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THE GROWTH, RETURNS AND USES OF PLANTED COTTONWOOD IN IOWA

Cottonwood plantation four years old on bottomland subject to overflow. The trees averaged 2.6 inches in diameter and 21 feet in height. Picture shows one type of land, unsuited for agricultural crops, which will produce better than 30,000 board feet of lumber and 50 cords or firewood per acre when 35 years old.

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AMES, IOWA

SUMMARY

Cottonwood is one of the fastest wood producers grown in Iowa.

A fair yield from 35 year old cottonwood plantations is 30,000 board feet of lumber and 50 cords of fire-wood per acre.

The average production found in single rows one-half mile long was 71,000 board feet, and 274 cords of fire-wood.

When growing fence posts cottonwood will produce over 600 first class posts in 6 years, or over 1,400 in 12 years, per acre.

Cottonwood posts untreated last about three years and should not be used until treated with creosote or some other preservative. Creosoting cottonwood posts costs about 15 to 20 cents each. After treatment they will last 20 to 25 years.

On overflowed land unsuited for agricultural crops cottonwood plantations 35 years old will produce in lumber and cord-wood an average annual return of $10.09 in addition to six percent compound interest on the money invested.

On waste land cottonwood fence posts produce an annual profit of $5.67 to $7.39 an acre in addition to six percent compound interest on the investment.

Cottonwood fence posts for local farm use can be grown profitably on land valued as high as $100 an acre.

Cottonwood lumber is very serviceable for rough construction work in barns, sheds, and similar uses, especially in places protected from the weather and contact with the ground. This lumber on the farm takes the place of other lumber which costs $30 to $50 per M.

When planted, the trees should be spaced about 6 by 6 or 7 by 7 feet apart.

The number of trees in the stand should be reduced in about three thinnings from approximately 900 per acre at the start to between 125 and 175 at the end of the 35-year rotation.

THE GROWTH, RETURNS AND USES OF PLANTED COTTONWOOD IN IOWA

By G. B. MacDonald

The merits of the common cottonwood tree *(Populus deltoides)* as a producer of lumber, posts and fuel have not been fully appreciated. The tree is one of the most rapid in growth and the need of using it for the production of forest crops will be realized more as we are forced to grow our own supply of timber in the future. The cottonwood can be grown to saw log size in 20 to 25 years time. Yields of from 20,000 to 40,000 board feet of saw timber per acre are obtained in 30 to 45 years in addition to 25 to 50 cords or more of fire-wood.

Data from the investigations of the Iowa Agricultural Experiment Station made over a period of years are presented in this publication which indicate the possibilities in growing cottonwood on small areas of non-agricultural land on the farms of Iowa. Results from artificial plantings only, including the rate of growth, yields and returns to be expected are given.

The common cottonwood belongs to the poplar genus, a number of species of which are represented in this country. In native stands the tree is found thruout the United States east of the Rocky Mountains. The tree is suitable for extensive planting both within and beyond its native range.

During the early development of Iowa many plantations of quick growing trees were set out for wind protection and fuel production. Others were planted primarily for the purpose of qualifying under the old "Timber Cultural Act". Cottonwood plantations were set out in great numbers especially in the northern part of the state. During the past 20 years many of these have been harvested. Splendid returns have been obtained from the plantations which had attained an age of from 30 to 50 years. A large part of the groves received little or no attention after planting and many were actually severely injured by excessive grazing of livestock and thru other causes. Even with this poor attention, most of the plantations have yielded surprising amounts of lumber for construction purposes. Many farmers who had considered the cottonwood a more or less worthless tree, changed their attitude entirely after building barns or other farm structures with the lumber sawed from their cottonwood plantations or from the rows of trees which had been planted along the fence lines.

The production of cottonwood lumber is especially desirable on bottom lands, subject to frequent overflow, which are unsuited for agricultural purposes. In many places in the state, lands of this character may be made to produce returns comparable to those from the higher priced farm lands.

The cottonwood is not recommended for planting on good agricultural land except for a shelter or some other desirable purpose in addition to the production of lumber, fuel and posts. When planted on waste corners of the farm such as overflowed areas, it produces a splendid return on the investment. There are few farms in the state which do not have areas of from one-half to several acres of this type of land which might well be used for cottonwood production. Along the larger streams of the state, including the islands of the Mississippi River, there are many thousands of acres of low priced land which could be made to produce a splendid return when planted to the quick growing cottonwood.

Altho rows of cottonwood trees are sometimes in disfavor among the farmers as windbreaks for crops, the tree often has been greatly misjudged. The long lateral roots of the cottonwood sap moisture which might otherwise be available for field crops and the shading, especially from east and west rows, injures crops for a short distance. However, investigations of the U. S. Forest Service indicate that the injurious effect on the crops close to the windbreak are more than offset by the increased production due to the protection given to the parts of the field at some distance from the row.[1] Windbreaks more than pay for the ground actually occupied, shaded and sapped, in addition to the returns from the trees when cut into lumber and fuel.

USES OF COTTONWOOD

Cottonwood is used for a great variety of products. Its lightness and toughness make it very desirable for crates, packing boxes, and various veneered products. Weight for weight, cottonwood packing boxes are superior in strength to most other woods. Large amounts of the wood are manufactured into veneer for berry baskets and other kinds of small containers, some from Iowa being used for this purpose. Large quantities in other states are used for cooperage stock, paper pulp and excelsior. The latter product has been manufactured in Iowa to a limited extent from cottonwood.

In addition to the many uses to which cottonwood is put in the wood-working industries, it is used extensively in the rough for many building purposes. In the northern and western parts of the state especially, lumber from numerous plantations

[1]Bulletin 86, U. S. Forest Service, "Windbreaks, Their Influence and Value", by C. G. Bates.

Fig. 1. A barn near Des Moines, 44 years old, constructed entirely of locally sawed cottonwood lumber (except shingles). It had never been painted. Interior timbers were in perfectly sound condition. Outside boards which did not come close to the ground were in good state of preservation.

and from many acres of native timber land has been cut by small portable mills and used locally. The wood has been used to construct the framework of houses, barns and corncribs. For interior construction, many builders prefer the cottonwood to the poorer grades of softwoods which may be purchased at an equal price. Cottonwood has also been used extensively for rough flooring, interiors of corncribs, fence boards, and heavy dimension material. Altho cottonwood is not recommended for exterior work, it has occasionally been used with good results, where exposed to the weather. In one instance a barn constructed entirely of cottonwood (except shingles) was in excellent condition after ten years of service. The only fault to be noted was that some of the boards warped. Another barn near Des Moines served its builder for 44 years. The lumber was exclusively cottonwood (except shingles) and the structure had never been painted. The portions protected from the weather showed no deterioration; the exposed wood was weathered to a depth of about one-sixteenth of an inch and the portions of the boards near the ground were entirely decayed. M. J. Seger of Delaware, Iowa, is using a barn 32x106 feet, built almost entirely of cottonwood lumber. The barn when observed, had withstood 52 years wear and tear and was in good condition.

The cottonwood boards deteriorate rapidly from decay when kept moist and when exposed to such conditions they should be protected by painting or creosoting. It has been found especially desirable to protect barn sills and such timbers which are placed near the ground, by giving them a good treatment of creosote.

Little trouble is reported in handling cottonwood lumber if properly seasoned, which is accomplished by piling the boards as they come from the saw. The piles should be large and should have an even, solid foundation. The boards should be placed evenly and separated by cross strips of uniform thickness. When seasoned, the wood becomes quite hard and tough, holds nails well and gives little trouble from warping when kept dry.

In 1907 a barn, octagonal in shape, 72 feet in diameter and 55 feet to the cupola, was constructed near Storm Lake entirely of locally sawed cottonwood lumber, except the shingles and siding. The barn required about 70 M. feet of lumber. The cottonwood used was cut mostly into one inch lumber, 2″x4″, 2x6″, 2x8″ and 2x12″ pieces. When observed about 12 years after construction, the barn was in good condition.

In reporting on the sawing of cottonwood lumber Ben Holbrook, in Buena Vista county, says: "The cottonwood has been extensively used for dimension material for houses and barns with entire success. It is absolutely necessary to pile the lumber with strips and in large piles as it comes from the saw in order to prevent warping."

Tim Kane of Cherokee, in speaking of cottonwood in his locality, said: "The largest of our cottonwood trees have been cut and sawed into lumber for barns, corncribs, hog houses and stables. The wood is good and strong and better than we get from the lumber dealers." Frank Frisbie at Okoboji cut some home grown cottonwood for his own use. He said: "I cut about 20 M. board feet of lumber which was sawed principally into dimension lumber and common boards and was used in the construction of a barn to very good advantage. The lumber was used only for inside work, and I believe that for this purpose it is about as good as the ordinary pine lumber."

