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UNIVERSITY OF ILLINOIS,
Agricultural Experiment Station.

CHAMPAIGN, MAY, 1893.

BULLETIN NO. 26.

THE FOREST TREE PLANTATION.

Preliminary History.

The first official act in the establishment of this experiment was the report made to the Board of Trustees of the University by its Committee on Horticulture, November 18, 1865. The members of the committee were Burden Pullen, Samuel Edwards, O. B. Galusha, M. L. Dunlap, and W. C. Flagg. The following is taken from the report:

The great feature of these horticultural grounds, and what is of paramount importance at this time to the whole people of the state, is the planting of forest trees for useful purposes. It is a new demand upon their industry and upon their lands, from which they cannot fail to reap the most valuable results.

The new condition of things created by railroads and improved agricultural implements presents new industries, both to the cultivators of the soil and to the mechanic, in which they have a mutual interest. The forests are rapidly disappearing, or at least those useful trees that have a commercial value, and yet many of the new demands have not been met nor is the old supply likely to hold out. But if the forests of Michigan, Wisconsin, Minnesota, and Indiana were adequate to the demand, as a matter of economy in freights, if not in the superior quality of our second growth timber, especially of the deciduous varieties, it is an object to grow them at home rather than to buy them.

Timber for railroad ties, culverts, cars, roadways, and buildings, fencing, vineyard stakes, hop poles, stanchions for coal banks; soft wood, like white willow and the poplars, for berry boxes, crates, and staves; hoop poles, carriage and wagon material, agricultural implements, and the multiform wants of the age, make up a demand of most surprising magnitude, that will add to our rural industry an importance that the most sanguine have not heretofore dreamed of.

If we look at this as simply the demand of agriculture, it must be conceded that it is legitimate and ought to be granted without an objection; but we have added to this the claim of the mechanic, who is also largely interested, for it will enable him to compete with those of other states in the supply that commerce demands.

The state that sells the raw products of its soil is never rich, while the states that manufacture for others do well; those that grow the raw material and manufacture it at home are the most prosperous. No doubt the State of Illinois had these facts in view when it established this great school of the industries for the especial benefit of those two classes who create the wealth of the state.

There are in this state about eighty species of forest trees, besides the larger shrubs. With the exception of the oaks, yellow poplar, and hickory, we have not drawn largely from our native forests, and to-day we purchase nearly all of our...
timber. Nearly all of the ash timber used for agricultural implements, a part of our fence posts, and a portion of our railroad ties come from other states. Added to these are the greater part of the material for our wagons and carriages; when not wholly manufactured in other states; the timber for railroad cars, and the hardwood lumber for many other useful purposes, that ought to be grown near the place of manufacture.

To bring these useful trees within the bounds of culture and to utilize them is one of the objects of this industrial institution. To teach the people of the state how to add these products of the forest to their other crops, and thus add millions of dollars annually to the wealth of the state, to give labor a wider range and a more comprehensive field for its employment, are objects worthy of such an institution.

Thousands of acres of timber can be planted in shelter belts, to check the winds that come down from the north, with its polar cold, destroying the plants that the genial summer, fanned with the breath of the tropics, has made to flourish on our open plains. Wall in these prairies of central and northern Illinois with belts of conifers and deciduous trees, and we shall have one of the best of climates, genial and equable; and with the best soil in the Union, with a geographical position midway between the two oceans, over which must pass a large part of the commerce of the world, if we are not laggards in the world's progress we may reap from such surroundings a rich reward.

The committee has divided these thirty species of useful forest trees into three classes, according to their supposed value for the demands of commerce and for domestic use. In the first class they include the European larch, Austrian pine and Norway spruce, native trees of Europe, and the osage orange, native of the southwestern states. In the second and third classes white willow, a native of Europe; black spruce and Norway pine, natives of the more northern states. Thus making up the list with four European, three of other states, and twenty-three species from the forests of Illinois.

Our other native trees of minor importance will find a place in the arboretum, where those of other sections of this continent and of Europe may be tested side by side. It is probable that among them may be found many of value.

**First Class.** European larch, osage orange, white pine, white ash, Austrian pine, green ash, arborvite, blue ash, red cedar, Norway spruce.

**Second Class.** White sugar maple, black sugar maple, American chestnut, shell-bark hickory, cucumber, Norway pine, silver leaf maple, tulip, white willow, black walnut.

**Third Class.** Red maple, white elm, red elm, butternut, catalpa, hemlock, basswood, white oak, black spruce, bur oak.

The white pine, Austrian pine, Norway spruce and hemlock to be planted eight by eight feet: all others four by four feet. The former requiring six hundred and eighty trees to the acre, and the latter two thousand, seven hundred and twenty. The above distances to be varied to some extent by way of experiment, to ascertain, by actual trial, the most proper distances for the planting of the several species.

In accordance with this report an appropriation was obtained from the state legislature, from which $1,000 was set apart, March 11th, 1869, for trees and seeds.

**Location of Plantation and Character of Soil.**

The experimental forest tree plantation of the University was begun in the spring of 1871; since then additional plantings have been made from time to time. It is located upon the east end of what is known as the experiment farm, and at present comprises about thirteen acres planted. The land was originally prairie, but had been under cultivation for thirty or more years, mostly in corn. A part, however, had been too wet for tillage, and was used for pasture or meadow. Through this portion, before the trees were set, an open ditch was dug, which rendered the ground sufficiently dry for planting. The soil is the black loam common to the prairies of central Illinois, but varies a good deal as to richness in different parts. On the highest portions the wash of many years and the continual cropping without fertilization in any
<table>
<thead>
<tr>
<th>European Larch</th>
<th>Alpine</th>
<th>White Pine</th>
<th>Wood</th>
<th>Scotch Pine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Peter</td>
<td>Dabbled</td>
<td>Heartwood</td>
<td>White</td>
<td></td>
</tr>
<tr>
<td>Dooling</td>
<td>Yellow</td>
<td>Black Jack</td>
<td>Apple</td>
<td></td>
</tr>
<tr>
<td>Horse Chest</td>
<td>Black</td>
<td>Adirondac</td>
<td>Maple</td>
<td></td>
</tr>
<tr>
<td>Horse Chest</td>
<td>Black</td>
<td>Adirondac</td>
<td>Maple</td>
<td></td>
</tr>
</tbody>
</table>

**Plat of Forest Tree Plantation**
way had left the soil so poor that the common farm crops failed to be remunerative; while some of the lower parts have a deep vegetable loam overlying tenacious clay. In no case, however, has manure been applied—probably none had ever been applied—to any portion of the land upon which the plantation exists. As far as practicable, advantage was taken of this diversity of soil and location in planting, so as to suit the requirements of the several kinds of trees. The tract is one hundred and six rods long from north to south. The rows of trees run north and south. An east and west roadway divides the plantation into two equal portions.

Varieties of Trees.

The kinds of trees originally selected were such as were esteemed of special value or importance, but owing to various causes the list as first made has not been completely filled, while a few other kinds have been added. The following species of trees have been planted. The names are those of Gray's Manual.

Basswood (Tilia Americana).
Tree of heaven or ailanthus (Ailanthus glandulosus).
White, silver, or soft maple (Acer dasycarpum).
Sugar, rock, or hard maple (Acer saccharinum).
Box elder or ash leaved maple (Aegungo aceroides).
Three thorned accacia or honey locust (Gleditschia triacanthos).
Hardy catalpa (Catalpa speciosa).
Tender catalpa (Catalpa bignonioides).
Green ash (Fraxinus viridis).
American or white elm (Ulmus Americana).
Osage orange (Maclura aurantica).
Butternut or white walnut (Juglans cinerea).
Black walnut (Juglans nigra).
Shell-bark or shag-bark hickory (Carya alba).
Big shell-bark or king nut (Carya sulcata).
Bur oak, over cup, or mossy cup (Quercus macrocarpa).
Chestnut (Castanea vesca).
White willow (Salix alba).
White pine (Pinus strobus).
Austrian pine (Pinus Austriaca).
Scotch pine (Pinus sylvestris).
Norway spruce (Abies excelsa).
European larch (Larix Europaea).
Red cedar (Juniperus Virginiana).

Method of Planting.

Most of the trees were purchased as seedlings, one to three years old, of various nurserymen, and were placed in the nursery for about two years. The larch were planted directly in the forest when one year old, and the first chestnuts at two years. The catalpa, butternut, black walnut and bur oak were grown in nursery from seed, the white willow from cuttings, while the box elder, chestnut second planting, and the two hickories were planted as seed directly in the forest. In this latter way were also planted white oak and pecans, both of which failed—the former mainly from the depredations of rabbits and mice digging and eating the acorns, the latter by being plowed up by a careless employé. These have not been replanted. The ailanthus, honey locust, and linden were transferred from the nursery when about six to eight feet high.
Later some apple were planted when four or five years from the root-graft. All of the early planting was done in rows four feet apart, and with the exception of Scotch, Austrian and white pine, two feet in the row. At this time it was strongly argued that the trees would make a more upright growth if planted very close, and that the trimmings from time to time would be a source of profit. The later plantings, however, including the hardy catalpa, linden, ailanthus, honey locust, oak, and the transplanted hickory, were made in rows eight feet apart, and with the trees usually four feet apart. The method of planting for all small trees was as follows:

The ground being put in good condition by plowing, harrowing, and the use of a plank "clod-crusher," a line was stretched the length of the proposed row, when by walking upon the line a straight mark was made, sufficiently distinct for the purpose, after the line was removed. Two men went together, one with a spade or shovel, the other with an armful or basketful of seedling trees. Guided by the mark the former raised a shovelful of earth, the latter put into position a young tree; the earth held upon the shovel for the purpose was now thrown on the roots, and was tramped down by the man carrying the trees. In this expeditious way the work was done well, and at comparatively little cost. The planting of the larger trees was necessarily attended with much more labor, in excavating a sufficiently large and deep hole, in digging and distributing the trees, and in more carefully filling around the roots, while the result with the small stock ordinarily proved more satisfactory.

The seeds of the box elder, oaks, chestnut, and hickories mentioned above, were planted in the autumn as soon as gathered; otherwise the planting was all done in the spring, and as early as possible. As stated, the chestnuts and acorns were destroyed by rabbits and mice; otherwise the fall-planted seeds did excellently well.

Cultivation, Trimming, and Thinning.

The young trees were cultivated during several summers, usually about five, just as corn is worked. While the trees were small enough, two-horse corn cultivators were used, after which one-horse double-shovel plows. For the first two seasons the rows were also hoed out about twice each year. Some of the later plantings were not so well cultivated, with sufficient indications of the fact in the less satisfactory results.

As soon as the trees shaded the ground, so as to keep down an injurious growth of weeds, cultivation was discontinued; after this very little expense was involved in the management of the plantation.

Up to the year 1888 there was but little trimming except such as always comes naturally to thickly grown trees. The branches of all deciduous trees soon decay and fall off, and this has given most of the older trees clean trunks ranging from ten to thirty feet. In most of the pine and pine-like trees the dead branches, being full of resin, remain for
a long time, and, as the tree grows around them, they make loose knots in the timber.

In the winter of 1888-9, the white, Austrian, and Scotch pine trees were trimmed up to a height of about ten feet, though not all the dead wood was taken off. The branches of the white pines are dead now to a height of twenty to twenty-five feet, in some cases more. The Scotch and Austrian pine branches have not died so high. During February of the present year the Norway spruce and European larch have been trimmed; the spruce to the height of about eight feet and the larch to ten or more. The spruce were trimmed as high as all the branches were dead; but the larch have but few live branches until a height of twenty feet or more is reached.

