisable to leave a few chestnut seedlings per acre along with oak and hickory at the time of the final harvest, as has been suggested.

Throughout the woods of the State there are individual chestnut trees of different age and size from that of the surrounding woods. The owner often wishes to know what policy to pursue in regard to these individual trees.

If they are to be used for fuel alone, they should be cut when they are 20 inches in diameter.

If sound and straight enough for poles, they may profitably be left until 25 inches in diameter.

Having decided that chestnut increases in value up to the diameter of 25 inches under good health conditions, the question naturally arises whether chestnut begins to decay before this period, for if so, this would be a reason for cutting trees at smaller sizes.

The following table shows the proportion of sprouts and seedlings partially decayed in the trees measured for this study.

TABLE XIV.

Diameter (inches).	Sprouts. Number of Trees.		Per cent. decayed.	Seedlings. Number of Trees.		Per cent. decayed.
	Trees sound.	Partially decayed.		Trees sound.	Partially decayed.	
3–5	42	15	26	..	..	..
6–10	66	15	18	12	0	0
11–15	56	24	30	46	6	11
16–20	8	5	38	28	7	20
21–25	4	8	66	12	8	40
26–30	2	3	60	6	2	25
31–35	0	1	100	2	1	33
	178	71	28	106	24	19

This table shows a much greater proportion of sprouts affected by disease than seedlings, especially among the smaller sizes. This is due to the fact that fungus diseases from the old stumps are liable to grow up into the trees sprouting from them.

The table also shows that both sprouts and seedlings have a very much greater proportion of disease as they reach the diameter of 20 inches. These figures indicate that it is safer policy, as a rule, to cut trees when they reach this diameter, than to leave them. As the average age for this size is 75 years, this corresponds fairly well with the age at which chestnut has been shown to reach its main height growth.

Lest it should seem that 28 per cent. and 19 per cent. are large proportions to be diseased, it should be remarked that many of these are just beginning to decay, the remainder being absolutely sound throughout.

SPROUTING OF CHESTNUT.

The sprouting ability of chestnut apparently does not follow any regular rules. It seems to sprout equally well in all parts of the State and at various altitudes where the species exists, provided there is plenty of fair soil. A study was made of the question from various aspects, but without results. An attempt was made to discover whether seedlings or sprouts when cut produced the largest number of sprouts. The number of sprouts from seedlings varied from 2 to 145, while those from sprouts varied from 1 to 123, most stumps having from two to ten sprouts. In fact, sprouts from sprouts were found to have undiminished ability for resprouting. This is evident all through Connecticut, where we find thrifty trees of the fourth or fifth generation from the nut. Instead of the number of sprouts diminishing with the age of the mother stump, as would be expected, more sprouts were found from old stumps. For example, the stump which sent up 145 sprouts was 111 years old, and one which had 122 sprouts was 75 years old. These figures might lead to the belief that it was simply a matter of the size of the original stump and the room it afforded for sprouts. While it is a fact that the small stumps do not have great numbers of sprouts, it is also a fact that many of the large stumps have only a few sprouts. Neither does the soundness and recent growth of the mother tree have any apparent effect on the number of sprouts, one tree which had been growing only one twenty-eighth of an inch in diameter a year having 145 sprouts, while another growing at the same slow rate had only two sprouts. Of course stumps largely decayed have fewer sprouts.

No rules can be laid down, therefore, regarding the cutting of woodlots for sprout reproduction except those which relate to the after development of the sprouts.

BEST DEVELOPMENT OF CHESTNUT.

Of not less importance than the average development of chestnut, which has hitherto been discussed, is the development which it attains under more favorable conditions. Probably the largest chestnut in Connecticut as regards girth is in Branford, and has a circumference of 23½ feet at its smallest point below the branches.

The largest chestnut of known age was three feet in diameter at breast height, and 98 feet high. This was 110 years old, and scaled 1,225 board feet. It grew in Hampton, Conn. It made its best growth between the ages of 40 and 70 years.

The oldest tree analyzed was in Washington, Conn., and was 135 years old. This was only 21 inches in diameter and 68 feet high. It was unsound, but sawed into eleven ties. Of course the Branford tree must be very much older than this, probably over 250 years, and other large trees indicate very old age. Evidently the scarcity of old chestnut is due to cutting rather than to any weakness on the part of the species.

TABLE XV.—AVERAGE AND MINIMUM LENGTH OF TIME REQUIRED FOR A CHESTNUT TREE TO PRODUCE VARIOUS NUMBERS OF TIES.

Number of ties per tree.	Average age of tree.	Minimum age of tree.	Kind of tree.
1......	30	21	Sprout
2......	36	21	Sprout
3......	42	26	Seedling
4......	47	28	Sprout
5......	52	38	Sprout
6......	56	42	Seedling
7......	60	47	Seedling
8......	63	50	Seedling—2 trees alike
9......	65	52	Seedling
10......	68	62	Sprout
11......	70	50	?

This table is of more interest as showing the minimum age at which various numbers of ties can be raised by individual trees, than for the average age. The average age of trees producing six ties is given here as 56 years, but this is a variable figure, depending entirely on the trees analyzed, which happen to produce six ties. The fact that eleven ties have been produced by a tree in fifty years is definite, and shows what the species is capable of doing.