In a number of places over the state the interior of buildings constructed of cottonwood have been damaged by "powder post" beetles. These insects, when present in sufficient numbers may completely destroy the strength of the timbers by reducing the interior to a powdery mass. A good application of a mixture of kerosene and creosote will prevent the insects from gaining entrance. Round timbers are especially susceptible to attack of these insects. Users of cottonwood should give this matter their careful attention.

Cottonwood is used extensively, in parts of Iowa, for fuel. Most of the planted groves are located in the parts of Iowa where native timber is scarce and consequently fire-wood has a ready market. Cord-wood sells for as high as $4.00 a cord. During lumber sawing operations large amounts of slabs, edgings and branches are easily worked up into cord-wood at a small cost. Altho the heat value of cottonwood is not high compared with the denser woods, the seasoned wood makes a bright, quick heat relatively free from smoke and is especially desirable for cooking.

The use of cottonwood for fence posts is practical only when treated with creosote, water gas tar or other preservatives. Cottonwood posts untreated with a preservative will last only three years and sometimes less. The Experiment Station[2] has butt-treated cottonwood posts in experimental fence lines which have been in service in the ground for 17 years. Many of these are in good state of preservation and will last a number of years longer.[3] The posts were given an "open tank" treatment of creosote at a cost of about 10 cents each.[4]

The use of cottonwood for posts will probably become more general, especially in northern Iowa, as the more commonly used fence posts become increasingly more expensive and as the merits of creosoting become more generally known. One acre of waste land devoted to cottonwood post production would keep the average sized Iowa farm well fenced for all time.

DIAMETER GROWTH OF COTTONWOOD

Under favorable conditions the cottonwood makes a greater diameter growth during the first 40 years than any other native or introduced tree in Iowa. If crowded too much or shaded the diameter growth is relatively small. The greatest growth naturally occurs in trees which are grown singly or in single rows, but such trees do not produce the quality or quantity of lumber which may be grown in plantations with properly regulated spacing.

In normal plantations the diameter growth is rapid from the start. An average of .65 inch in diameter growth (measured at 4½ feet from the ground) was made in a cottonwood plantation on the Experiment Station grounds during the first four years.[5] The more favored trees had made a diameter growth

[2]Bulletin 158, Iowa Agricultural Experiment Station, "The Preservative Treatment of Fence Posts, 1915, by G. B. MacDonald.
[3]Bulletin 109, Extension Service, Iowa State College, "Longer Durability for Fence Posts and Farm Timbers", 1922, by I. T. Bode.
[4]At the present time the cost of creosoting would be about 20 cents per post, due to the higher price of creosote.
[5]The trees were one year old from cuttings when set out . The plantation was located on land subject to annual overflow.

of 4 inches. The same plantation measured at the middle of the growing season between the sixth and seventh years shows an average diameter growth of 4 inches and a maximum of 6.2 inches at $4\frac{1}{2}$ feet from the ground.

Table I shows the distribution of diameter classes at different ages in the development of a cottonwood plantation on the grounds of the Experiment Station at Ames. It will be noted that at 12 years the average diameter growth of all living trees was 6.66 inches which is equivalent to an average annual diameter growth of .55 inch. The following year, after a thinning had been made which removed 175 trees per acre, the average diameter of all living trees on the area was 7.65 inches and the average annual diameter growth of the trees remaining amounted to .6 inch.

DIAMETER GROWTH IN OLDER PLANTATIONS

When grown in plantation form the average diameter growth is less at any certain age than is the case with trees grown in single rows. This is due to the more or less restricted crown development in plantation-grown trees and also to the forced height growth during the earlier years. Table (11), page 176, shows the average and maximum diameters for all the living trees in plantations of different ages measured in different parts of Iowa. The average diameter of the trees in most of the plantations is rather small due to the fact that in many cases the plantations have been allowed to shift for themselves. If thinnings had been made during the progress of growth it is certain that the average diameter of the remaining trees would be considerably larger and also the yield of wood per acre would be greater. In plantations 20 to 30 years old, containing from 112 to 368 trees per acre, the average diameter of the trees was between 11 and 12 inches. Individual trees were found which had a diameter of 25 inches. In the plantations between 31 and 40 years old, it was found that the average diameter of the trees was approximately 15 inches and individual trees which had had an abundance of light showed a diameter of 30 inches. In 10 plantations between 41 and 50 years old the average diameter of all the trees was no larger than in the 30 to 40 year old plantations. This may be due in part to the particular plantations measured but no doubt indicates that the growth of the cottonwood slows up materially after about the fortieth year. That cottonwood does not do well in dense stands after 25 to 30 years is illustrated by the diameter measurements in two plantations of the same age. Both plantations were 40 years old. One had 256 trees per acre with an average diameter of about 13 inches. The other had only 50 trees per acre

TABLE I. PROGRESS OF DIAMETER GROWTH IN COTTONWOOD PLANTATION ON EXPERIMENT STATION GROUNDS AT AMES, IOWA

Age of plantation when measurements were taken	Total no. of trees alive per acre	Number of trees per acre by diameter classes — Diameter at 4½ feet from ground											Average diameter at 4½ ft. from ground at different ages	Average yearly diameter growth
		1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"		
Planting	909[6]	..	...	...	...	...	...	......	......	......	......	......	....	....
4 years	838	21	340	447	30	...	...	......	......	......	......	......	2.6 inches	.65 inches
8 years	566	15	41	80	116	129	127	51	7	......	......	......	4.63 inches	.58 inches
10 years	491	..	9	47	82	90	109	100	44	11	1	..	5.6 inches	.56 inches
12 years	445	...	...	7	45	55	77	113	96	37	9	4	6.66 inches	.55 inches
13 years	270[7]	...	...	1	0	12	39	63	92	43	13	7	7.65 inches	.59 inches

[6]Trees averaged about one-half inch in diameter when set out.

TABLE VII. PROGRESS OF HEIGHT GROWTH IN COTTONWOOD PLANTATON ON EXPERIMENT STATION GROUNDS AT AMES, IOWA

Age of plantation when measurements were taken[11]	Total number of trees alive per acre	Number of trees per acre by different heights													Average height at different ages in feet	Average yearly height growth in feet
		0-5 ft.	5-10 ft.	10-15 ft.	15-20 ft.	20-25 ft.	25-30 ft.	30-35 ft.	35-40 ft.	40-45 ft.	45-50 ft.	50-55 ft.	55-60 ft.	60-65 ft.		
At planting	909	909	...	...	...	...	...	...	...	...	...	...	...	...	.....	....
4 yrs.	838	...	...	21	294	508	15	...	...	...	...	...	...	...	20.57	5.14
8 yrs.	566	...	...	12	20	26	29	92	115	224	45	3	...	...	37.1	4.63
10 yrs.	491	...	...	...	1	4	9	17	36	80	93	181	60	10	48.21	4.82
12 yrs.	445	...	...	...	...	...	3	8	26	59	117	115	85	32	57.2	4.76
13 yrs.[7]	270	...	...	...	...	...	4	2	0	3	24	84	110	43	55.0	4.20

[7]The plantation was thinned after the twelfth year measurements were taken. Atthis time 175 trees were removed.
[11]Trees averaged about three feet in height at the time of planting.

but the average diameter of all the trees was about 23 inches. At the time the measurements were made the 50 trees were producing almost exactly the same amount of lumber in board feet as the 256 trees in the other plantation. A stand of from 100 to 150 trees per acre would have given better results.

DIAMETER GROWTH IN SINGLE ROWS

A great variation in diameter growth of the cottonwood is found even with conditions which appear to be the same in regard to soil and moisture. When planted in single rows the trees will average about one-half inch in diameter growth per

TABLE II. AVERAGE AND MAXIMUM DIAMETER FOR TREES IN COTTONWOOD PLANTATIONS OF DIFFERENT AGES

Age of plantation in years	Grazed	Total trees per acre	Soil condition	Average diameter of all trees. Inches	Maximum diameter. Inches
15	No	186	Bottomland	10.0	16
18	Yes	320	Average	7.71	16
20	No	324	"	9.6	14
20	No	320	"	9.7	14
25	No	288	"	11	16
25	No	240	"	11.6	20
26	No	350	"	11.8	17
26	No	224	Upland	12.4	19
28	Yes	112	Average	13.7	21
28	Yes	368	"	8.9	12
29	Yes	296	"	9.4	14
29	Yes	176	"	13.2	25
30	Yes	120	"	10.9	16
30	No	128	Upland	14.6	23
30	Yes	126	"	13.3	20
30	Yes	272	"	13.1	25
32	Yes	300	Average	10.8	16
32	Yes	150	"	11.6	19
32	Yes	184	Bottomland	13.4	18
33	No	160	"	14.9	24
34	Yes	64	Average	17.2	22
34	Yes	74	Upland	14.2	20
35	Yes	264	"	11.7	17
36	Yes	160	Average	13.1	20
37	Yes	108	"	14.0	24
38	Yes	256	"	17.7	27
38	Yes	236	Average	10.4	14
38	Yes	252	Upland	14.4	25
40	Yes	256	Average	12.9	18
40	No	324	"	15.4	25
40	Yes	50	"	22.6	29
40	Yes	55	"	17.6	30
40	No	144	"	13.8	21
40	Yes	124	Upland	16.5	27
40	No	140	Bottomland	16.1	25
42	Yes	224	Average	11.7	18
42	Yes	165	"	12.3	25
43	No	128	"	16.1	23
43	Yes	172	"	15.4	24
44	No	50	"	14.5	21
44	Yes	156	"	13.8	22
45	No	132	"	15.1	19
45	No	156	"	11.1	15
45	Yes	29	"	15.5	28
45	No	164	"	16.3	25
52	Yes	48	"	15.2	24