From time to time the rows were thinned so that the remaining trees stood four to six or eight feet apart, and after about seven years alternate rows were cut out from the ash, Norway spruce, larch, butternut, black walnut, soft maple, osage orange, tender catalpa, and elm. The remaining rows were further thinned, in some cases as the trees were required to be set out on the University grounds, or for use on the farm, as posts, etc.; or in the case of the pines, as the trees died. Some of the trees have been trimmed up—the lower branches being cut away so as to leave a clean trunk several feet high; but by far the greater number have been left to trim themselves.

MISTAKES IN VARIETIES.

In the spring of 1869 there were purchased 3,000 seedlings of green ash, and special pains was taken by the committee to secure a lot of white ash. The search for seedlings of the latter caused a delay of one year, when 20,000 seedlings, believed to be of this species (*Fraxinus Americana*) were secured.

It certainly requires the knowledge and acuteness of an expert to identify this species in the seedling state; though the seeds themselves and the matured trees are quite readily recognized. The second lot of seedlings was green ash, though named in the reports for several years as white ash. It may be well to state also that an attempt followed to get genuine white ash seed; an order was made on one of the best nurseries in the country for a sufficient amount of seed to furnish the required seedlings. This seed upon arrival was pronounced green ash again, but the dealer being confident to the contrary, some of it was planted and green ash seedlings appeared. Once more true white ash seed was gathered, but for some reason, probably because allowed to become too dry, only a small proportion germinated. No white ash has yet been planted in the forest. The mistake here made is a very common one in the country generally, and is productive, as in this case, of serious consequences. It is the more to be regretted because of the easy identification of the seed of the several species of ash; no nurseryman need blunder in planting.
In a similar way 10,000 seedlings of "black" sugar maple (Acer nigrum) were purchased of one nurseryman and a like quantity of "white" sugar maple (Acer saccharinum) of another. Both proved to be the latter. In this case, however, the distinctions are not so pronounced. Botanists now usually make the former a variety only of the latter, the recognized difference not being deemed sufficient for specific distinction. Furthermore there is little difference in the trees for timber purposes.

When this plantation was commenced, attention had not been called to the fact that there were two kinds of catalpa, differing from each other in very important particulars for the purpose of timber-growing as well as other uses; but two species are now recognized: C. speciosa, the hardy western type, and C. bignonioides, the tender or south-eastern type. Unfortunately the latter was used in our first planting. Indeed, the true western type of this tree, indigenous in the Mississippi Valley, though so much better than the eastern variety, was rarely seen in cultivation even in western localities until within the last fifteen years. We now know that the two kinds are easily distinguishable, and as the seeds are sufficiently unlike, no further mistake should be made. As the records will show, the two kinds give very different results in the plantation.

Differences in Varieties.

In this connection mention should be made of the difference in varieties of many species of timber trees and of the capital importance of attention to these differences in selections for practical arboriculture. The white elm (Ulmus Americana) varies so much that woodsmen have several special names for the kinds, of which some are very valuable for certain uses, while others are worthless. The same may be said of box elder, tulip poplar (Liriodendron tulipifera), and cottonwood. Some differences are due to soil and situation (a thing also worthy of study), but the seed of certain trees gives very different stock from that of certain other trees of the same species; sometimes the varieties grow mixed together in the same region of country, sometimes the distinctions are seen only in trees geographically separated. The so-called yellow cottonwood of the Mississippi Valley, the wood of which is readily split and worked, is specifically identical with the almost worthless common cottonwood (Populus monilifera) of our part of the country.

History of the Plantation.

As a further contribution to the history of the plantation, extracts from some of the annual reports are here appended, together with tables taken from the same. It is interesting to note the estimation placed upon the results at the times reported:
### Forest Record for 1871

<table>
<thead>
<tr>
<th>Name</th>
<th>No. acres</th>
<th>No. of trees</th>
<th>Age when planted or height</th>
<th>Cost of planting</th>
<th>Cost of cultivation</th>
<th>Cost of dist. planted</th>
<th>Dist. planted</th>
<th>Per cent living</th>
<th>Av. growth in feet.</th>
<th>Total cost to date.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash, green</td>
<td>1/4</td>
<td>1,360</td>
<td>3 yrs.</td>
<td>$27.20</td>
<td>$6.95</td>
<td>$6.19</td>
<td>2x4 98</td>
<td>-5</td>
<td>-</td>
<td>$40.34</td>
</tr>
<tr>
<td>Ash, white</td>
<td>2 1/4</td>
<td>14,974</td>
<td>2</td>
<td>149.74</td>
<td>35.63</td>
<td>4.79</td>
<td>2x4 95</td>
<td>-5</td>
<td>-</td>
<td>190.16</td>
</tr>
<tr>
<td>Catalpa</td>
<td>1/4</td>
<td>1,361</td>
<td>2</td>
<td>21.77</td>
<td>4.17</td>
<td>2.53</td>
<td>2x4 100 1</td>
<td>1</td>
<td>-</td>
<td>28.47</td>
</tr>
<tr>
<td>Chestnut</td>
<td>1/4</td>
<td>1,361</td>
<td>2</td>
<td>30.00</td>
<td>6.79</td>
<td>3.95</td>
<td>2x4 50</td>
<td>-5</td>
<td>-</td>
<td>40.74</td>
</tr>
<tr>
<td>Elm, white</td>
<td>1/8</td>
<td>860</td>
<td>2</td>
<td>4.76</td>
<td>3.95</td>
<td>3.43</td>
<td>2x4 100 1</td>
<td>1</td>
<td>-</td>
<td>12.14</td>
</tr>
<tr>
<td>Larch, European</td>
<td>2</td>
<td>10,801</td>
<td>1</td>
<td>98.01</td>
<td>21.20</td>
<td>8.50</td>
<td>2x4 25</td>
<td>-5</td>
<td>-</td>
<td>127.71</td>
</tr>
<tr>
<td>Maple, white</td>
<td>1/8</td>
<td>680</td>
<td>3</td>
<td>8.16</td>
<td>6.17</td>
<td>3.89</td>
<td>2x4 98 2</td>
<td>1</td>
<td>-</td>
<td>18.22</td>
</tr>
<tr>
<td>Osage orange</td>
<td>1/4</td>
<td>1,361</td>
<td>2</td>
<td>5.44</td>
<td>4.78</td>
<td>1.30</td>
<td>2x4 98 2</td>
<td>1</td>
<td>-</td>
<td>11.52</td>
</tr>
<tr>
<td>Pine, Austrian</td>
<td>1/4</td>
<td>680</td>
<td>g1012in</td>
<td>30.00</td>
<td>4.40</td>
<td>2.94</td>
<td>4x 2</td>
<td>1</td>
<td>-</td>
<td>37.34</td>
</tr>
<tr>
<td>Pine, Scotch</td>
<td>1/4</td>
<td>680</td>
<td>110 2 ft</td>
<td>30.00</td>
<td>4.25</td>
<td>3.04</td>
<td>4x 2</td>
<td>1</td>
<td>-</td>
<td>37.29</td>
</tr>
<tr>
<td>Walnut, white</td>
<td>1/4</td>
<td>1,361</td>
<td>2 yrs.</td>
<td>26.40</td>
<td>3.43</td>
<td>.85</td>
<td>2x4 99</td>
<td>-5</td>
<td>-</td>
<td>24.98</td>
</tr>
<tr>
<td>Willow, white</td>
<td>1/4</td>
<td>1,361</td>
<td>1</td>
<td>8.00</td>
<td>4.67</td>
<td>1.42</td>
<td>2x4 98 2</td>
<td>2</td>
<td>-</td>
<td>14.09</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>7</strong></td>
<td><strong>36,749</strong></td>
<td></td>
<td><strong>$433.48</strong></td>
<td><strong>$106.59</strong></td>
<td><strong>$42.83</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$583.00</strong></td>
</tr>
</tbody>
</table>

All the above trees looked very well the first part of the season, but during the latter part the white grub (the larvae of the May beetle) almost destroyed some of the varieties. They worked mostly on the European larch and white ash, in some instances girdling the roots entirely, from one and a half inches below the surface, several inches down; and owing to the season being so dry, the trees could not repair the injury. White ash two feet high were girdled in the same manner. In the case of the Austrian and Scotch pines we attribute losing so many mostly to the dryness of the season. The Scotch pine were never transplanted before, which we think was one cause of so many dying. Chestnuts were injured somewhat by the grub.''}
Forest Tree Record for 1875 and 1876.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>1875.</th>
<th>1876.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Height</td>
<td>Growth</td>
</tr>
<tr>
<td>Norway Spruce</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>White pine</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Austrian pine</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Scotch pine</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>White ash</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Green ash</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Catalpa</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>American elm</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>European larch</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Osage orange</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Butternut</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Black walnut</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>White willow</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Soft maple</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>Sugar maple</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Chestnut (all dead)</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Box elder (few trees)</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Apple (Cultivating)</td>
<td>15</td>
<td>7</td>
</tr>
</tbody>
</table>

The foregoing table shows the average height and size of the trees in this plantation, together with the total cost of each kind and the whole plantation from the commencement. With the exception of the chestnut, all the kinds planted are now represented by nearly their full numbers except as removed by thinning, and all are in a healthy, vigorous condition. In 1875 a peculiar blight affected the young leaves and shoots of the sugar maple, but its cause was not ascertained. It has not appeared this year, and the trees have recovered. A fungus leaf parasite has made its appearance upon the silver maple, forming black shining patches or scabs sometimes an inch across and often several of them upon a leaf. It does not appear to be very destructive, but evidently reduces the thriftiness of the tree. The disease is by no means new elsewhere, being widely disseminated east and west, but not found, to my knowledge, in this vicinity before. No remedy is known to me except the all but impracticable one of gathering the fallen leaves and burning. From the nature of the parasite, this must be a specific where it is possible to make use of it. The scientific name of the fungus is *Rhytisma acerinum*, Fr. The plantation has been remarkably free from insect depredations. Several leaf eating caterpillars have worked upon the elms and walnuts, but not so as to do serious damage. The larva of a butterfly (*Grapha interrogationis*) has defoliated very injuriously the elm trees planted singly, as along streets and on the ornamental grounds, and a sphinx larva in like manner the ash; but upon trees in masses they do not appear to work much.

The only addition made since the last report is a quarter of an acre of apple, planted four by four feet. I recommend the addition of box elder and honey locust, the plants to be grown from seed, which can be obtained at little or no cost. The measurements of a few box elder are given in the table for 1875. They were planted by chance with the white ash and were then of the same age and size of the latter; but at the date given the average height of the box elder was 15 ft. 7 in. against 11 ft. 10 in. for the ash, and the diameter of trunk one foot from the ground, 3 3/4 to 3 7/8 in.