It will be noticed that these exceptional trees are evenly divided between sprouts and seedlings. They were all dominant trees, i.e. they stood alone, not being shaded by other trees. The 21 year tree which produced two ties had a crown 15 × 20 feet, occupying about 254 square feet. So it would be possible to grow 171 such trees per acre. This was a sprout from a seedling tree. The sprout which produced four ties in 28 years was the only one from its mother stump. It scaled 83 feet of lumber. The sprout which gave five ties in 38 years would have sawn into 130 board feet, or made a pile forty feet long. It grew with one other sprout. The 62 year sprout, sawing into ten ties, scaled 284 feet B. M.

Of the seedlings, the one producing three ties in 26 years scaled 75 feet B. M., and had a crown occupying 800 square feet, so that only 54 to the acre would be possible. This tree grew in diameter 1.2 inches in the past year. The tree 42 years old scaled six ties, or 206 feet B. M., or made a pile fifty feet long. In the decade between its seventeenth and twenty-seventh year it increased its diameter from 8 to 14 inches.

SUMMARY.

In the foregoing we have tried to indicate wherein forestry differs from the usual method of handling the woodlot, and have shown what may be expected as financial results from such treatment. Forestry is particularly a good investment for the farmer, or for the owner of a large estate (a class which is growing in Connecticut), for the manufacturing company which requires a permanent supply of wood, for a railroad company requiring a permanent supply of ties, or for a water company which has woodland for the protection of its watershed, and last, but especially, for the State. It is not to be advised for the lumberman who buys only the timber without the land, for he cannot make a sacrifice for the benefit of some one else.

Almost every farmer owns a woodlot. These lots are usually left to care for themselves, the farmer cutting small sections clear when he desires wood. As soon as the trees bear one or two ties he cuts the wood off or sells it, usually for less than it is worth, to a lumberman. He is particularly able to make thinnings profitably, because he can do the work himself at a time of the year when he is least busy, and because he can use the material removed in his own household. Farmers should also appreciate that straight trees pay best made into poles, and that lumber is more profitable than ties, and should carefully estimate the value of their lots before selling to lumbermen.

Land in Connecticut is probably as cheap now as it ever will be, and many good investments can be made in land covered with thrifty, rapid-growing sprouts. The State has purchased 1000 acres of such land in Portland at an average cost of $1.64 an acre. Many of these lots purchased at $4.00 will be worth $40.00 an acre in twenty-five years at present prices. It is probable that the price of chestnut and our other native woods will increase considerably as timber in other parts of the country becomes scarce. Men who invest in this kind of property can considerably increase their interest by applying forestry methods.

Some manufacturing companies require so much wood annually that they are obliged to import much of it from great distances, even from other States. The woods in the neighborhood of Waterbury have been cut off so frequently and have been so damaged by fire that their productivity has been seriously impaired. A certain manufacturing company in that region uses 16,000 cords of wood per annum. This is the annual product of fully 32,000 acres of such land as forms most of the Naugatuck watershed. Yet it is perfectly possible to raise this 16,000 cords annually on 25,000 acres, and a tract of that size could probably be purchased for $75,000 within a few miles of the factory. The interest on $75,000 at four per cent. and taxes at two per cent. amount to $4,500. The cost of 16,000 cords at $3.00 (plus $1.00 for transportation) is $64,000. The cost of manufacturing and transportation could not bring the expense up nearly to these figures, so the desirability of forestry in such a case depends entirely on the permanency of a business.

It is becoming more and more difficult for railroad companies to secure ties, and the price is rising already. The New York, New Haven and Hartford Railroad uses 1,500,000 ties annually, which cost fully half a million dollars. These are mostly grown in Connecticut and Rhode Island. As it is undoubtedly possible to raise eight ties per acre per annum on most land in the State under good management, it would require 187,000 acres to continually supply this company with ties. This could probably be purchased in different parts of the State for $935,000. Four per cent interest on this amount is $37,400, and taxes at two per cent. would amount to $18,700, and the cost of maintenance and manufacturing would still leave a large saving as compared to an annual expenditure of $500,000. The profitableness of forestry in this case is especially to be found in the fact that the company would be assured of a permanent supply of ties.

Water companies could derive a regular income by a series of thinnings in their woodlots, planned in a systematic way so that by the time the whole tract had been gone over once the lots first thinned would be ready to thin again.

For the State the proposition is better than for any other body, for the State is supposedly a permanent organization which must always require an income. European nations derive considerable portions of their running expenses from such state forests, and our own national government and some of the States are entering upon the policy of forest ownership. Besides yielding a permanent revenue, these forests will supply larger timber than those under private ownership, and will thus be a benefit to the communities in which they are located. Connecticut has barely entered upon this policy of State ownership, having acquired, as an experiment, 1000 acres in Portland and 300 acres in Union.

ASSISTANCE GIVEN TO WOODLAND OWNERS.

Two years ago the Experiment Station through the forester issued a circular offering expert advice on the treatment of woodland to any land owners of the State, without other expense to them than incidental traveling and board.

The character of the advice given depends upon the size of the tract and the class of owner. To the farmer with a woodlot of moderate size the forester usually gives a few hours of instruction in selecting trees to be thinned, marking the trees on a few acres in the presence of the owner.

For a tract of over one hundred acres owned by an individual or corporation a detailed plan of management is drawn up covering work for a series of years, usually ten years. If the plan is satisfactory to the owner, the forester supervises each year the marking of the trees to be removed.

Application for assistance of this kind should be sent to the forester, whose office is at the Experiment Station, New Haven.

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