TABLE III. AVERAGE AND MAXIMUM DIAMETER FOR COTTONWOOD TREES GROWN IN SINGLE ROWS

Age of trees	Grazed	Number of trees measured as basis	Spacing	Soil condition	Average diameter of trees inches[0]	Maximum diameter inches
18 yrs	Hogs	40	Irregular	Average	11.8	17
28 "	No	40	6 ft.	"	10.7	15
29 "	No	49	Irregular	"	13.4	20
29 "	No	71	8 ft.	Upland	13.7	20
29 "	No	50	8 ft.	Average	19.6	27
31 "	No	31	Irregular	"	18.0	24
32 "	No	46	"	Bottomland	17.3	27
35 "	No	42	8 ft.	Average	12.3	17
37 "	No	40	10 ft.	"	16.3	24
37 "	No	50	8 ft.	"	17.1	23
38 "	No	85	Irregular	"	17.6	27
38 "	No	52	"	"	18.6	33
38 "	Yes	30	"	Upland	17.1	31
38 "	Yes	60	"	Bottomland	17.8	25
38 "	No	26	"	"	20.6	32
39 "	No	51	8 ft.	Average	14	20
39 "	No	40	Irregular	"	16.8	24
40 "	No	42	"	"	16.1	25
40 "	Yes	50	"	"	22.3	33
40 "	No	25	6 ft.	"	23.2	34
40 "	No	24	Irregular	Upland	18.0	28
40 "	No	80	"	"	16.7	25
40 "	No	60	10 ft.	Bottomland	19.4	29
41 "	No	64	Irregular	"	23.9	36
43 " [h]	Yes	60	"	Average	25.3	45
44 "	Yes	47	"	Upland	17.7	28
45 "	Yes	40	"	Bottomland	22.4	22
47 "	No	36	"	Average	22.3	32
48 "	No	36	6 ft.	"	19.0	34
54 "	No	22	Irregular	"	22.9	28
56 "	No	25	"	Upland	24.0	35

[h]Original trees cut off. Present trees from sprouts.
[0]All diameter measurements are taken at 4½ feet from the ground.

year on medium and lowland soils up to 40 or 50 years, and somewhat less than this for upland soils.

By reference to table (III) it will be noted that there is no marked distinction between the average diameter growth in rows of the same age which are growing on the different soil situations.

Table III shows that the average diameter for trees in lowland single rows, over 25 years old, varies from 17.3 inches to 23.9 inches. The average diameter for medium situations varies from 10.7 inches to 25.3 inches and that of upland rows, over 25 years old, ranges between 13.8 and 18 inches. As might be expected the average diameter growth in plantations is considerably less, age for age, than for trees in single rows. Single row trees have an abundance of light on at least two sides. The crown development and, therefore, the wood producing power is greater than in the closely spaced stands.

Altho the diameter growth and yield of individual trees are greater in the single rows the lumber production per unit of area is greater in plantations.

The following illustrates the difference in rate of diameter growth between plantation grown trees and those in single rows.

Average diameter of trees in 11 plantations (28 to 32 yrs. old) 12.1 inches.
Average diameter of trees in 6 single rows (28 to 32 yrs. old) 15.5 inches.
Average diameter of trees in 11 plantations (38 to 42 yrs. old) 15.4 inches.
Average diameter of trees in 14 single rows (38 to 42 yrs. old) 18.7 inches.

HEIGHT GROWTH OF COTTONWOOD

HEIGHT GROWTH OF CUTTINGS

The cottonwood is generally propagated from cuttings either directly in the permanent plantation or by first growing one-year-old rooted stock from the cuttings. In moist soils thrifty cuttings will produce sprouts of considerable size in one year's time.

The measurements of one-year-old sprouts in experimental nursery rows showed the following height growth:

TABLE IV

Height of trees	Number of trees	Percent of total
From 0 to 2 ft.	73	8
From 2 ft. to 4 ft.	273	32
From 4 ft. to 6 ft.	464	53
From 6 ft. to 8 ft.	63	7
Totals	873	100

Of the total of 873 sprouts measured, 684 or 78 percent ranged between the heights of 3 and 7 feet. The trees in the above case were spaced 6 inches apart in the rows and the rows 3 feet apart. The cuttings were cultivated until about 2 feet in height when the ground was shaded sufficiently to keep out grass and weeds.

HEIGHT GROWTH IN YOUNG PLANTATIONS

The cottonwood probably makes a greater height growth during the first few years than any other tree grown in Iowa. Height measurements of a three-year-old plantation of cottonwood on bottomland gave the following results.

TABLE V

	Number of trees	Height of trees	Percent of total
	5	5 to 9 ft.	3
	45	10 to 14 ft.	25
	78	15 to 19 ft.	43
	51	20 to 24 ft.	29
	1	25 to 29 ft	...
Totals	180		100

The trees were originally spaced 6x8 feet apart. A part of the stand was killed out during the first two years, due to ini-

Fig. 2. Cottonwood plantation three years after establishment. The land is subject to annual overflow. Trees were spaced six feet apart in rows and the rows eight feet apart when planted. Note the great difference in size between individual trees. The smaller are hopelessly overtopped and should soon be removed.

tial losses in planting and overtopping of the weaker trees by the more thrifty ones. At this age nearly half of the trees were from 15 to 19 feet in height. The average height for all the trees was 17 feet, or 4.25 feet per year.[10] One tree measured 25 feet in height which is equivalent to an average annual height growth of 6.25 feet.

The same plantation measured 2 years later when the trees had been set out for 5 years, showed the following growth in height.

TABLE VI

	Number of trees	Height of trees	Percent of total
	6	5 to 9 ft.	2.1
	8	10 to 14 ft.	2.3
	42	15 to 19 ft.	13.4
	100	20 to 24 ft.	31.8
	142	25 to 29 ft.	45.3
	16	30 to 34 ft.	5.1
Totals	314		100

When the plantation was 5 years old almost half of the trees measured 25 to 29 feet in height. The average height of all trees was 24.7 feet or the equivalent of a growth of 4.1 feet in height per year. The maximum height growth was 37 feet or

[10]Altho the plantation was three years old, the trees were one year old when set out, making the present age of the trees four years from cuttings.

6.2 feet per year. It will be noted that the average rate of height growth and the maximum height growth is practically identical at each measurement of the plantation.

Table VII, page 175, shows the distribution of trees of different height classes in a plantation on the Experiment Station grounds at Ames. Measurements have been taken every year or two in order to determine the rate of height growth in young plantations on overflowed land which is not suited for agricultural crops.

From Table (VII) it will be noted that four years after the plantation was set out (the trees were one year old when set) about 94 percent of the trees were from 15 to 25 feet in height. At eight years of age the heights were more generally distributed since by this time many of the trees were becoming badly crowded, which interfered with their growth. At this time the heights ranged between 10 and 55 feet. The maximum number at this age, consisting of 40 percent of the total, were in the 40 to 45 foot class. When the plantation was 10 years old the greatest number of trees were in the 50 to 55 foot height class. This number made up about 37 percent of the total stand. When the plantation was 13 years old the heights of living trees ranged from 25 to 65 feet and the maximum number of 40 percent, were between 55 and 60 feet in height. The plantation had been thinned the winter before the thirteenth year measurements were taken. In the thinning a number of the large, as well as the suppressed trees, were cut out. The 270 trees remaining per acre had made an average annual growth in

Fig. 3. Cottonwood tree 11 years old, 12.5 inches in diameter and 65 feet high. On bottomland soil, where trees are not too heavily crowded, saw timber can be grown in 20 to 25 years.

Fig. 4. Cottonwood plantation seven years old. Trees were spaced 6x8 feet apart when planted but some have already shaded out.

height of 3.9 feet during each of the 14 years from cuttings. During this same period the larger trees had made an average growth in height of 4.4 feet per year.