By the showing of the table, the willow is now making the most rapid growth, having gained in average height 6 ft. in 1876. Next comes in order the soft maple.
(Acer dasyacarpum), 4 ft. 6 in.; the catalpa and osage orange, each 4 ft., and the white ash and European larch each 3 ft. 4 in. The two first do not furnish very valuable timber, while that of the four following are very useful. From the most reliable information, we know that the wood of both the osage and the catalpa is almost proof against decay—the dead logs in their native places lie for ages upon the damp ground, hard and sound, while generations of human beings come and go. A log of catalpa certainly known to have lain upon the earth in the wet woods of Pulaski county, Ill., during the whole century of our republic, was sawed into boards, and one of them, perfectly sound and receiving a high polish, helped form the collection sent by this University to the Centennial; a piece cut from the plantation, nearly four inches in diameter, also went with the collection. This was from seed sown in 1869. The osage orange wood, perhaps, is still more valuable, and the woods of the ash and of the larch are highly esteemed. Upon very extended inquiry during the last winter, in connection with the Centennial wood collection, it was found that the price of wood as fuel had not increased during the last ten years in our state, and that in more than half of the timbered regions the growth was estimated to be fully equal to the destruction. With our immense supplies of coal, it is doubtful if wood can, for many years to come, be profitably grown for fuel, but the finer and better varieties of trees, such as are named above, may yield a handsome profit, while natural forests are burned to clear the ground.

The Coniferae, as indicated by the figures, are growing rapidly—the white pine being first for the last year; the Scotch and Austrian, for the year before. The growth of these trees should not be compared with that of the deciduous ones, because of the natural slowness of their growth when young. In after years they will outtake their present rivals. The proportionately great expense of the larch, walnut, and butternut for 1876 is due to extra work, pruning and transplanting.

Forest Record for 1886.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Distance planted, ft.</th>
<th>When planted</th>
<th>Age in feet after planting</th>
<th>Average height, ft.</th>
<th>Condition</th>
<th>Cost of trees</th>
<th>Cost of planting</th>
<th>Cultivation, etc.</th>
<th>Total cost</th>
<th>Receipts</th>
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<tbody>
<tr>
<td>Ailanthus</td>
<td>4 1/8 1881</td>
<td>2</td>
<td>18</td>
<td>3 1/2</td>
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<td>Apple</td>
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<td>18</td>
<td>3 1/2</td>
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<td>34</td>
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<td>7 1/4</td>
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<td>Pine, white</td>
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</table>

$637.30 $192.25 $1029.79 $1846.87 $1831.25

In explanation of the above table it may be said that the distance apart is the original spacing of the trees. Most kinds have been thinned. The dimensions of the trees are those taken in October, 1886. The present condition of healthfulness and thriftiness is indicated in the column by crosses. Here one cross stands for poor order, two, fair only, and three, in excellent condition and promising in appearance. In the case of the larch, a double indication is required on account of the difference in the
plantation on the low and high ground. In the columns of cost, the exact items are put down when known, otherwise approximate estimates are made. When the young trees were purchased, as was the case with all those planted in 1871 and 1872, except the tender catalpa and butternut, the exact figure is recorded, but when the seedlings were grown on the University grounds the account of cost was kept with the whole forest-tree nursery — not with the separate rows or blocks of different species. So in the cost of cultivation, the amounts named were often obtained by dividing the full amount according to the areas occupied by the kinds. In the column of receipts the amounts are approximate sums. When trees or trimmings were used for the University a definite credit was not usually made, and was not carried to the special kind of tree. The items of cost of the trees and the receipts so far are not regarded as of any importance in the experiment, because they cannot be made use of in arranging for another plantation, on account of the great variation of prices and circumstances. As already said, the small receipts were almost wholly for trees to transplant. Another time or place there might not be such a demand. Certainly no one should count upon such sales as one of the legitimate and regular items of income from a forest plantation. Only in so much as the latter partakes of the nature of a nursery can the sale of living trees be considered appropriate to it.

When not done directly by the University, the trees were cut away in thinning by men who took the poles for the work. In this way, while no credit is given for the trees, the removal of those in alternate rows, as described, has not cost anything which should be charged against the plantation.

In most instances these trees removed were used for firewood; sometimes, for stakes or poles.

History of the several Varieties.

Ailanthus (Ailanthus glandulosus). These trees were grown from seed in nursery, and when two years old transferred to the forest, in 1881. They made a very rapid growth from the beginning, probably surpassing all other kinds in this respect. In four years' time a height of about sixteen feet was attained, with proportional diameter of stem. But during the winter of 1884–5 they were killed to the ground. One large specimen on the University lawn, which had stood unscathed the rigors of fourteen winters, also perished. The following summer prodigious shoots were sent up from the old stocks, some of them stretching up during the single season to eight or ten feet in height. The new growth has been suffered to care for itself, and the block therefore looks rough and uneven. The trees are very irregular in size. Many of those that were not killed entirely to the ground are now 35 to 40 ft. in height and one foot in diameter of trunk one foot from the ground. Sprouts have come up thickly from the roots so that there are trees of all sizes from 2 or 3 ft. up to 40 ft. in height. They have so nearly taken complete possession of the ground where they were planted that no other woody plant except the black raspberry has been able to get a start among them. This habit of root sprouting is one of its greatest drawbacks as an ornamental tree. In the forest plantation where the ground has not been fully occupied by other trees the ailanthus has spread in this way as much as 50 ft. The more the sprouts are cut off the thicker they come up again, but on land that is fully occupied by other trees they seldom sprout.

Aside from the liability to destruction by frost during specially trying winters, it is questionable whether this species has any value for timber. It certainly does grow wonderfully fast, at least when young,
and that, too, on poor soil; but the wood has little value. It is coarse grained with a rather pleasing color, does not take much polish, but when well prepared it might make an agreeable variety for use in some kinds of furniture.

Apple trees (Pyrus malus). In 1876–77 there was an overstock in the nursery of Perry russet and Stark apple trees, root-grafted in 1872. These trees were in excellent condition, but as no market was found for them it was decided to try some as timber trees. One-fourth of an acre was planted in the spring of 1876 with trees four years old, and a similar area, or a little more, the following season. All had been "cut" with a tree digger in the fall of 1875, but not moved from their place until transferred to the forest. The first were planted 4 ft. by 8 ft. apart, and occupy a block on the west side of the plantation, where they are exposed to the sweep of the prevailing winds of which they clearly show the effects. The outer rows are bent over to the eastward very conspicuously, and the average height is less than would otherwise have been the case. In this block the average measurements in 1886 were: height, 17 ft. 9 in., circumference of trunk, 10 4-5 in. In the second block, planted 4 by 4 ft. apart, well sheltered on all sides, the height was 22 ft., and the trunk same size as above. Four or five years after planting the whole ground became shaded by these trees, after which no undergrowth of any kind, except mosses and other low plants, existed. The trees have grown much more erect than they commonly do in the orchards, but the main stem soon becomes divided into many branches, even when closely crowded. Little can be said in favor of the tree for timber. The wood, if of good size and straight grained, is very valuable for purposes where fineness and straightness of grain, together with hardness and susceptibility of polish, are requisites.

The block of Stark, surrounded on three sides by larger growing trees, is 32 feet in height and ten of them 4 to 5 inches in diameter. Many of them are dead or dying, though apparently not from blight. The trees in the two rows next the white pines are nearly all dead, and the influence of the pines is seen on the third and fourth rows to some extent. The block of Perry russets, fully exposed on the west, seems to have given a strong argument against protection. There are only four rows of these trees, eight feet apart. East of the apple are two rows of basswood that were set five years later and next east of the basswood are black walnuts. The apple trees in the west row are all alive and nearly all in good health. The second row from the west is nearly all alive. More than two-thirds of the trees in the third have died, while in the east row there are only six trees left alive. These trees did not all die at once but have been going year after year for the past eight years.

Green Ash, (Fraxinus viridis). As has been stated the greater portion of the ash planted was supposed to be white ash (Fraxinus
Nearly three acres were planted 2 by 4 ft. in one block, and one-fourth of an acre in another block, on, however, similar ground. All proved to be green ash. Both lots were planted in the spring of 1871 and in both cases nearly all the trees grew thriftily from the beginning, gaining 6 in. the first year. Those in the three-acre lot were two-year-old seedlings, the others, three years old; both were from nursery beds. Like the larch and chestnut, the roots of these young trees were considerably gnawed by white grubs the first season, and the losses may be almost wholly attributed to this cause.

The ground upon which the ash are growing is rather low and level. For any agricultural crop, tile draining would materially improve it. The black, vegetable loam is quite deep, underlaid with tenacious yellow clay. An open ditch through the lowest portion carries a stream of water during the first half of most summers.

Cultivation by plow and hoes was thorough during the first four seasons, and afterwards the plow was run occasionally between the rows. When the trees became large enough for planting in shelter belts, streets, etc., a large number were taken here and there from the rows, beginning in 1875 and continuing ten years. In 1876 and afterward whole rows were dug for these purposes, and in 1878 the remaining alternate rows were cut down. The growth of the trees has been exceedingly irregular. Those that get the first start gain more and more upon their shaded companions, so that there may often be found two trees of the same age standing side by side, yet one ten to twenty times as large as the other. Evidently this ash does not succeed well in the shade, though the latter is not dense enough to keep down the conspicuous undergrowth of weeds and many kinds of shrubs. An occasional box elder apparently grows as vigorous surrounded by thickly set ash as though the latter were not present. In natural forests the green ash is found especially on the banks of streams, while the white ash more commonly grows among other trees on rich bottom land. Does the former perish in the shade and succeed in the opening made by the water. In this connection it ought to be noted that sprouts were abundantly sent up from the low stumps left in thinning and that these still make a slender but considerable growth. Some of these are now larger than certain specimens of the original planting.

There is more undergrowth among the ash than appears under any other trees. It is indeed very interesting to observe the great number of shrubby and other growths which normally belong to woods. It will be remembered that the land was originally prairie and had been cultivated in farm crops for thirty or more years, yet one now finds here great numbers of raspberry and blackberry bushes, cherry, Virginia creeper, poison ivy, dogwood, elder, grape, red and black haws, red cedar, besides beggar lice, "stick-tights," and various forest dwelling weeds and grasses; in smaller numbers laurel oak, scarlet oak, white oak, hickory, hazelnut, sassafras, mulberry, hackberry, honey-suckle,
gooseberry, currant, cat briar, and a few others. These introduced
woody plants now considerably outnumber the ash trees.

They evidently have been brought in by birds, for it will be noticed
that the kinds named bear berries or other fruits commonly eaten by
birds, or are furnished with appendages by which the seeds or pods ad-
here to feathers, etc. Great numbers of birds do resort to the planta-
tion for roosting and shelter. The nearest natural wood is about three
miles distant.

It is difficult to state the average size of these trees, on account of
the extreme variation. In 1886 the better specimens were 5 to 7 in. in
diameter and 40 ft. in height, a few running over that. At present the
range of diameters is from 1 in. up to 11 in., but the small ones can of
course never make anything of value. The average diameter is near 6
in. while the better specimens such as were given seven years ago are
from 8 to 9 in. in diameter, and 45 to 48 ft. high. The trunks are tall,
slender, nearly free from living branches for half or more of their
height and in the main are straight. What are not straight now would
become so before reaching a size suitable for making into lumber. The
growth of the tree is always greatest on the inside of a crooked
place, and unless the crook has been too great, the tree shows
nothing of it by the time it is full grown. Among the specimens
from 1 to 3 in. in diameter, at least half are dead entirely, or dead
at the top. As the trees stand at present each one has a space of about
seven feet square, though the distribution is very irregular.

The actual sizes of the trees on the large plat are as follows: 63 are 1
in. in diameter; 653, 2 in.; 657, 3 in.; 516, 4 in.; 392, 5 in.; 257, 6 in.;
131, 7 in.; 57, 8 in.; 9, 9 in.; 1, 10 in.; 1, 11 in.