HEIGHT GROWTH IN OLDER PLANTATIONS

It is of interest to know the height growth which may be expected for cottonwood trees of different diameters. A compilation of figures secured in a large number of plantations over the state has been made in an attempt to show the average total heights which may be expected for cottonwood trees of varying diameters and on different soil situations. It should be understood that many factors influence or retard the height growth of trees in the different plantations. However, the following figures (table VIII) are based on a large number of measurements and should give good average figures for the state.

It will be noted that bottomland or lowland situations show a greater height growth than either the medium or upland situations for trees of corresponding diameters. This is true for groves as well as single rows. From the figures available it seems that the plantations on bottomland continue height growth for a longer period than the trees on drier ground.

The following charts (1 and 2) show graphically a comparison of the height of trees of different diameters on the different soil situations. In chart 1, which shows graphs for groves or plantations, it will be seen that the curve (C) for upland trees runs above the curve (B) for trees of medium situations. This would seem to indicate that there was little or no difference in soil moisture between the two situations. In the field studies

TABLE VIII. AVERAGE TOTAL HEIGHT OF COTTONWOOD TREES BY DIAMETER CLASSES

Table based on measurements of 4,246 trees. Figures evened by curves.

Diameter classes	Trees grown in plantations			Trees grown in single rows		
	Lowland situations	Medium situations	Upland situations	Lowland situations	Medium situations	Upland situations
Inches	Height ft.	Height ft.	Height ft.	Height ft.	Height ft.	Height ft.
3	...	17	..	...	..	..
4	...	25	..	...	13	..
5	...	32	..	...	20	..
6	...	37	..	...	27	..
7	39	42	..	...	34	..
8	45	46	33	...	40	30
9	50	50	43	...	45	35
10	55	54	50	...	50	40
11	58	57	55	43	54	45
12	62	60	59	54	58	50
13	65	62	62	62	60	54
14	68	64	65	68	63	58
15	71	66	68	73	65	62
16	74	68	71	76	67	65
17	77	70	73	78	68	68
18	80	71	75	80	69	70
19	83	73	77	81	71	72
20	86	74	78	82	72	73
21	89	75	79	82	73	74
22	91	76	80	83	74	75
23	94	77	81	83	75	76
24	97	77	81	83	76	77
25	100	78	..	83	77	78
26	102	78	..	83	77	79
27	105	79	..	84	78	79
28	107	79	..	84	78	80
29	110	79	..	84	79	80
30	113	79	..	..	79	80
31	115	..	..	...	80	80
32	118	..	..	...	80	80
33	...	..	..	...	81	80
34	...	..	..	...	..	80

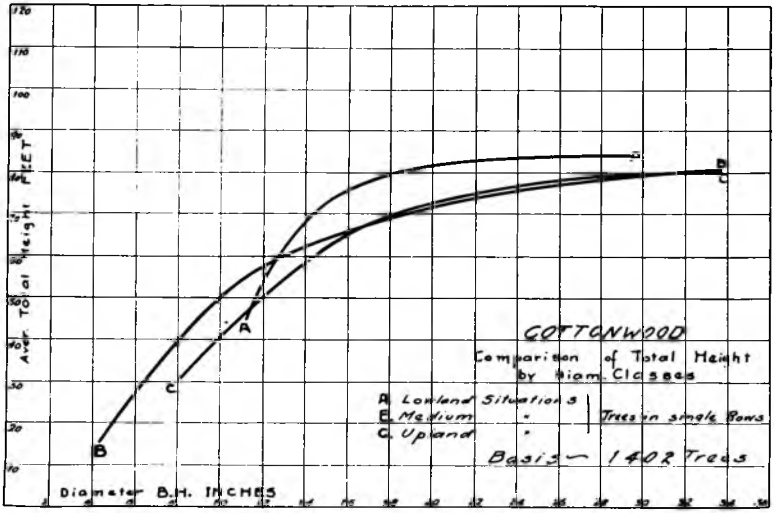

Chart 1.

it was often very difficult to differentiate between the medium and upland soils. The upper end of curve A, representing bottomland trees, is based on only a few trees of large size. If more trees of the larger diameters had been available it is probable that the curve would have shown a more rapid dropping off of height growth for the larger diameters.

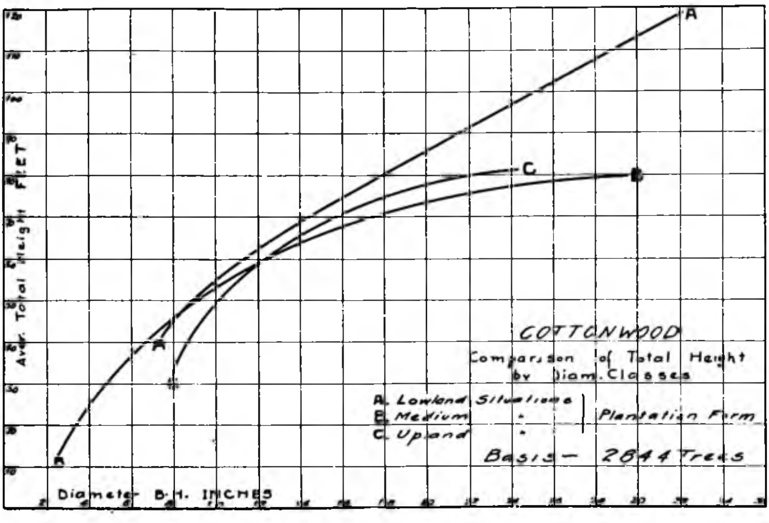

Chart 2.

TABLE IX. DOMINANT, CO-DOMINANT, INTERMEDIATE AND SUPPRESSED TREES IN TYPICAL IOWA COTTONWOOD PLANTATIONS. MEDIUM AND LOWLAND SITUATIONS.

Age of plantation years	No. of trees per acre	Dominant[13] trees in plantation			Co-dominant trees in[14] plantation			Intermediate trees in[15] plantation			Suppressed[16] trees in plantation		
		Average ht. ft.	No.	Percent	Average ht. ft.	No.	Percent	Average ht. ft.	No.	Percent	Average ht. ft.	No.	Percent
15	176	52	83	47	44	48	27	40	38	22	32	7	4
18	308	58	95	31	51	111	36	39	65	21	20	37	12
28	100	85	62	62	73	24	24	60	6	6	35	8	8
29	172	76	72	42	69	36	21	54	24	14	33	40	23
30	120	54	76	63	46	32	27	43	8	7	40	3	4
32	128	74	54	42	69	32	25	54	24	19	33	18	14
33	152	88	68	45	82	49	32	73	20	13	50	15	10
34	64	78	37	58	74	17	27	65	10	15	..	0	0
35	164	68	97	59	60	44	27	52	23	14	..	0	0
37	110	78	52	47	72	30	27	63	10	9	37	18	17
38	224	87	137	61	78	31	14	65	47	21	40	9	4
40	276	78	157	57	71	88	32	63	28	10	60	3	1
43	212	83	127	60	70	62	29	61	17	8	48	6	3
51	68	97	34	50	83	14	21	68	6	9	46	14	20

[13]Dominant trees are those of the stand which are "head and shoulders" above their associates.
[14]Co-dominant trees are those which are distinctly superior in development but not as prominent as those classed as dominant.
[15]Intermediate are those trees which are crowded from the sides but which still have abundance of overhead light.
[16]Suppressed trees are the ones which are hopelessly overtopped by adjoining trees.

TABLE XVII. AVERAGE BOARD FOOT CONTENTS FOR COTTONWOOD TREES GROWN ON DIFFERENT SOIL SITUATIONS. BASED ON MAINE LOG RULE.

Compiled from measurements of 4,566 trees. Figures evened by curves.

Soil situation	Diameter of trees at 4½ feet above ground—inches																			
	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Average board foot contents of trees by diameters																			
Upland planted groves	16	24	41	57	75	94	113	134	157	181	209	238	265	295	327	360	400	441	488	534
Medium situations planted groves	18	28	46	64	82	103	122	144	170	197	227	260	290	327	362	398	440	483	536	600
Lowland situation planted groves	20	37	55	75	100	126	156	187	221	256	290	334	375	420	465	520	580	640	...	...
Upland trees in single rows	17	20	31	50	68	96	115	138	165	190	220	251	283	316	347	380	417	454	497	547
Medium situations single rows	17	21	37	55	75	95	122	147	173	200	230	260	292	324	357	392	430	467	510	558
Lowland situations single rows	18	27	41	58	82	110	134	165	200	231	268	308	344	380	420	463	509	560	615	675

Chart 2 compares graphically the height growth of cottonwood in single rows. It will be noted that after the trees reach a diameter of 13 inches, the lowland trees are considerably taller than trees of corresponding diameter on either of the other two soil situations.