On the small plat the trees are of the following sizes: 3 are 1 in.
in diameter; 19, 2 in.; 112, 3 in.; 77, 4 in.; 31, 5 in.; 24, 6 in.; 5, 7 in.;
4, 8 in.; 1, 9 in.

At the end of the first year after planting, the three-year-old trees
cost at the rate of $160 per acre, while the plantation of two-year-old
seedlings cost $85—the difference coming from the greater original cost
of the three-year-old seedlings and the greater labor in handling them.
It requires at least twice the labor properly to plant a three-year-old
tree of this kind than it does one a year younger. At the present time
no difference can be discerned in the size of the trees.

Black walnut (Juglans nigra). The nuts were planted in the
spring of 1869, in nursery. There is, by some inadvertence, a break in
the records concerning the transplanting of these trees, and the facts
connected therewith, have not been remembered. They were not trans-
ferred until after 1872, but in the autumn of 1875 they were over 9 ft.
in height, and had been growing vigorously in their permanent
place. When transplanted—probably in the spring of 1873—quite a
number died, as might be expected of this variety at four years of age.
They were put into rows 4 ft. apart, 2 ft. in the row, but the following
year were distributed so as to make, as nearly as practicable, the
distance in the row uniformly four feet. They occupy three-eighths
of an acre on soil of good quality for corn.

In the autumn of 1876 these trees were 12 ft. high and ex-
ceedingly healthy and vigorous in appearance. They were fairly well
cultivated, and the lower branches were trimmed off so as to leave a
smooth trunk 4 or 5 ft. high, but since 1878 no labor has been expended
upon them. In 1886 the best of the trees were 37 ft. high and 25½ in.
in circumference of the trunk. They were making a rapid growth, with
straight, clean stems and fairly good amount of foliage. The latter,
however, is never so abundant as in several other species. The better
specimens are now 8 to 9 in. in diameter, 40 to 45 ft. in height, and most
of them have fairly straight trunks for half to two-thirds their height.
The small trees (those running from 2 to 4 in.) are out-topped and are
beginning to look bushy or dead in the top. There are now standing on
the 36 of an acre, 176 trees. That does not allow quite ten feet
each way for a tree. It cannot be expected that trees standing so close
can make the best development long and these will soon need further
thinning.

The sizes of the trees on the plat are as follows: 15 are 2 ins.
in diameter; 8, 3 in.; 17, 4 in.; 27, 5 in.; 26, 6 in.; 39, 7 in.; 26, 8 in.;
15, 9 in.; 3, 10 in.

There is considerable undergrowth, consisting for the most part of
shade-loving weeds and grasses, but also various shrubs and climbing vines.

While these trees make a rapid growth, and ultimately reach a
great size, it can hardly be claimed for them that they stand at the head
of the list for timber purposes. The wood of old, well grown trees is
exceedingly valuable. But it is only the wood of large trunks that com-
mands high prices. That of young trees is not specially prized for
anything. From seventy-five to a hundred years is not too great an
estimate for the time required for the development of this tree into a
product of high commercial value, and who can count upon the relative
value of kinds of woods a century hence? Then these large trees de-
mand a large area in which to reach the majestic proportions of com-
mercial prominence. As shelter belts we have better trees, and for fur-
nishing the miscellaneous purposes of farm supply other kinds will be
first selected. It is not, however, wished to cast any discredit upon this
noble tree—the most prominent representative abroad of our North
American forests. Its lofty, feathery crown is worthily worn, and, no
doubt, in judiciously mixed planting for timber, this regal tree should
have its place.

**Box elder (Negundo aceroides).** The seed was planted in the
fall of 1876 thickly in rows 4 ft. apart, where the trees were to
grow. The next spring the rows were thinned with the hoe, so as to
leave the seedlings at first one foot apart. Two years later every other
tree was removed, usually for transplanting. Alternate rows were dug for planting a part at a time as the trees were wanted from 1881 to 1884. During this time the remaining rows were also thinned to about four feet between trees. The area is about one-fourth of an acre in a long strip adjoining the wet portion planted with larch. A part of the ground is very wet in the first part of the season; one end is moderately well drained. The trees have done excellently well throughout, and the block has cost less in proportion to size or number of trees than any other. The first year cultivation was thoroughly kept up during the season, and the second year double shovel plows were run in the rows three or four times. After this the shade was sufficient to keep down the weeds, and from that time to the present the ground has been perfectly free from any kind of undergrowth.

The trees are tall and slender, with clean trunks high above one's head, and they are remarkably uniform in size for such close growth. While the trees appear straight to the casual observer it is almost impossible to find one that is not crooked. The crooks are not short but take the form of long curves. The size (ten years from seed) of the larger specimens, was 30 to 31 ft. in height and 16½ in. in circumference. The larger specimens are now 40 to 45 ft. in height and 6 to 8 in. in diameter at one foot from the ground. This plantation is in appearance very excellent, and, were the wood worth anything, most valuable results might be anticipated. The record is worth consulting in regard to groves and belts for shelter. The tree seems to accommodate itself easily to its place. There is a space of about a rod wide between these trees and the plat of larch, and the outside rows (and especially the outside one) produce much the larger trees, and the trees lean very decidedly toward the open space. As the trees are now standing they have a space of less than 5 ft. square each.

The sizes of the trees on the plat are as follows: Forty-nine are 1 in. in diameter; 93, 2 in.; 85, 3 in.; 105, 4 in.; 72, 5 in.; 50, 6 in.; 20, 7 in.; 13, 8 in.; 2, 9 in.

Butternut (Juglans cinerea). The nuts were planted in nursery rows early in the spring of 1869, and when the seedlings were transplanted two years afterward they were 15 to 20 in. high. Ninety-nine per cent survived and made an average growth the first season of 6 in. At the end of the second year (four years from seed) the average height was 2 ft. In the autumn of 1876 the trees were 10 ft. 6 in. in height. In 1886 the better trees were 30 ft. in height, with a circumference of trunk of 17 1/4 in. At present (1893) the better trees are from 6 to 8 in. in diameter and from 38 to 42 ft. high. Most of them carry a straight trunk as much as three-fourths of their height. These trees for the first five years received good cultivation and were twice trimmed, taking off the lower branches, which were very heavy and spreading. No pruning has been done among them since. The lower branches have been gradually smothered out and have rotted and dropped off until now.
very few of the trees have any under twenty feet in height. Most of
the trees that are given in the table as 2 and 3 in. in diameter are either
dead at the top or are otherwise in very poor condition. As the trees
stand at present they occupy only a little more than 7 ft. square each.

The sizes of the trees on the plat are as follows: 37 are 2 in. in
diameter; 151, 3 in.; 168, 4 in.; 118, 5 in.; 46, 6 in.; 21, 7 in.; 6, 8 in.;
2, 10 in.

The soil is rather wet yet not too much so for corn growing, ex-
cept in specially wet seasons. Probably the trees would have done bet-
ter on drier land. As it is, no kind except the larch on wet land has
shown so much disease. But there is nothing in common with these
two as to the manner of destruction. With the larch the whole tree
assumed a sickly appearance, growth became slow, the foliage thin, and
fruit (cones) abnormally produced. Finally the half-dry branches failed
to respond to the stimulating influences of spring time and death occurred.
In the case of the butternut the difficulty apparently began with the
trunk and seemed to be due to frost. The living bark was forcibly
separated in patches from the wood, or not unfrequently cracks occurred
through bark and wood toward the center of the trunk. In some cases,
however, patches of bark on the trunk or larger limbs died without ap-
parent separation, and various fungi afterward grew out of the decaying
parts. Indeed, the trees seem to suffer just as orchard apple trees have
done throughout the Northwest during the last decade. Trees of this
species are not usually healthy or long lived in the native woods of the
vicinity. It is not common that good saw-logs can be had from them
on account of the irregular growth or unsoundness of parts of the trunk.
In deeper woods on richer but better drained land the trees appear in
much better condition and not unfrequently free from any apparent
defects.

The widest spaces caused by the death of trees as described were
filled by transplanting from the thicker rows, but the distribution is still
uneven, and not seldom the vacant spaces are now too wide. Although
the shade has never been very dense, there is not much undergrowth,
except weeds. Altogether the prospect is not favorable for this tree in
timber plantations.

Catalpa (Catalpa bignonioides). This is the southern or eastern
variety, sometimes called the tender catalpa. The seed from which
the trees were grown was gathered by Hon. W. C. Flagg, from trees
planted by himself upon his farm at Moro, Illinois. At this time
(1869) and for several years afterward the distinctions which are now
known to exist between trees of this genus had not been made out.
Since eastern nurserymen supplied the western parts of the country
with most of the nursery-grown trees, and since this tree produces
within six to ten years an abundance of seed, it need not be surprising
that even in the areas in which the hardy catalpa naturally existed the
seeds for planting were mostly gathered from cultivated trees, and so
from the eastern or tender kind. This was the case with Mr. Flagg and also with the University. The catalpas planted in the early years were also of the tender kind.

This seed was planted in the spring of 1869 and the seedlings were transplanted 2 by 4 ft. apart in 1871. Having a crooked and much branched top, this was cut off near the ground in the spring of 1872, and a single shoot allowed to grow from each. This latter often attained 6 ft. or more in height the first season—a straight, clean, unbranched stem. In five years the average height was 16 ft. and the average diameter of the stem 2 3/4 in. The height of the better specimens in 1886 was 28 ft. 3 in., and the circumference of trunk 20 to 21 in. The better specimens at the present time are 7 to 9 in. in diameter and 35 to 38 ft. in height. Very few of them have straight trunks as much as ten feet in length, and most of them are so crooked that it is hard to get good 7 ft. posts without considerable waste. Taking crooked and straight, together with what might be split, the trees would make an average of about four posts each. But few of the trees are perfectly sound. By actual count 132 of the 263 trees give evidence of being unsound, and there are not doubt other unsound ones that do not yet show decay externally. None of the trees have escaped injury by frost. Usually the wood of certain annual growths of the trunk is dead and decaying while many of the limbs, not unfrequently the terminal portion of the "leader," have been killed, making the subsequent growth irregular and crooked. When the trees were 2 3/4 in. in diameter every other one was removed and used as grape stakes. They were cut in the spring and immediately driven into the ground by the side of a vine. Notwithstanding the known durability of this wood in the earth, these stakes rotted so badly that many had to be replaced after the first year, while none lasted longer than three to four years. But it must be remembered that the wood was in part already injured by winter Killing and that the stakes were used while green. The sap wood soon decays in the earth under any circumstances, and since in poles of this size there is a large proportion of sap, it is to be expected that such stakes will soon become more or less reduced by rot. But they last much longer if seasoned before setting in the ground and especially if cut in late spring time when the bark peels readily.

Alternate rows were removed six years after planting. As the trees now stand each one occupies an average of a little more than 6 ft. square. The tops of all are thrifty and continue to make good growth. During the past winter one-fourth of the plat was cut down close to the ground and the trees worked up into posts. It is the intention to allow the trees to sprout and grow again from the stump. The sprouts so growing will probably make straighter trees than the originals.

The numbers and diameters of the trees are as follows: 4 are 2 in. in diameter; 34, 4 in.; 71, 5 in.; 61, 6 in.; 50, 7 in.; 28, 8 in.; 9, 9 in.; 6, 10 in.
**Hardy catalpa (Catalpa speciosa).** The seeds from which these trees came were planted in nursery May, 1876. When two years old the young trees were moved to the permanent plantation and set in rows 8 ft. apart, 4 ft. apart in the rows. From the first these seedlings took an upright growth quite different from those of the tender variety.