HEIGHT CLASSES IN COTTONWOOD PLANTATIONS

Table (IX) illustrates the extent of crowding and suppression of trees in plantations of different ages. An original stand of 900 to 1200 trees per acre at the time of planting will be reduced thru natural agencies to from 100 to 300 trees per acre at maturity. A moderate amount of crowding is beneficial since this will tend to develop tall straight trees relatively free from side branches. In managed plantations the severely crowded, overtopped and suppressed trees should be removed and utilized in order to give space for the more advanced trees of the stand to develop.

It will be noted for the first few years (table VII), that the trees in a cottonwood plantation are mostly of about the same height. As the plantation matures some of the trees in the stand gain an advantage and the less fortunate individuals, due to lack of shade endurance of the cottonwood, are soon overtopped and killed.

TABLE X. AVERAGE MERCHANTABLE LENGTH OF COTTONWOOD TREES BY DIAMETER CLASSES TO DIAMETER LIMIT OF SIX INCHES.

Table based on measurements of 3,067 trees. Figures evened by curves.

Diameter classes	Trees grown in plantations			Trees grown in single rows		
	Lowland situations	Medium situations	Upland situations	Lowland situations	Medium situations	Upland situations
Inches	Merch. length ft.	Merch. length ft.	Merch. length ft.	Merch. length ft.	Merch. length ft.	Merch. length ft.
6	8	..	..	..	..	..
7	8	8	7	..	5	..
8	14	15	13	..	10	10
9	22	20	17	..	15	15
10	27	23	22	14	19	20
11	32	27	26	20	23	24
12	37	29	30	24	26	27
13	41	32	33	28	29	30
14	44	34	35	32	32	32
15	47	36	37	35	34	34
16	49	37	39	38	36	36
17	50	38	40	41	37	38
18	51	39	41	42	38	40
19	52	40	42	43	39	42
20	53	40	43	44	39	44
21	53	41	43	45	40	45
22	54	42	43	46	41	46
23	54	42	44	47	41	48
24	54	42	44	47	42	49
25	..	42	44	48	42	..
26	..	42	..	48	42	..
27	..	..	..	48	42	..
28	..	..	..	49	42	..
29	..	..	..	49	42	..
30	..	..	..	49	42	..
31	..	..	..	..	..	..
32	..	..	..	..	..	..
33	..	..	..	..	..	..

MERCHANTABLE HEIGHT OF COTTONWOOD

Table (X), page 185, shows the average length of the cottonwood trees which is usable for saw log purposes. This disregards the tops of the trees and branches which are utilized for posts or fuel wood.

YIELDS FROM COTTONWOOD PLANTATIONS

A great range in yields will be found in the cottonwood plantations in Iowa because of the great variety of conditions under which the plantations have grown. Some plantations had the trees closely spaced at the start while some were widely spaced; some were grazed and some were not; others were cultivated, pruned and thinned while some received no attention.

Altho the plantations measured occur on a great variety of soils no attempt was made to classify these except in three general groups consisting of lowland, upland and soils of average moisture. In the field studies it was often difficult to make a distinction between average and upland soils. The studies of Iowa plantations indicate that cottonwood will yield excellent returns on upland soil as well as on bottom lands. Where there is a sufficient amount of soil moisture the tree seems to thrive even tho the soil is of poor quality.

TABLE XI. YIELDS FOR IOWA COTTONWOOD PLANTATIONS OF DIFFERENT AGES. MEDIUM SITUATIONS

County	Age yrs.	Trees per acre	Original spacing	Board feet on 1 acre basis Maine rule	Estimated cordwood per acre
O'Brien	18	316	12'x3' & 16'x3'	4,996	36 cords
Kossuth	19	...	8'x4'	25,400	65 "
Kossuth	20	312	6'x6'	15,556	42 "
Kossuth	20	320	4'x6'	25,200	40 "
Kossuth	20	...	10'x4'-6'	15,168	45 "
Kossuth	25	292	8'x10'	23,792	52 "
Winnebago	25	240	10'	22,736	38 "
Osceola	26	300	3'x3'	20,270	55 "
Kossuth	28	368	6'x8'	38,576	40 "
Kossuth	38	108	12'x6'	12,038	26 "
Worth	29	288	12'x4'	14,904	37 "
O'Brien	29	140	6'x6'	19,736	46 "
O'Brien	30	124	6'x6'	5,556	55 "
Worth	32	300	8'x irregular	21,660	40 "
O'Brien	32	112	12'x irregular	9,346	21 "
Lyon	34	62	8'x8'	13,979	19 "
Tama	36	144	7'	13,500	26 "
O'Brien	37	96	6'x6'	12,690	33 "
O'Brien	38	208	10'x6'	40,120	38 "
Worth	38	232	10 x irregular	16,592	49 "
Clay	40	256	8'x8'	24,384	45 "
Sioux	40	316	11'x8'	39,000	51 "
Sioux	40	52	8'-30'	23,057	16 "
Grundy	40	55	Irregular	10,192	17 "
Kossuth	40	144	Irregular	22,900	27 "
Kossuth	42	224	Irregular	24,320	38 "
Poweshiek	42	178	Irregular	12,216	32 "
O'Brien	43	128	6'x6'	22,568	33 "
Clay	43	168	Irregular	23,384	35 "
Bremer	45	132	Irregular	25,076	52 "
Chickasaw	45	148	Irregular	15,596	50 "
Osceola	45	164	6'x16'	23,304	44 "

TABLE XII. YIELDS FOR IOWA COTTONWOOD PLANTATIONS OF DIFFERENT AGES. UPLAND SITUATIONS

County	Age	Trees per acre	Original spacing	Board feet on one acre basis Maine rule	Estimated cord-wood per acre
Kossuth	26	224	Irregular 10'x12'	18,852	22 cords
Winnebago	30	128	Irregular	23,784	25 "
Sioux	30	120	8'	24,300	30 "
Winnebago	30	272	12'x12'	30,416	35 "
Kossuth	35	264	8'x10'	26,256	27 "
Marshall	38	228	8'x irregular in rows	27,804	30 "
O'Brien	40	120	12'x4'	25,556	30 "

Several plantations were measured which were producing in the neighborhood of 40,000 feet per acre in addition to varying amounts of cord-wood. One plantation in O'Brien county produced 40,120 board feet at the age of 38 years. This grove was originally spaced 6x10 feet. Stock was permitted to graze in the area which probably injured some of the trees. Another plantation in northwestern Iowa produced 39,000 board feet in a period of 40 years. The original spacing was about 8x11 feet. At the time the plantation was measured the grove was in excellent condition. The trees remaining in the area numbered about 300 to the acre and were reasonably uniform in size. The entire plantation of five acres had not been used for grazing. Another plantation located in Kossuth county produced 41,500 board feet and 52 cords of fire-wood per acre during a period of 39 years. At the time the measurements were taken there were over 300 standing trees to the acre. The trees varied from 10 to 20 inches in diameter. Several other plantations were measured which produced better than 30,000 board feet per acre in addition to cord-wood.

One plantation was found which was 45 years old but which had received no care. The grove had been used for years as a hog lot. At the time of measurement it contained 3,534 board feet of lumber . This illustrates the great variation in yields in plantations which have received different treatments.

The results show that if reasonable care and protection is given the cottonwood plantation a yield of 30 M board feet per

TABLE XIII. YIELDS FOR IOWA COTTONWOOD PLANTATIONS OF DIFFERENT AGES. LOWLAND SITUATIONS

County	Age	Trees per acre	Original spacing	Board feet on one acre basis Maine rule	Estimated cord-wood per acre
Kossuth	15	250	10'	10,608	21 cords
Butler	32	180	Irregular	21,150	27 "
Sioux	33	128	8'x3'	31,368	38 "
Kossuth	39	395	8'x12'	41,500	52 "
Kossuth	40	140	8'x16'	34,278	40 "
Kossuth	44	156	10'x10'	26,460	36 "

acre, in addition to 25 to 40 cords of fuel, may be expected on a conservative basis, in 35 years.

Tables (XI, XII, and XIII) indicate the returns from plantations in different parts of Iowa.

YIELDS FROM COTTONWOOD ROWS

Many thousands of feet of cottonwood lumber have been cut from single rows. The yields in some instances have been very surprising to the owners. One row in Monona county on the farm of Carl Anderson, consisting of 64 trees, produced 48,000 board feet of lumber in addition to an estimated 95 cords of fire-wood. This row when measured was 41 years old and the trees averaged 750 board feet and about 1½ cords of fire-wood per tree. Another row of trees in Fayette county made up of 23 trees produced 13,345 board feet of lumber and about 35 cords of fire-wood. This was an average of 580 board feet and 1½ cords of wood per tree.