The land is the highest and is accounted the poorest in the plantation. It is the same as that occupied by the portion of the European larch which has succeeded so well. As was the case with the other catalpa all the young trees grew—not one died in either case. Notwithstanding the transplanting a growth 4 ft. in height was made the first season. Good cultivation was given the first year, but nothing was done with trees or soil the second season on account of the pressure of business in other quarters. The third year again the ground was kept in good order, after which little attention was given to it.

The trees continued to grow luxuriantly, forming straight trunks, furnished with coarse and distant, but symmetrical branches. Not a bud or branch has been noticeably injured by frost. The average height of the better trees in 1886 was 17½ ft., and circumference of trunk a little over 14 in. This was for six years’ growth, or an average of about 3 ft. increase in height per year. Quite a number of the trees have been taken out for transplanting, leaving them, so far as the thinning has gone, 8 ft. apart each way.

The better trees now are 30 to 34 ft. high and 7 to 9 in. in diameter at one foot from the ground. Unlike the tender catalpa these decrease rapidly in size for the first 3 or 4 feet. After that they carry their trunks straighter and hold their size better than *C. bignonioides*. Without a more thorough examination than has been made it would be impossible to tell the condition of the timber in these trees; but two of what appeared to be the best specimens (which were cut for use in a forestry exhibit) were both rotten at the heart from the ground to 8 or 10 ft. in height. Many of the trees taken from the same lot, 6 to 8 years ago, for transplanting soon broke off from one cause or another and all were found to be decayed except a thin outer shell.

The ease of propagation, the usual freedom from disease and injury, the easy success in transplanting, the wonderful rapidity of growth, the excellent form of the tree and the value of the wood eminently distinguish this species as valuable for timber plantations. Its home is upon rich "river bottoms," where the trees attain a height of 80 ft. and a diameter of trunk of 2 to 3 ft., or equal to that of the white ash. But on poor soil it is probable that the mature tree will be smaller than several of the oaks and other first class forest trees. From such information as we have the tree cannot be said to be especially long lived. In the woods they are often found dead and often lying on the ground. Of the proved durability of the wood on or in the ground, too much can hardly be said. Fence posts cut from old logs have
remained sound in wet ground forty years, and old stockades have been examined after double this length of time and the wood still found free from decay except the slow wasting away of the surface portions. A log lying across a creek forming a foot-bridge was known by one man to have occupied its place for sixty years, and his information was that at least forty years before his time the log was used for the same purpose. This log was in 1875 cut into boards one inch thick, the widest of which were 18 in. of sound wood. The outer edges were more or less decayed and worm-eaten.

The wood is soft and coarse-grained, is easily worked and keeps its shape well even when cut green. For posts, piles and railroad ties, and for some manufacturing purposes it takes high rank, but for fuel and many special uses other kinds are superior.

The sizes of the trees on the plat are as follows: 11 are 2 in. in diameter; 5, 3 in.; 11, 4 in.; 18, 5 in.; 32, 6 in.; 33, 7 in.; 17, 8 in.; 8, 9 in.

All the trees, except those put down as 2 and 3 in. in diameter, are vigorous and making a good growth.

Red Cedar (Juniperus Virginiana). A few trees of this species were planted when about three feet high in the spring of 1871, on rather dry but rich ground. They stand in two rows about ten feet north of blocks of other trees. They have had except for the first year or two but little attention. The transplanting succeeded well; nearly all the trees lived. They have made a very moderate but steady growth, not, however, appearing very luxuriant or vigorous. The stem usually continues through the head with, however, in numerous cases, competing branches. The head itself is bushy, with close and dense foliage. There is nothing of special promise about them as timber trees on our soil, notwithstanding the recognized value of the wood.

There are now standing only 46 trees; the rest have been cut down or dug out for various purposes. They vary in height from 18 to 25 ft. and are from 5 to 7 in. in diameter at one foot from the ground, and decrease rapidly in size. They would undoubtedly be better for closer planting which would compel them to run up more slender and sooner to lose their lower side branches.

Chestnut (Castanea vesca). This has been a failure. In 1871 1,360 two-year-old seedlings were planted, of which one-half died the first season. But the roots were badly gnawed by the white grub which existed that year in great numbers in the soil, which was kept clear from other vegetation upon which the worms might feed. As the trees were first set 2 by 4 ft. apart, an attempt was made to make the distribution uniform by transplanting, but the growth continued feeble, and all the trees ultimately died. The land was high and dry adjoining that upon which the larch has so abundantly prospered. A few trees, however, which were set in nursery survived, and after becoming well established have grown rapidly and continue healthy.
It having been asserted that these trees succeeded better if grown from seed without transplanting, the experiment was tried by planting, in the area first occupied by them, fresh nuts in the fall of 1879. These were badly destroyed by rats and other vermin, but such as were left grew very satisfactorily the following year. During the first winter rabbits cut off many of the young stems, and some died. Growth continued poor, and the number of trees gradually became less. Those remaining were transplanted into one row, and now this remnant of the lot are bushy, poor looking, shrubby specimens of little promise. On the other hand some trees three or four year old, received from Mr. C. N. Dennis, of Hamilton, Ill., in 1860, and planted in the arboretum, have done remarkably well. They are exceedingly thrifty, finely proportioned, and gaining as fast as the neighboring ash and elms. No explanation is attempted of the difference. The soil in the latter place is richer. The cultivation was altogether better with those first described.

American elm (Ulmus Americana). Only one-eighth of an acre is planted with this common white, or American elm. There are four species of elms native to Illinois. The largest and most abundant is the subject of this report. The next largest, and also next in usual numbers, is the red, or slippery elm, well known for its thick and mucilaginous inner bark. The hickory elm, found in special localities only, is a medium or small sized tree, known, as the common name suggests, for its tough wood and the peculiar wing-like expansion of bark along the branchlets. The fourth species is found in the southern part of the state only, and from the growth of bark on the branchlets, surpassing the latter in prominence, is called the winged elm. It is scarcely more than a tall shrub.

Among these it ought not to be difficult to identify the species with which we are now concerned. Yet such are its variations; so different the appearance of trunk, branches, and foliage; so diverse the characteristics of wood; and withal so many the woodman's names, that many hesitate to put all forms and kinds together as one species. Of the specific unity, however, there can be no question. Many of the observed differences are due to the surrounding conditions, as of very wet and of dry soil, of the chemical or physical characteristics of the latter, of the sweep of winds, etc. But there is also great natural variation in the individual trees when grown under conditions as nearly identical as it is possible to get them in a group or along an avenue. It is entirely probable that seed from individual trees of such species reproduces the characteristics of the parent. Plants that have not been changed under cultivation come more nearly true from seed than those that have been changed. There are comparatively few elm trees that are perfect in shape.

The seedlings were two years old when, in 1871, they were placed 2 by 4 feet apart in the plantation. All lived and grew rapidly.
As they became large enough for the purpose, the most of those to be removed for thinning were dug for transplanting. The better trees measured in 1886 a little over 28 ft. in height and 15 in. in circumference of trunk. These at present are 45 to 48 ft. in height and have a diameter of trunk at one foot from the ground of 7 to 9 in. Of those put down in the table below as 1 to 3 in. in diameter, most have a stunted appearance and some of them are nearly dead. The better ones have nearly straight trunks, free from limbs 20 to 25 ft. in height. The shade is dense enough to keep down most of the undergrowth except what grows naturally in the shade. As the trees now stand they have a space of less than 8 ft. square.

The sizes of the trees in the plat are as follows; 2 are 1 in. in diameter; 22, 2 in.; 13, 3 in.; 8, 4 in.; 15, 5 in.; 14, 6 in.; 11, 7 in.; 4, 8 in.; 6, 9 in.; 3, 10 in.; 2, 11 in. This is far less than the same trees measure planted along streets 50 ft. distant from each other. Even some of those transplanted from these very rows are now twice the average size of their thickly set companions. This seems to show that the elm does not bear crowding well, at least by its own kindred. As a timber tree little can be said in its favor, however much we may admire it for ornamental purposes. There are special uses for its fine-grained, interlocked, fibrous wood, but the demand is limited and uncertain.

**Hickories (Carya alba and C. sulcata.)** Nuts were collected of these two kinds, known as the small-fruited and the large-fruited shell-barks, in the autumn of 1879, and at once planted in the forest-tree rows. Some of the nuts were destroyed by vermin, but the most of them germinated and grew the following spring, making, however, small progress during the summer. During the first winter, and to some extent, afterward, many of the young trees were cut off by rabbits. These, however, usually sprouted out again from the stump.

The hickory is naturally of slow growth when young, and the trees are on land that is comparatively poor, high, and dry. In the spring of 1883, the rows as planted were thinned out and the trees taken up were planted in rows 8 ft. apart and 4 ft. apart in the row. Considerable care was taken with the young trees both in digging and setting. The tap root was taken up from 16 to 20 in. long and but little loss occurred from moving. The transplanted trees as well as the others were cultivated for two years; since then they have received no attention except to prune off the lower branches in 1890. In 1886, the trees that had not been removed were from 4 to 8 ft. high, twice as tall as those that were reset. At present the trees not transplanted stand 4 ft. apart each way and are all making a good vigorous growth; the better ones are 15 to 18 ft. high and from 2 to 3 in. in diameter.

The better ones of the transplanted trees are 10 to 12 ft. high and comparatively few of them exceed 2 in. in diameter.

The sizes of the trees in the plat are as follows: Hickories not
transplanted, 46 under 1 in.; 252, 1 in.; 63, 2 in.; 5, 3 in.; hickories transplanted, 109 under 1 in.; 364, 1 in.; 37, 2 in.

The land, as before stated, is high and dry and the soil is poor. This is one reason for the slow growth, but the ailanthus and hardy catalpa, on the same soil, have shown remarkable vigor. As between the two hickories, the large-fruited one has surpassed the other, though it is more often found on lower land.

Honey Locust (Gleditschia triacanthos). Two-year-old seedlings were planted, 4 by 8 ft. apart, in the spring of 1882. At the time of planting the trees were 4 to 5 ft. in height, and were not cut back in any way. In 1886 the better trees were 18 ft. high and 6½ in. in circumference. At present they are 28 to 32 ft. high and 4 to 5 in. in diameter. All of them look very crooked and if they did not straighten up as they grew older they would be a worthless lot; but the trunks and larger branches seem actually to bend in their effort to straighten, so that a branch this year does not occupy the same position absolutely that it did last.

This tree attains lofty dimensions in native woodlands, but is not highly esteemed. The wood is coarse-grained, not tough, but exceedingly hard. It is said that it shrinks less in drying than any other native wood. It is not very durable when subject to moisture. There may be special uses for which the hard and conspicuously grained wood would be highly prized. It is susceptible of a fine polish, and probably could be advantageously used in furniture making and in joinery.

The sizes of the trees on the plat are as follows: 71 are 1 in. in diameter; 164, 2 in.; 95, 3 in.; 31, 4 in.; 11, 5 in.; 4, 6 in.