On a farm near Schaller, Iowa, 40,000 feet of lumber and 80 cords of fire-wood were cut from 86 cottonwood trees which were grown along a fence line. The trees were 35 years old. Twenty-one trees were left standing in the row which would yield 8,000 board feet and 15 cords of wood. The entire row which was one-half mile long, had yielded 48,000 board feet and 95 cords of fire-wood in a period of 35 years. In addition, this row had served as a windbreak during this period.

TABLE XIV. YIELDS FOR IOWA COTTONWOOD. SINGLE ROWS OF DIFFERENT AGES. MEDIUM SITUATIONS

County	Age years	Number or trees	Length of row	Board feet in entire row. Maine rule	Average Board ft. per tree	Estimated cord-wood in entire row
O'Brien	18	40	224 ft.	1,984	49.6	20 cords
Sioux	29	50	432 ft.	10,161	203.02	35 "
Kossuth	29	49	396 ft.	6,839	139.57	30 "
Sioux	31	35	320 ft.	6,101	174.31	30 "
Sac	35	84	..	52,500	625	90 "
Cerro Gordo	35	41	320 ft.	4,909	119.73	33 "
Worth	37	40	396 ft.	7,624	190.6	40 "
Butler	37	50	554 ft.	9,963	199.26	42 "
Hancock	38	52	250 ft.	16,988	326.69	50 "
Osceola	38	83	640 ft.	17,216	207.42	70 "
Worth	39	40	480 ft.	8,762	219.05	32 "
Kossuth	39	51	400 ft.	8,082	158.47	37 "
Kossuth	40	42	336 ft.	9,498	226.14	30 "
O'Brien	40	49	480 ft.	15,451	315.32	50 "
O'Brien	40	23	320 ft.	7,315	318.04	26 "
Guthrie	40	50	400 ft.	8,501	170.02	31 "
Butler	42	60	...	12,790	213.01	44 "
Black Hawk	43	57	390 ft.	19,367	339.77	55 "
Buchanan	45	36	480 ft.	13,724	388.55	43 "
Buchanan	47	14	160 ft.	3,113	222.35	16 "
Butler	48	37	240 ft.	9,288	251.02	30 "
Cedar	51	37	192 ft.	10,211	275.97	44 "
Buchanan	54	24	240 ft.	8,269	344.54	30 "

TABLE XV. YIELDS FOR IOWA COTTONWOOD. SINGLE ROWS OF DIFFERENT AGES. LOWLAND SITUATIONS

County	Age	Number or trees	Length of row ft.	Board feet in entire row. Maine rule	Average Board ft. per tree	Estimated cord-wood in entire row
Butler	32	46	552	8,456	183.82	28 cords
Floyd	38	60	720	19,369	322.81	65 "
Allamakee	38	26	240	9,872	379.64	32 "
Butler	40	60	600	17,954	299.23	60 "
Monona	41	64	...	48,007	750.10	95 "
Butler	47	39	...	12,378	340.46	42 "

TABLE XVI. YIELDS FOR IOWA COTTONWOOD. SINGLE ROWS OF DIFFERENT AGES. UPLAND SITUATIONS

County	Age	Number or trees	Length of row ft.	Board feet in entire row. Maine rule	Average Board ft. per tree	Estimated cord-wood in entire row
Kossuth	29	71	568	9,551	134.52	30 cords
Sioux	38	28	240	5,680	202.89	20 "
Black Hawk	40	24	480	4,494	187.25	15 "
Osceola	40	79	512	14,044	177.77	70 "
Black Hawk	44	50	...	12,203	244.06	42 "
Fayette	56	23	286	13,345	580.21	35 "

S. R. Haines of Buena Vista county reported that he sawed a row of 273 cottonwood trees 25 years old and secured an average yield of 300 board feet per tree. The largest tree which was 36 inches in diameter, sawed out 530 board feet.

The individual trees in single rows produce greater volume per tree, age for age, than trees grown in plantations, due to the fact that each tree has more growing space. The plantation trees, on the other hand, usually have the trunks clearer of branches and produce more lumber free from knots.

The heavy production of lumber and cord-wood from rows of cottonwood trees, often is not realized. It was found that in averaging together the production of all single rows measured in this study (35 rows in different parts of the state) there was a production of 71,544 board feet of lumber and 274 cords of wood for each half mile. This is 27.1 board feet and .104 cords of wood for each linear foot of row, or 1000 board feet of lumber were produced on an average for every 37 feet of row and 1 cord of wood for every 10 feet. The average age of the trees was 39 years.

Tables (XIV, XV and XVI) indicate some yields from typical cottonwood rows in Iowa.

YIELDS FROM INDIVIDUAL TREES

A detailed study of the yields in board feet of individual trees show that the best producing trees are those grown on bottomland soil where there is an abundance of soil moisture. This is true for both the planted groves and the single rows. Based on the Maine Log Rule individual trees were found under 55 years of age which had produced 1,000 to 1,800 board feet of lumber. These trees were between 30 and 45 inches in diameter. The largest producers were in single rows or in uncrowded stands where the trees had ample room for growth.

Fig. 5. Cottonwood plantation 11 years old just before it was thinned out. The trees were tall and straight and free from large side branches but the stand was becoming too crowded for the best production of saw log material. The larger trees are 11 inches in diameter. The accompanying picture on page 191 shows the same stand after thinning.

Table (XVII), page 184, based on the measurements of 4,566 trees, indicates the average board foot contents of trees of different diameters both in plantations and in single rows.

A graphic comparison of the yields of individual trees grown on different soil situations will be found in charts 3 and 4. It is interesting to note in chart 4 that the board foot contents of trees grown in single rows run very nearly the same for the trees on upland and medium situations. Charts 3 and 4 both

Fig. 6. Cottonwood plantation 11 years old just after thinning. The picture on page 190 shows the same stand before thinning. The trees taken out were made into fence posts which will be used after being creosoted.

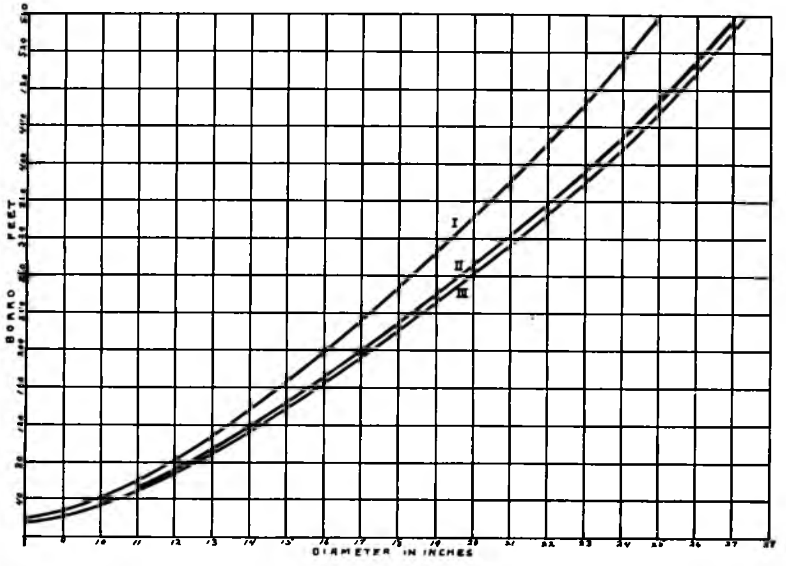

Chart 3.

Board foot contents of trees in cottonwood plantations. I—Lowland soil. II—Medium soil. III—Upland soil. Based on measurements of 3047 trees.

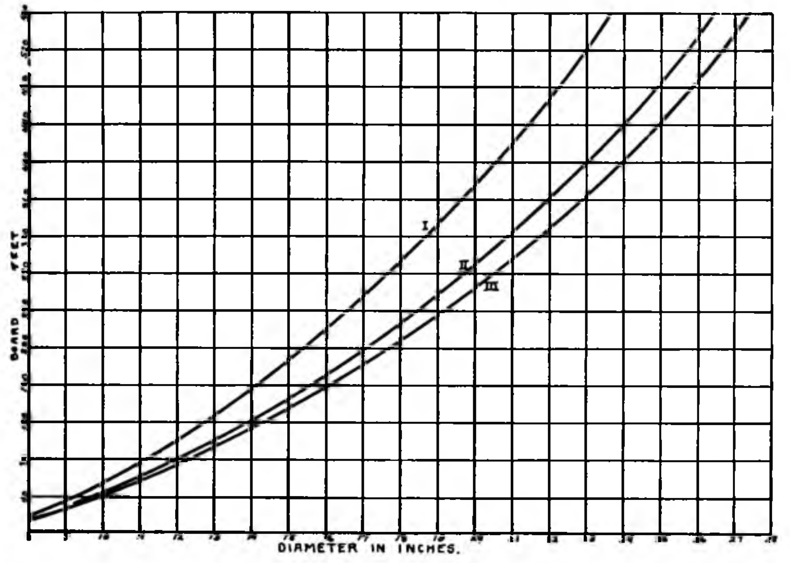

Chart 4.