European Larch (Larix Europea). One and one-fourth acres were planted; rows four, and trees in rows two feet apart. The land varies much in fertility and in subterranean drainage. One-half of the area is relatively high, and in the soil no water stands within several feet of the surface at any time of the year, at least not for many days at a time. This soil is too poor to grow a fair crop of corn, but would answer satisfactorily for oats. The subsoil is yellow clay, with enough admixture of sand to make drainage fairly good. The northern end of the area reaches down into lower land, where water would run from a tile drain during a large part of the spring and early summer, though it does not stand upon the surface. Sometimes in the spring the wettest portion is so soft that a horse’s feet would sink three or four inches in the black and rather mucky soil. The seedlings were one year old when planted in the spring of 1871. During the first year three-fourths of these died, more dying upon the high than upon the low ground. All started well, but the roots were badly damaged by the white grub-worm, and the season proved to be very dry; during August the dead or dying numbered more than the thrifty trees. Cultivation was diligently kept up during the summer.

The next spring 4,000 more seedlings were purchased and planted
in the rows, leaving no spaces of more than four feet. In this way the
distribution of the trees was not quite even over the ground, but was
sufficiently so to accomplish the object of thick planting. Again the
grub-worm did some damage to the roots, but far less than during the
preceding season; none was noticed afterwards. Nearly all the trees
lived and made a fair growth. Cultivation was kept up during the
summers of 1872, 1873, and 1874; but in 1875 the land was so wet
during the spring and early summer that it was deemed best not to run
the plows. The weeds grew abundantly and made a bad appearance,
but they did not seem to injure materially the growth of the trees. At
the end of this season, however, it was observed that the trees occup-
ying the wettest portions of the ground looked unhealthy and many were
found entirely dead the following spring (1876). Up to this time they
had apparently done nearly as well on the low as upon the higher land.
Finding that the trees, now five years planted, needed thinning where
two feet apart, a considerable number were dug and planted in the
vacant spaces. Most of these transplanted trees lived and grew without
serious check, but from this time on those on the low ground proved
more or less unhealthy. The trees which lived had less than the normal
amount of foliage, which was usually yellowish in tint; the branches were
slender and wiry, and fruit-cones were abundantly developed. More or
less of the trees have died every year until at present, 1893, there are not
quite one-fourth as many trees on a given area as on the higher ground.
The roots on the low ground run near the surface, with apparently no
tap roots. During the spring just past at least ten trees, better than the
average in appearance, have been blown down on the low ground, but
among the taller trees on the higher ground none have been disturbed
by the winds. While there are a considerable number of trees on this
lower ground still living, the plantation is anything but attractive or
hopeful in appearance. On the higher ground, however, scarcely a tree,
except such as have been out-topped, has died or shown any indication
of unhealthfulness.

In 1876 the trees in two of the central rows were trimmed by cut-
ting off the lower branches so as to leave a clean trunk 2½ to 3 ft.
high. The rest of the trees were left untrimmed, with their
branches issuing from very near the ground and spreading so as to
interlace with each other. The average height of the trees was at this
time 10 ft. These trimmed rows cannot now be picked out, except
upon the closest looking for the few remaining dead branches on those
not trimmed, and an occasional appearance of the old wounds. But
during three succeeding years the growth in height of the trimmed
trees was evidently less, and no doubt careful measurements would have
shown a similar result for the circumference of the trunks. Unfortun-
ately such measurements were not made. Now the variation in growth
in other ways obscures the results, if there are any.
Except in the outer rows there are no living branches under 20 to 30 ft. in height. The dead branches do not rot and drop off readily, being kept from rotting by the large amounts of resin in them, but they are easily broken off. During the winter just past the whole plat has been trimmed to a height of 10 ft., only stopping at that because the man could not reach higher with the tool he was using.

In the winter of 1883-84 a heavy sleet storm broke the leaders out of a few of the trees. While those broken off have made new leaders, they have also started to decay where broken.

During the winter of 1877 and 1878, alternate rows were removed by cutting the trees near the ground. Since the spring of 1889 over 100 of these trees, those below the average size, have been cut down and made into fence posts or grape stakes. The trial has not continued long enough to decide, but the indications are that the larch will not prove specially valuable for such uses.

Since 1880 the ground has been entirely free from weeds, owing to the dense shade of the inwoven branches and the thick carpet of fallen leaves. This plantation on the high ground is a beautiful and encouraging sight. The trees are quite regular in size, symmetrical in growth, tall and straight, with the lower limbs wasted away so that one walks easily under the thick canopy of foliage above, and on the soft and clean matting of the fine leaves below. The height of the better trees in 1886 was 33 ft. 9 in. and the circumference of trunk one foot from the ground 24½ in. At the present time they are 50 to 55 ft. in height and from 7 to 9 in. in diameter at one foot from the ground. There is not much difference in height on account of place in the plantation, but the trees around the outside are usually considerably larger in diameter of trunk.

The outer part of each annual ring becomes very hard when the timber is seasoned, while the rest remains soft. It does not have the appearance of being valuable for lumber except for the coarsest uses, such as framing stuff. No tests have yet been made as to the quality of the wood as grown on the different soils, though there can be little doubt that considerable difference does exist.

Some plantations of the European larch in the state are unthrifty, due, as it appears, to an obscure, or at least not yet determined, disease. The twigs are abnormally slender and the growth poor, the leaves die at any time after appearing, progressively from the outer portions, and prematurely fall. Often new ones are pushed out in little tufts, soon to share the same fate; finally the twigs themselves die. As stated the cause or causes of the disease, if indeed it is a disease, have not been ascertained. But the trouble has not been certainly seen in the University plantation, though indications of a mild form of what seems to be the same exists without damaging results. Early in October—a month before the leaves ought to become discolored and fall—what seems to be another disease has been observed. In this case the leaves assume a
sickly yellow hue and gradually drop from the branches, leaving the twigs naked but apparently uninjured. A minute fungus of low type (*Cladosporium*) is found on these fading leaves, even after a long season of fair and dry weather, but it cannot be said that the low parasite is the cause of the trouble, from which the tree appears to suffer but little. Red spiders (mites) sometimes become destructive to the foliage of the larch, as they do, in warm, dry weather, to the leaves of many other trees. (See 14th report Illinois State Entomologist [1884], page 117.)

This larch finds a congenial home in high mountainous regions and is especially valuable as a timber tree in the rough, rocky lands of Scotland. It is on trial now for the prairie regions of our country. While the facts now known of it in these situations are not by any means all favorable, the University plantation on dry ground is certainly in most excellent condition, twenty-two years after planting, and the experiment appears to be eminently interesting and instructive as well as hopeful for practically valuable results in timber growing.

**Basswood or Linden** (*Tilia Americana.*) The seedlings were collected in the forest in the spring of 1876. It was not the intention at first to put them into the plantation, hence they were allowed to grow longer in nursery than should have been done for this purpose. As it was, however, the smallest trees had been left in the nursery rows, and these were transferred to the forest in 1881, placed 4 by 8 ft. apart.

In 1886, the better trees were 17 to 18 ft., and 8½ in. in circumference of trunk. Now, 1893, they are 26 to 28 ft. in height and 4 to 5 in. in diameter. A considerable proportion of the trees have been broken or otherwise injured, and that causes them to sprout badly around the bottom, otherwise they are well formed and are making a healthy vigorous growth. The trees were cultivated and kept in good shape for the first two years after planting, but since then have received no care.

The sizes of the trees on the plat are as follows: 24 are 1 in. in diameter; 54, 2 in.; 89, 5 in.; 44, 4 in.; 17, 5 in.; 1, 6 in.

**Hard Maple** (*Acer saccharinum*). Seedlings—6 to 12 in. high—were collected in the woods in the spring of 1870, and were placed in nursery rows. Though they had been pulled from the light soil of the woods, and were well in leaf, nearly all lived and grew. However, for the first six to ten years the growth of this tree is very slow, even in rich soil, where alone it thrives. After three years in the nursery some of the trees were transferred to the forest and set 2 by 4 ft. apart. Others were transplanted in the nursery and kept there until 1877, when they were placed 4 by 8 ft. apart in the forest.

There has been considerable call for these trees for streets, etc., and the block has been thinned to about 8 ft. each way between trees by digging from time to time for transplanting. In this way the hard maple has credited to it more than any other species. Yet this is a
temporary and local circumstance, which must not be taken as of general application.

The small trees first planted were so slow in growth, and care was so long required, that they cost more in the handling and management than did those left in the nursery a longer time. Under ordinary circumstances, it is no doubt best to give the forest-collected seedlings about three years in close rows, then to transplant them in nursery with wider spaces, to remain three or four years longer; then to transfer to the forest. It would be difficult for any one now to detect the difference in shape and size of trunk of those originally set 2 by 4 ft. apart and those later planted from the nursery 8 ft. distant.

All the trees, either in the nursery or afterward in the forest, had the side limbs removed from time to time, and this certainly added to the temporary appearance of the trees for timber purposes and is essential for ornamental purposes, but is really of doubtful expediency in practical forestry, except to prevent forking.

The land upon which these trees are growing is as rich as that of any of the plantation, and fairly good for corn, but sometimes too wet for early planting to this crop. The trees are now growing rapidly, making clean, straight, beautiful trunks, fairly furnished with branches. The shade is less dense than that of the soft maple plat, but mostly on account of the smaller size and less crowded condition of the trees. The shade being so long in developing, many trees and shrubs, like cherries and raspberries, gained considerable footing, while weeds and grasses were not entirely overpowered. Later much of the undergrowth has been crowded out. The height of the better trees in 1886 was about 22 ft., with a circumference of trunk of 9 in. At present, 1893, they are 28 to 32 ft. in height and 4 to 5 in. in diameter. In the first ten years after planting in the forest the gain in height was nearly 20 ft. In the past 7 years the gain has been about 10 ft.

The sizes of the trees on the plat are as follows: 4 are 1 in. in diameter; 34, 2 in.; 43, 3 in.; 62, 4 in.; 28, 5 in.; 4, 6 in.

This shows good results and indicates that more attention ought to be paid to the hard maple in artificial timber growing. The wood is in demand at good prices for the finer uses, such as furniture, building, implements, etc. Too much consideration has evidently been given to its slow growth at the beginning. Its beauty as an ornamental tree is commonly appreciated and acknowledged.

Soft maple (Acer dasycarpum). One-fourth of an acre, in a strip twenty rods long, was planted with three-year-old trees of this variety, two by four feet apart. Nearly all the trees lived and made an average growth the first year of about one foot in height. They have grown very rapidly each season since. Being larger when transplanted, and furnishing almost at once considerable shade, the ground was more easily kept in order than for most others. Cultivation was, however, kept up three years, and there was some needless pruning the second year.
The only thing done with this block since 1874 has been to thin to four feet in the rows and to remove alternate rows, the latter in the fall of 1876. From the low stumps some straggling shoots have grown; otherwise the shade keeps down nearly all undergrowth. The trees prune themselves, and the dead branches soon fall and decay. The trunks are very tall and straight, of nearly uniform height, but vary a good deal in diameter. The difference in the size (diameter) of the outside trees and those surrounded on every side by others is very striking. These trees cast the densest shade of any of the deciduous trees, with the possible exception of the box elder, so that not only are the various shrubs and weeds nearly excluded, but the trees crowd inexorably upon one another. In 1886 the better trees of this species were 42 to 44 ft. in height, with a circumference at one foot from the ground of about 23 in. At present the better specimens have a height of 50 to 55 ft. and a diameter of 9 to 11 in., in one case reaching 18 in. The trees still stand quite thick, having an average of less than 6 ft. sq. each, if only the area intended to be planted by them is taken into account. But, as there are no trees planted along one side and one end, the outside row, in which the largest trees are found, has considerably more space on which to grow.

The sizes of the trees on the plat are as follows: Fifty-six are 3 in. in diameter; 42, 4 in.; 41, 5 in.; 38, 6 in.; 26, 7 in.; 20, 8 in.; 24, 9 in.; 23, 10 in.; 10, 11 in.; 5, 12 in.; 3, 13 in.; 3, 14 in.; 1, 15 in.; 1, 18 in.

When grown as street trees, subject to bruises and wounds, or on account of any serious check in their progress, wood and bark borers are very common in the trunks, where they do much damage. But in the forest plantation not a sign of these depredators existed up to six years ago. At that time the soft maple plat was fenced off, making it a part of a pasture field. Since then there have been some trees damaged by cattle rubbing against them and trampling about the roots, and the borers have begun to make their appearance.

**Bur oak (Quercus macrocarpa).** In the fall of 1879 acorns of white and bur oak were planted as soon as gathered, but from lack of proper treatment were all lost soon after they started to grow. Two years afterward a quantity of bur oak acorns was gathered and at once planted in nursery rows. These grew well the following season. In the spring of 1884 the tap roots were cut with a sharp spade, the earth having first been plowed away on one side of the row. The next spring the young oaks, two to three feet high, were successfully transferred to the forest, where they are again making very satisfactory growth. During the season of 1890 many of the trees made growths of 3 to 4 ft. in height. The next year the leaves were badly attacked by a fungous disease, and the growth of the trees was much less, but few of them making as much as two feet. It is of course impossible to say how much of this is due to disease, and how much to difference of season.
There was but little disease during the season of 1892, and yet the growth of the trees was but little more than in 1891.

**Osage Orange (Maclura aurantica.)** Two-year-old seedlings were planted two by four feet apart in the spring of 1871. After the end of the first season they were two feet high, all living and promising. The location was well adapted to the habits of the tree, except that the catalpa crowded upon them on one side and apple trees upon the other. The soil is good corn land, not usually too wet for early planting. In 1876 (six seasons' growth) these trees averaged 13 ft. 6 in. high, and during the last year had gained from three to four feet. Taking into account the well-known value of the wood, it then appeared, and was so stated in a report upon the plantation, that the Osage orange gave every indication of standing first upon the list of timber trees. As a farm hedge plant its superiority had been fully established, and single trees had often been observed to grow into valuable size with satisfactory rapidity.

After the stems have a diameter of 3 in. they are highly prized for stakes, proving very strong and exceedingly durable. With increase in size the value likewise increases for posts, paving-blocks, etc., and finally for various manufacturing purposes. No other wood serves so well for wagons. For turned handles and other purposes where fineness of grain, hardness, and great strength are esteemed, the wood is especially valuable. Added to these uses is that of fuel. The osage surpasses hickory and maple in this respect.

With such characteristics, combined with rapidity of growth, adaptability to our soils, entire freedom from injurious insects, etc., there is little wonder that the species should take first rank among timber trees. But it is always easy to reach conclusions too soon. The later experience with this block in the experimental plantation falls below the anticipated results. After eight years after planting, the growth became much less rapid, and at this time the trees were slender, with long, straggling branches. In 1876 the average diameter of the stems near the ground was recorded as 1½ in. In 1886 the average height is 23 ft., and the average circumference of stems 13 in. Compare this with the larch, over 33 ft. high and 24 in. in circumference of trunk.

At the present time—1893—the better trees are 28 to 30 ft. in height and from 5 to 6 in. in diameter. A few of them have comparatively straight trunks, 15 to 20 ft. high, and most of the trees would make three good posts each. In March of the present year, one-fourth of the plat was cut down, with the expectation of allowing the trees to grow again from the stump. The trees—forty-seven of them—made 116 posts that have sold readily at 10 cents each. The rest of the plat is better than the part cut. The trunks and main branches have evidently grown straighter with age, though they still give but poor promise of making valuable timber trees in this latitude. However, their great durability in the ground makes them valuable as posts, and it is a question
if it would not be worth while for farmers to grow small areas of them for this purpose alone. Like the elm and some others, the crowding in a close plantation seems to injure the development of the individual tree; but unless they are crowded, they make a very short trunk, which is soon lost in the branches. If they were judiciously mixed with other kinds, it is quite likely that better results would be obtained.

Cultivation was kept up for the first four years, and during this time the side branches were kept trimmed off to facilitate the work to be done. The trees, though irregular in size, are no more so than most of the other kinds. While there is considerable undergrowth of other trees and weeds, there is not so much as under either the ash or walnut.

The sizes of the trees on the plat are as follows: Three are 3 in. in diameter; 40, 3 in.; 42, 4 in.; 43, 5 in.; 16, 6 in.; 8, 7 in.: 3, 8 in.

**Austrian Pine (Pinus Austriaca).** These trees occupy a strip of land 26 rods long, 36 ft. wide, comprising about 34 of an acre. The land slopes slightly to the north; the soil is good and the drainage sufficient in an ordinary season, for successful corn growing. The first planting was done in the spring of 1871, the trees were set 4 ft. apart each way. The young trees, 9 to 12 in. high, had been grown in the University nursery, in shaded beds. Nearly all the trees died the first year. These were replanted in 1872, and again a large proportion died. Nearly all the spaces were finally filled, however, in 1873. Cultivation was kept up until 1875, after which time the weeds were mowed for three seasons.

After gaining a hold on the soil the young trees began to grow very thriftily. In September, 1875, the average height was 2 ft. 8 in. A year later they were 4 ft. 8 in. high. No thinning or pruning was done on them until the winter of 1890-91. During that winter the dead branches were trimmed off to a height of 8 to 10 ft.—as high as a man could conveniently reach with an ax. The dead branches were not all taken off at that time, and they have died since, until there is now an average height of about fifteen feet, on which none are living.

At the same time the pruning was done seventy-three dead trees were cut out. These were principally such as had been overgrown, but some had evidently died from other causes. There are now standing in the plat eighteen dead trees, all small, and there are a good many more of the small trees that do not look as if they would live very much longer. There is more variation in height among these trees than in any other of the evergreens. The appearance of the plat as a whole is not so promising as it was eight years ago, though there are still enough trees in apparently good health, and growing vigorously, to fill the space when they are fully grown. The trunks are nearly all straight and erect. None of the leaders were broken off by the sleet storm that injured so many of the Scotch and white pines, and there are no double trees among them.

A few Scotch pines were planted in the plat by mistake and they average much larger than the Austrians.
In 1886 the average size of the better trees was given as: height, 27 ½ ft. circumference, a little more than 20 in. The same comparative grade of trees is at present 35 to 38 ft. in height and 8 to 9 in. in diameter.

Until about eight years ago the trees were so thick and cast so dense a shade as to exclude undergrowth. Now there is a thick growth of weeds, with some raspberries, Virginia creepers, and other woodied plants.

The sizes of the trees in the plat are as follows: Nine are 2 in. in diameter; 31, 3 in.; 63, 4 in.; 58, 5 in.; 52, 6 in.; 21, 7 in.; 13, 8 in.; 4, 9 in.; 1, 10 in.; 1, 11 in.

Scotch pine, (Pinus sylvestris). In the spring of 1871, seedlings of the Scotch pine were obtained of Robert Douglas, of Waukegan, Illinois, and at once set in the permanent plantation, in rows 4 ft. apart and 4 ft. apart in the row. The trees when received were 1 to 2 ft. high, and, as an experiment, they had been grown without transplanting. It was hoped in this way to produce trees at a reduced cost, and the result might have been better under more favorable circumstances, but the soil becoming very dry, and the winds scorching and heavy, nearly all the young trees died.

The next season, Mr. Douglas, without charge, refilled the order with transplanted trees, 12 to 15 inches high, and these were planted as the first lot had been. Again, owing to unfavorable conditions, about two-thirds of the trees died. In the meantime trees had been grown in the University nursery, and in the spring of 1873 the plantation was completed so that very few vacant spaces remained. Previous to 1878 a few trees had been taken out for planting in other places, and considerable numbers had died, so that not more than one-fourth of a full stand remained; these, while not very regularly spaced, have taken such complete possession of the ground as practically to exclude all under growth.

No pruning or thinning of any kind was done until the winter of 1890-91, when the dead branches were taken off to a height of 8 to 10 ft., and the dead trees were cut out. Only eighteen dead trees were found, and nearly all of these were such as had been overgrown and smothered. There are now no dead trees standing. Except on the outer edge of the plat the branches are all dead to a height of 15 to 20 ft.

After the Scotch pines became well established, they made a very good growth—more rapid than either the white or Austrian pines; and they are now larger and appear more healthy and vigorous than either of the others. They are very irregular in their habit of growth, so that there are but few straight trunks with single leaders among them. Their irregular habit of growth was made worse by a sleet storm in the winter of 1882–83, which broke off the leaders of nearly half of them. The trees will incline to straighten some with age, and will probably make timber that will be of value when they are full grown.
As the trees now stand they occupy a space of a little more than 8½ sq. ft. each. In 1886 the better trees were reported to be, on an average, 29 ft. high and a little more than 23 in. in circumference at one foot above the ground. At present the same grade of trees are from 38 to 40 ft. high and 9 to 10 in. in diameter.

The sizes of the trees on the plat are as follows: Three are 3 in. in diameter; 14, 4 in.; 33, 5 in.; 41, 6 in.; 50, 7 in.; 46, 8 in.

The plat on which these trees are growing is quite level, with what surface drainage there is, across the rows. The trees were kept well cultivated until 1875, since when, instead of plowing, the weeds were mowed off twice a year with a scythe.

Mr. Douglas writes that these trees were from seeds collected in northern Europe, and belong to what is sometimes called the Riga pine. This statement is important, since it is well known that the Pinus sylvestris is very variable, and for timber plantations the varieties differ much in value.

White pine (Pinus strobus.) White pine seedlings were collected in the spring of 1869, put in close nursery rows and shaded with lath frames. About 8 per cent died the first year. Of a few hundred trees, purposely left without shading, 32 per cent died. After having grown in the nursery three years, they were deemed in good condition for transplanting. They were at this time 12 to 15 in. high, well formed, healthy trees.

The land, one acre, where the white pines are planted, is quite flat, what slope there is being to the south; and at least one-half of it is too wet in spring, and often in the early part of summer, for the best results in tillage. The soil is black, part of it mucky, one to two feet in depth, and underlaid, for the most part, with a rather stiff, blue clay. The trees were planted May 4, 1872, 4 ft. apart each way. The white pine is a comparatively hard tree to transplant successfully. The roots are soft, long and naked, with very few small or fibrous roots near the tree. Knowing the necessity of careful handling, no effort was spared, from digging in the nursery to setting in permanent place, to secure successful results.

Throughout the season the ground was kept in a good state of tilth by frequent cultivation, but it was exceedingly dry; and of nearly 3,000 trees planted, two-thirds died during the summer. Of Norway spruce, planted the same day, in the same manner, and on very similar soil, not more than 2 per cent died. It is difficult to explain this greater per cent of loss in the pines, except as we take into account the comparative method of development of the roots of the two species.

In the spring of 1873 the vacant spaces were filled from the nursery, and again in 1874 trees were set where needed. The result of the three plantings was an almost perfect stand of trees. The cultivation with horse and hoe was kept up thoroughly for three years. During the fourth, fifth and sixth years the weeds were mowed. But little cul-
tivating was done, because the ground was too wet in the early part of the season.