Board foot contents of trees in cottonwood rows. I—Lowland soil. II—Medium soil. III—Upland soil. Based on measurements of 1519 trees.

indicate the greater volume which is obtainable from trees grown on bottomland, diameter for diameter, whether in single rows or in plantations. A certain diameter is reached at an earlier age on bottomland than on upland and it is probable that bottomland will support a denser stand of trees than soils with less moisture. This indicates that greater production of wood is obtained in low land and emphasizes the importance of utilizing overflowed bottomlands for cottonwood planting.

YIELDS IN FENCE POSTS FROM COTTONWOOD PLANTATIONS

The more common use of creosote and other wood preservatives in treating fence posts has opened up the possibility of using cottonwood fence posts very extensively over the state. Experiments with creosoted cottonwood posts, which were conducted a number of years ago, indicate that these posts will last 20 to 25 years. The cost of treatment varies from 15 to 20 cents per post. A crop of cottonwood posts can probably be produced in a shorter time than from any other Iowa tree.

Detailed measurements show that one of the Experiment Station plantations produced the following fence posts at the respective ages indicated:

	Number of first-class posts on one acre basis	Number of second-class posts on one acre basis
Age of plantation 6 years	613	250
Age of plantation 12 years	1,408	220

It is easily possible to produce an average of from 100 to 150 fence posts per acre per year after the trees have reached an age of 6 years. Cottonwood plantations set out expressly for the production of fence posts might well be handled on a rotation of 6 to 8 years. In plantations which are grown primarily for saw logs, it is possible to secure large numbers of fence posts and a considerable quantity of fuel wood by making thinnings as the stand becomes crowded.

NUMBER OF TREES PER ACRE IN TYPICAL PLANTATIONS OF DIFFERENT AGES

The great diversity of conditions under which cottonwood plantations in Iowa have been grown, makes it difficult to determine the optimum number of trees which should remain in a plantation at different ages. Observations would indicate that a 6x6 foot spacing with 1200 trees per acre or a 7x7 foot spacing with about 900 trees, is the most satisfactory number at the start. The relatively close spacing when planted will force the trees up for light and the resulting stand will be straight, tall,

SPACING PLAN FOR COTTONWOOD PLANTATION.

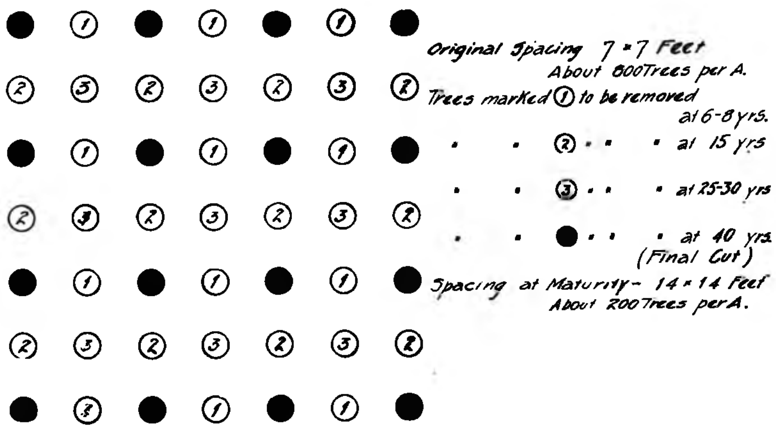

Chart 5.

and relatively free from side branches, all of which are advantages from the lumber production standpoint. At about 8 years of age the trees will have an average height of 35 to 45 feet. At this time about one-third to one-half of the original number of trees should be thinned out and utilized either for fence posts (creosoted) or fuel. At 15 years the stand will again be crowding severely and another thinning should be made, leaving about 300 to 400 trees per acre. A third thinning should be made at the twenty-fifth or thirtieth year and the final crop harvested in about 35 years.

The following table indicates the approximate number of live cottonwood trees which should remain in plantations for best development.

At 1 year about 700 to 1,200 trees per acre.
At 8 years about 500 to 600 trees per acre.
At 15 years about 300 to 400 trees per acre.
At 25 years about 220 to 275 trees per acre.
At 35 years about 125 to 175 trees per acre.

The above chart is a suggested plan for the spacing and removal of trees in cottonwood plantations. The plan is merely suggestive as it is never possible to make uniform thinnings because the poorer and defective trees should be removed even tho it leaves the remaining trees spaced irregularly.

HARVESTING THE CROP OF COTTONWOOD

Cottonwood lumber generally is used on the farm where it is grown or on adjoining farms. This decreases the cost of marketing. The small portable mill with a daily capacity of 5,000 to 10,000 board feet is used almost exclusively in sawing the logs. The cost of sawing a small plantation is greater per thousand feet than when a large amount of timber can be cut at one setting. On the other hand, the cost of hauling the logs is greatly reduced because usually the small portable mill is set up in or adjoining the timber to be cut. Data secured from mill operators indicate that four men operating the smaller type of mill are able to cut from 5,000 to 6,000 board feet per day. A slightly larger mill which requires 6 or 7 men to operate will cut about 10,000 feet per day. The sawing is usually done at a contract price per M. The price during the past few years has varied from $8.50 to about $10.00. The cost of felling, cutting into logs and yarding should not exceed $2.00 per M. The figure of $12.00 per M. for felling, cutting into logs and sawing into lumber should be about an average.

In order to get good results in sawing cottonwood, the lumber should be handled properly while seasoning. Warping and twisting will be prevented by piling the freshly cut lumber on a substantial foundation, keeping an inch or two of space between the boards in each layer and separating each layer by cross strips spaced about three feet apart. The piles should be made large enough so that the weight of lumber will keep the boards firmly in place while drying.

In harvesting young plantations for fence posts usually it is considered best to cut the posts in the winter time and peel them at once. Posts peel less readily in the winter than in the spring, but on the other hand more time is available in the winter for work of this kind. Posts cut and peeled in the winter dry more slowly and with less tendency to open up excessive season cracks. Before cottonwood posts are creosoted they should be thoroly seasoned, preferably for several months. A good absorption of creosote by the "open tank" method is not possible when partially seasoned posts are used. Where facilities will permit it is desirable to fell and cut the posts one winter and pile in open piles, off the ground, preferably under cover, until the next winter when they should be creosoted.

FINANCIAL RETURNS

It is extremely difficult to figure exact financial returns from cottonwood planting due to the impossibility of measuring in dollars the protective value which some of the plantations have afforded. It would only be proper in many cases to offset the taxes and interest on the value of the soil occupied by the plantation, by the value of the protection, which has been afforded the farm buildings, livestock and crops.

In the following calculations it is assumed that a yield of 30 M.

board feet per acre can be secured in 35 years time which is a reasonable figure, and that the plantations will average about 50 cords of wood per acre, in addition to the lumber. Most of the lumber sawed is used on nearby farms and since it replaces $30 to $50 lumber which otherwise would be purchased from lumber dealers, it is assumed that a value of $30 per M. for the mill run cottonwood lumber, is a conservative figure.

The following will indicate in a general way the profitableness of growing cottonwood.

Case No. 1. In this instance the cottonwood grove has given the farmstead protection against winds during the 35 years of its growth. The soil is good agricultural land valued at $200 per acre at the present time and with an estimated average value of $60 for the 35 year period during which the crop of trees was maturing. The purpose of setting out the grove originally was to give some shelter from severe winds and make the farm home more comfortable and beautiful. The idea of producing a crop of saw timber was incidental. The owner of the plantation considers that he received full returns on his investment before he cut a stick of timber. During the 35 years that the plantation has been growing, the dead, defective and wind-thrown trees have been used for fuel. In this case it is proposed to assume that the protection afforded and the fire-wood which has been utilized has paid for the rent of the soil and the taxes chargeable against the land occupied by the plantation, or, in other words, offsets the taxes and interest on the value of the soil. In this case these items will not be charged against the crop of timber. The following will summarize the returns per acre.

30 M. board feet per acre @ $30 per M.	$900.00	
50 cords fuel wood @ $2.00 per cord net	100.00	
Total returns		$1000.00
Cost of harvesting and sawing 30 M. feet of lumber @ $12	$360.00	
Planting cost of $10 at 6% compound interest for 35 years	76.86	
Net costs		$ 436.86
Returns per acre for 35 years		$ 536.14
Average returns per acre per year		16.09

This means that if the interest on the value of the soil, and the taxes are balanced against the returns received in protection and thinnings, the plantation has paid six percent compound interest on the original cost of planting and has yielded an additional average revenue of $16.09 per acre for each of the 35 years it has been growing.