For a number of years after the white pines were fairly started they made admirable growth, and promised to be very valuable timber trees for the prairie soil here, as well as for their native regions. In a report made in 1886, the following statement is made: "From the first the living trees have done exceedingly well. Very few trees have died from any cause since they began their growth in their present position. They are now remarkably healthy and vigorous, and the plantation vies with that of the larch in beauty and prospective value." At present they are not maintaining the early promise.

No thinning or pruning of any kind was done, except what nature does, until the winter of 1889-90. During that winter and the next the dead branches, to an average height of about 10 feet, were trimmed off, and the dead trees (some more than 350) were cut out. During the winter of 1891-92, sixty-eight more dead trees were cut out, and there are at present fifty-two still standing that have died since the last were cut. The trees cut out the first time had not all died recently. Some of them gave evidence of having been dead for a number of years, while others had died so lately that they still carried dead leaves. Most of the trees that have died were the smaller ones, such as were overgrown or badly crowded. A few only of the larger trees have died. Of the trees still alive, very few have any live branches lower than 20 ft. Many of them have an unthrifty look, either in the top or on the trunk, and the prospect is that there will be a very considerable number of trees to cut out year by year for some time.

The principal reason for so many trees dying is probably overcrowding. As the trees now stand they occupy a space of less than 7 ft. sq. each. The trees have been damaged in other ways than crowding, but not so far as can be judged, until after they had already begun to die. There is continually a thick mat of leaves on the ground, and these have been partially burned off twice, both times injuring the trees more or less from the ground up two or three feet, but apparently not any higher. Boys seem to delight to cut their names or designs in the smooth bark of the trees. Occasionally a tree is entirely girdled. The girdling soon kills the trees, but most of the lesser damage soon grows over. A woolly plant louse (Churnus pinicorticis, Fitch.) has been very abundant on many of the trees, attacking the trunks and larger branches for several years. They are sometimes so abundant that the whole trunk has from a little distance a white, or grayish white appearance.

The white pines do not cast so dense a shade now as they did ten years ago. At that time there was no undergrowth among them. At present there are some small wooded plants, such as grape, raspberry, cherry, box elder, etc., besides weeds, coming in, and there would likely be more of these were it not for the heavy mulch of leaves that covers the ground.
In 1886 the average size of the better trees was: Height, 24 ft. 9 in.; circumference, 17 in. At present the better trees are 38 to 40 ft. high and 8 to 9 in. in diameter. During the winter of 1882–3 the leaders of a considerable proportion of the trees were broken down by the weight of sleet. This was the cause of many trees being crooked at that point, and of others having more than one leader. Except for the trees deformed in this way nearly all have almost perfectly straight trunks. The trees are much more nearly uniform in height than in diameter.

The sizes of the trees in the plat are as follows: Fifty-eight are 3 in. in diameter; 194, 4 in.; 256, 5 in.; 236, 6 in.; 144, 7 in.; 70, 8 in.; 11, 9 in.; 5, 10 in.

Norway spruce (Abies excelsa). A large lot of small seedlings were put in close nursery rows in the spring of 1870 and grown there two years. In the spring of 1872 a plat of half an acre was planted 2 by 4 ft. in the low ground on each side of the open ditch that crosses the forest. Although the season was so severe with the other evergreens, not more than 2 per cent. of these died. Comparative ease of transplanting, at least when young, seem to be a characteristic of the Norway spruce, while the opposite characteristic seems to be more or less inherent in the pines.

When set, the trees were 12 to 15 in. high. In the fall of 1875, three years after setting, the trees were 2 ft. 8 in. high, and in the fall of 1876, 4 ft. 3 in., and were making a nearly uniform growth. In 1886 the better trees were about 25 ft. high and 16 in. in circumference. At present they are from 35 to 38 ft. high and 8 to 9 in. in diameter.

These trees have almost from the first taken such complete possession of the ground as to exclude all undergrowth, and there is not now another kind that casts so thick a shade as these. All the trees, except those that are badly overcrowded, seem to be in perfect health. As the trees stand at present, they occupy a space of a little more than 8 ft. sq. A few are beginning to be overcrowded and out-topped. After the trees had got well started, probably in the winter of 1877–8, alternate rows were cut out and the trees left to decay on the ground. Trees were taken out as wanted for planting until 1884. Others have been taken out up to the present time for Christmas and other decorations. Many of them were taken for use in other places about the University and grounds, and no charge was made, so it is impossible to estimate exactly the value of the trees used; but if they were counted at the regular prices, the returns from the Norway spruce would not fall much below those from the hard maples. But as such receipts are only incidental, and not to be relied on under ordinary conditions of forest planting, they cannot serve as a general guide as to profits.

During the winters of 1890–91 and 1892–93 the plat was trimmed up to a height of 7 to 8 ft. Only about half the dead branches were taken off. Four dead trees were found, all of them among the very smallest, such as had been completely smothered.
There is some question as to what the trees will be good for after they have been grown. The size and age they are at present, they last but a very short time. After lying on the ground for two or three years they are so brash as to be easily broken in two. Those 4 to 6 in. diam-
eter very seldom last more than two years in the ground. When the trees are full grown they would probably make lumber that would answer a very fair purpose for rough work, if kept in dry places.

The sizes of the trees on the plat are as follows: Six are 2 in. in
diameter; 43, 3 in.; 42, 4 in.; 78, 5 in.; 65, 6 in.; 53, 7 in.; 35, 8 in.; 9, 9 in.; 6, 10 in.; 1, 11 in.

White willow (Salix alba). Cuttings of the white willow were put in the nursery in the spring of 1870. The next spring they were put in their permanent place in the forest. The land on which they were planted is low and level, but is fairly well drained by the open ditch that runs across it.

The trees were planted 4 ft. apart each way, and the first year were allowed to grow as they would. In 1872 the young trees were trimmed to a single stem, but being still straggling and crooked they were cut down to the ground in the spring of 1873. The sprouts thrown up from these stumps grew vigorously. More trimming was done on the willows than on any other species of trees in the forest. After a single straight stem had been established for each tree the growth was very rapid. The willows have almost from the first been taller than any other kind of trees in the forest.

Cultivation of these, as of other trees planted at the same time, was thoroughly done with the plow and hoe, until the fall of 1875, since which time but little was done except to mow off the weeds. The trees have always been crooked at the bottom. At from 2 to 4 ft. in height the trunks become nearly, though never entirely, straight. The trees all carry a single leader to the top. The branches are very easily broken off, even when alive, and so the trees have been continually self-trimmed, making most of them practically bare poles all the time. Willows do not naturally make a dense shade, and this trimming makes them still thinner. As a consequence, the trunks from the bottom up are covered with watersprouts that very seldom live to be more than two years old.

About five or six years ago the willows began dying in the tops, and at present nearly half of them are dead; some only in the top, others nearly to the ground. The undergrowth is nearly as dense here as in the ash, but is of a different character. Not less than half of it is poison ivy (Rhus toxicodendron). Virginia creeper is more common here, too, than it is anywhere else in the forest. Other wooded plants are confined almost entirely to the black raspberry and wild black cherry.

In 1886 the larger trees were put down as 59 ft. in height and 26½ in. in circumference. The height was probably given a little too great at that time, since the better trees are now only 65 to 68 ft. The best
trees are now 10 to 11 in. in diameter, though a few of those that soon
fork are considerably larger than that at a foot from the ground.

While these trees have made such a good growth, they do not prom-
ise to be of much value except for temporary posts or stakes. The wood
is very soft and light. It does not take a high polish, but still is rather
handsome when well dressed.

The sizes of the trees in the plat are as follows: Eight are 3 in. in
diameter; 44, 4 in.; 52, 5 in.; 60, 6 in.; 50, 7 in.; 62, 8 in.; 45, 9 in.; 26,
10 in.; 12, 11 in.; 6, 12 in.; 1, 13 in.; 1, 14 in.; 2, 15 in.; 1, 16 in.; 1, 23 in.

There is no record as to whether the trees died badly or not when
young, but from the irregularity of the stand one would naturally sup-
pose they did. In 1886 the alternate rows were cut out; but it is impos-
sible to decide now which rows were cut and which were left because
of the sprouts from the stumps. As the trees stand at present they
occupy a space of about 6½ sq. ft. each.

CONCLUSIONS.

Under present circumstances it seems impossible for forest tree
plantations to be profitable as a farm crop on land fit for wheat and
corn. It is idle to talk of growing wood for fuel—except on farms, for
home use—when good bituminous coal can be had at present prices.
The fact is, in Illinois, though the extent of the natural forests has been
vastly diminished, the price of cord wood does not advance. Lands,
even though well timbered, sell at a less price per acre than adjoining
lands of the same quality that have been cleared, or than prairie lands of
the same productiveness. The value of the timber in such places is less
than the cost of clearing and bringing under cultivation. It must, how-
ever, be recognized that the value of natural forests gives little informa-
tion as to the worth of artificial plantations. The former may be mainly
composed of what is in the locality most prized; but it is usual that a
small proportion only of the trees are those commanding the highest
price. In the artificial plantation, judiciously managed, the whole may
be high-priced, useful material; this, too, may be more readily accessible
and within easy reach of the market.

Let it be clearly understood that in the foregoing, tree-growing for
timber has been the point discussed. But the planting of trees has other
and higher claims. Whether or not the actual amount of rainfall is
modified by forests, there is not the slightest doubt but that the climate
is affected. The temperature is equalized; the extremes of heat and cold
are not so great. The air is modified as to the amount of moisture,
especially in dry times in summer. The moisture of the soil is better
distributed through the year. The running streams are better sustained,
and also less subject to destructive floods, where the country is well tim-
bered than where the land is kept bare by cultivation and the surface so
drained that the water runs away at once. Heavy winds are greatly
checked, much to the comfort of man and animals. Crops are preserved
in various ways from the destructive influence of air moving too rapidly. Lastly, trees for the ornamentation of the home area, as well as for the wide expanse of the country itself, can never be neglected by a people whose cultured tastes and educated perceptions give them pleasure in the beautiful and the picturesque. To one who has no love for trees as such, half their value is lost. He who can see nothing but wood for fuel or for the manufactory in a shady grove, sees nothing but the dullest and poorest side of life. While it must be insisted that the figures presented by theorists as to the value of timber as a crop are extravagant, and by no means a proper basis for business, tree-planting for the many and varied purposes of health, comfort and pleasure, with financial profit as a subordinate factor, should be studied and practiced by individuals, communities and nations. It is to be hoped that the experiment of which this account is made will not be considered worthless, if the expenditures are never equalled by the receipts.

There is one reason for uneasiness about this experiment, as there must be about every forest tree plantation. The matter is so serious that this report ought not to be closed without a word upon it. The danger of fire is a real and imminent one. The areas bearing the conifers are liable to be burnt over during any dry time, and in autumn, after the fall of the leaves, the portions devoted to deciduous trees are quite as unsafe. A burning wad from a gun, a spark from a pipe, a negligent use of fire by a tramp, may be sufficient to start a conflagration which shall destroy within a few hours the products of years and decades. The incendiary has an abundant chance for the practice of his most despicable and criminal acts. In Europe there is some protection in the *gens d'arms*; American police only beat the thronged streets far away from the farms. Our plantations would not multiply fast if it were understood that a guard must be furnished night and day. It is impracticable to gather the fallen leaves and branches, which, moreover, are necessary as a mulch for the best growth of the trees. There seems to be little offered but to take the risk. If so, this must be included among the items of obstacles and expenses.

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