Case No. 2. In this case all costs are charged against the wood produced, including compound interest on the average soil value for the 35-year period, as well as the taxes carried at compound interest. The average farm land values in Iowa, including improvements, have increased about as follows: In 1880 the value per acre was $22.92; in 1890, $28.13; in 1900, $43.31; in 1910, $96.00; in 1920, $227.09. It is assumed that $60 per acre is a fair average valuation of Iowa farm land during the past 35 years. The census figures show that the taxable value of average Iowa farm land and the tax levy has been as follows: In 1885 the taxable value was $7.98 and the levy about 20 mills; in 1905, the taxable value was $10 per acre and the tax levy about 30 mills. In 1921 the value was $20 per acre and the average tax levy about 70 mills. The above would mean that the tax per acre for farm land was 15 cents per year in 1885; 30 cents in 1905 and about $1.40 in 1921. In the following calculations it is assumed that a tax of 50 cents per acre per year has been paid on average Iowa farm land during the past 35 years while the cottonwood plantations have been maturing.

Returns per acre

30 M board feet of lumber per acre @ $30 per M......$	900.00
50 cords fuel wood @ $2.00 per cord net.............	100.00
Returns from thinnings per acre disregarded.	
Total returns ....$	1000.00

Costs per acre

Cost of harvesting and sawing 30 M. @ $12.00 per M...$	360.00
Compound interest for 35 years @ 6% on $10.00 cost of planting	76.86
Taxes, 50 cents per year, at 6% compound interest....	55.64
Compound interest at 6% on estimated average value of the soil ($60) for the 35 year period............	400.80
Total costs ....$	893.30
Net returns per acre for 35 yr. period...........	106.70
Average net returns per acre per year.........	3.05

This means that in the above case an average extra annual profit of $3.05 per acre has been received in addition to six percent compounded interest on all of the money invested in the plantation including value of the soil, taxes and cost of establishment. The venture would be considered a splendid paying investment if all the costs carried at compound interest for the 35 year period had just balanced with the returns. In the above case the investment earned between six and seven percent compound interest during the 35-year period. When it is considered that the average farm land in the state brings in a much lower rate of simple interest on the investment it can be seen that cottonwood plantations have given very satisfactory returns.

The foregoing figures indicate that if the farmer is satisfied with a long time three percent compound interest investment he could plant cottonwood on land valued at more than $250 per acre and still secure this return, in addition to any protective value which might be afforded by the plantation. This is based on present lumber prices and in view of the fact that the prices of stumpage and lumber have been increasing very rapidly during the past few years.

Case No. 3. This is a strictly commercial proposition where the land planted is not suited to the production of agricultural crops and where the protective value of the plantation is negligible. This would include areas adjacent to streams which are subject to annual overflow and waste corners of the farm which are not used for annual crops. The value of these areas should not exceed $15 to $20 per acre, exclusive of any timber which may be on the land. Areas of this kind are particularly well adapted to growing cottonwood. The Experiment Station has a very thrifty plantation growing on this type of land. The return on the investment in this case is summarized as follows:

Returns per acre

30 M. board feet per acre @ $30 per M	$ 900.00
50 cords fuel wood at $2.00 per cord net	100.00
Thinning returns assumed to equal cost of making them.	
Total returns per acre	$1000.00

Costs per acre

Cost of harvesting and sawing 30 M. board feet of lumber @ $12 per M	$ 360.00
Compound interest for 35 yrs. @ 6% on $10 cost of establishing	76.86
Taxes, estimated at 50c per year compounded at 6% for 35 years	55.64
Compound interest at 6% for 35 years on soil value of $15.00	100.20
Total costs per acre	$ 592.70
Net returns per acre for 35 year period	407.30
Average net returns per acre per year	11.63

This means that in the above case an extra average annual return of $11.63 per acre was received in addition to six percent compound interest on all money invested for 35 years.

Stated in another way, the returns amounted to more than eight and one-half percent compound interest on the money invested. This same investment would earn six percent compound interest for 35 years if the plantation is set out on land valued at about $80.00 per acre.

Case No. 4. Returns from fence line rows of cottonwood. The measurments of 35 rows of cottonwood trees which averaged 39 years in age showed an average production of 27.1 board feet and .104 cord of fuel wood for each linear foot of row. On a basis of a row one-half mile in length the production would be 71,544 board feet of lumber and 274 cords of fire-wood.

Because of the difficulty in determining the acreage occupied by single rows of trees, no attempt will be made here to charge the taxes and interest on the value of the soil against the timber produced. The gross returns follow:

Returns per one-half mile of row

71,544 feet of lumber at $30 per M	$2146.32
274 cords of fire-wood at $2.00 net	548.00
Total returns	$2694.32

Fig. 9. Thinnings from a 11 year old cottonwood plantation. Pieces 3½ inches and over in diameter inside the bark will be peeled, creosoted, and used as fence posts. Treated cottonwood posts last 20 to 25 years. Young cottonwood plantations will produce an average of 100 to 150 fence posts per acre per year.

Expenses per one-half mile of row

Cost of harvesting and sawing 71,544 feet at $12 per M.	$ 858.53
Original cost of planting one-half mile row, $8.00 at 6% compound interest for 39 years	77.60
Total costs	$ 936.13
Gross returns from an average one-half mile row of cottonwood trees 39 years old	$1758.19
Average yearly return not considering interest on soil value and taxes	45.08

Case No. 5. Returns from fence posts on over-flowed land with low valuation. Plantation 6 years old.

In this case the actual number of fence posts produced on the plantation of the Experiment Station is taken as a basis for computation. On this plantation 613 first-class posts were produced in 6 years. (This does not include 250 second-class posts produced, a large percent of which were usable.) It is assumed that these posts have a stumpage value of 10 cents each.

Returns per acre

613 first-class fence posts on a 6 year rotation, at 10 cents, net	$ 61.30
Total returns during 6 years	$ 61.30

Costs per acre

6% compound interest on $10.00, cost of establishment, including two cultivations, for 6 yr. period....$	14.10
6% compound interest on value of the land ($15.00) for 6 years	6.15
Taxes, carried at 6% compound interest	3.42
Total net costs per acre....$	23.67
Net returns per acre for the 6 year period....$	37.63
Average net return per acre per year	6.27

This shows that a crop of cottonwood fence posts, produced in 6 years time on over-flowed land, will yield an extra profit of $6.27 per acre per year in addition to six percent compound interest on the money invested. Stated in another way, the fence posts netted a return of over 15 percent compound interest on the investment when planted on waste land with a value of $15.00 per acre. A six percent compound interest investment of this kind could be made on land with a value as high as $115 per acre.

Case No. 6. Returns from fence post production on over flowed land with low valuation. Plantation 12 years old.

As in the preceding case the returns are based on the actual number of fence posts produced in one of the experimental plantations. In 12 years time this plantation produced 1,408 first class posts and 220 second class. In this calculation the second class posts are disregarded entirely altho a fair percent would be usable. The financial returns per acre for this 12-year-old plantation may be indicated as follows:

Returns per acre

1408 first-class fence posts at 10 cents each, net.....$140.80	
	$ 140.80

Costs per acre

Cost of establishing plantation at $10 at compound interest for 12 years....$	20.12
Interest on value of land at $15.00 for 12 years	15.15
Taxes carried at 6% compound interest	8.41
Total costs....$	43.68
Net returns per acre for the 12 year period....$	97.12
Net returns per acre per year	8.10

By harvesting the cottonwood posts at the age of 12 years a greater net revenue, over and above six percent compound interest, is obtained than when the posts are harvested at 6 years of age. That is, a greater profit is secured in growing the posts on a 12 year rather than on a 6 year rotation. It will be noted that in 12 years time more than twice as many posts are produced than in 6 years time. In this case the fence posts would earn six percent compound interest when grown on land with a value of about $115 per acre. In case the land of higher valuation is used the planter must either be satisfied with less than six percent compound interest on the investment or must secure a greater yield of posts per acre. The above is based on the assumption that the posts are used on the farm where grown and might not hold good for the production of large quantities of posts for the general market.

WHERE AND WHEN COTTONWOOD SHOULD BE GROWN

In summarizing, cottonwood plantings in Iowa will produce a very good return on a long time reasonably safe investment. As a general procedure planting of cottonwood should not be attempted on high quality agricultural soil unless there is a protective or aesthetic value received from the grove in addition to the wood products produced. The investigations show that the cottonwood may be used very profitably on waste lands and small cut-off pieces of the farm such as overflowed areas adjoining water courses. Instead of allowing many of these areas to remain a liability they should be turned into an asset by utilizing them for the production of a profitable crop of cottonwood or other trees.