Oregon State College, School of Forestry

Thesis

SHORT ROTATION FOREST CROPS

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INDEX

INTRODUCTION.

For the past two years I have been interested in the utilization of waste lands, especially the flood lands that boarder most of our larger streams. It is with the second objective in mind, of conserving and utilizing these waste lands that I present this paper, on Short Rotation Forest Crops. The primary objective is of course to produce the greatest value in the shortest time.

SHORT ROTATION FOREST CROPS.

I believe that there are a few things necessary to all short rotation timber crops. First, that there must be a market for the products that it is desired to produce. This means a market for small products. This market may already exist or have to be developed. The market in the future should be free from competition with natural grown products or synthetic products. It is obvious that a Christmas tree plantation would not do well in a region where there is a large supply of wild trees near by. Naturally, if the plantation is close to its market it will reap additional profits because of decreased cost of transportation. It is usually desirable that the crop be grown within trucking distance of the market.

Rapid growth is another essential for short rotation crops. This means that the species selected for the crop must have the inherent ability to make rapid growth during its early years. This also means that the plantation should be located on situations suitable for rapid growth. Further, the species selected must be easily and cheaply propagated and established.

Some things that are desirable in shott rotation forest crops, but not absolutely necessary, are given below. If the crop can be produced on land that is not being otherwise used, it will increase the productivity of the region just that much. These crops can often be placed on long corners and odd shaped pieces of farm land. Rocky or infertile lands, flood lands and other low valued lands can be made to produce incomes that compare favorably with farm crops on good agricultural land.

Some of these crops can be made to check erosion on steep land. They may act as wind breaks in wind swept countrys. They also serve to build up the soil by adding a rich layer of humus to the soil. Where Black locust is planted, nitrogen is also added to the soil. It can be readily seen that these short rotation crops can easily werve a dual purpose. If they can be used in this manner, it is highly desirable to do so.

If the crop is of the nature that it allows of cultural treatment and harvesting during the dull season of the year, it is advantageous, in that it allows a better utilization of the managers time. If the crop is run in commection with a farm and the pruning, cultivation, and harvesting can be done in the winter when farm work is at a standstill, it creates a well rounded program of work for the year, as well as bringing in an income just when it is most welcome.

It is desirable that the crop be easily and simply managed. Difficult crops to produce, run up the production costs and this reduces the net returns.

Let us now consider some of the more outstanding Short Rotatio

Forest crops as well as some that show possibilities when managed on short rotations. Crops that can be considered in the first class are Christmas trees, Black locust, and Cottonwood while Cascara, Blue Gum, Red Alder and Southern Pine fall in the latter.

CHRISTMAS TREE PRODUCTION.

General: Christmas tree production as a side line crop should prove profitable in many localities, both as a source of cash and as a means of utilizing waste land on the farm. If desired such production may readily be combined with forest planting for timber production also. This is done by using the Christmas tree stock as filler for the timber stock.

This crop fits into the farm program very nicely. The planting can be taken care of in the early spring before other crops can be seeded in. The cultivation can be done during slack times in the farm program. There is nothing exacting about the time this should be done. It mearly keeps competition down and conserves the moisture The harvesting and marketing comes at a time when all farm activity is at a stand still. Further, it brings in an income at a time when a little cash is very welcome.

This crop offers an excellent chance to utilize old fields that have become exhausted by years of cropping. Odd corners and excess pasture land can be put to good use. The erosion problem on cultivated slopes can be checked.

Ideal Location: It is to be expected that some parts of the country is better adapted for Christmas tree production than others. Plantations located a long distance from the source of natural grown trees have an advantage over the plantation that must

compete with the natural product. The plantations should be within trucking distance of large centers of population as this greatly reduces transportation costs. Plantation trees may offer some advantage over natural grown trees where heavy snows force the cutting of trees from a month to two months before the holidays. Natural grown trees under these conditions must be stored, bundled closely together and shipped considerable distance. This means that the trees have poor shape, or may be broken, that they loose their odor soon after coming into warm rooms and that their needles are soon dropped. The Plantation tree, because of its nearness to the market does not have to be bound so closely and for a long period of time, consequently it has good shape, little breakage, a good odor for a long time and the needles stay on when they are taken into warm houses.

Ideal Tree.

Trees to be ideal Christmas trees for plantation purposes should have the following characteristics. They should be symmetrical with a dense, compact crown. This means that the tree should not grow too rapidly. On the other hand they should grow fast enough to keep the rotation as short as possible. The branches should be stiff enough to carry the weight of the decorations. The tree should have a pleasant odor that lasts, as the odor of the tree adds much to the Spirit of Christmas. The leaves should stay on the tree while the tree is indoors. And lastly, the planting stock should be rather cheap.

Trees that have been used are Norway Spruce, Picea excelsa; Blue Spruce, Picea pungens; White Spruce, P.glauca: White fir,

Abies concolor; Deodar Cedar, Cedrus deodara; Douglas fir, Pseudotsuga taxifolia; and Eastern Red Cedar, Juniperus virginiana. The Spruces are the most favored, especially the Norway Spruce. This is because it is the cheaper to purchase in the nursery and also because it makes slightly more growth.

Planting Stock.

It has been the practice to use 2-2 or 3-I transplant stock in starting plantations. It is felt that the seedlings and young transplants can be given better care in the transplant beds than when set out in the plantation. A practice that has been used successfully, is to purchase 2 year old seedlings from the nursery, then set these out in transplant rows or beds for two more years. A saving of from 8 to I2 dollars is realized by this practice.

Preparation of Site.

It has been found that if cultivation is contemplated, that it pays to prepare the land before planting. All sites except those subject to erosion should be plawed and harrowed. It is found that this practice greatly reduces the cost of planting and also reduces the cultivation costs for the first year.

Planting.

Planting is usually done in the early spring, as soon as the frost leaves the ground but before growth starts. A spacing of about 3by3 feet or 4by4 feet is usually used. Planting should be followed by cultivations made often enough to keep competition due to weeds to a minimun, and to conserve moisture in the soil. It was found that cultivation caused the crop to mature about 2 years earlier than a similar uncultivated crop. On steep slopes cultiva-

tion should be avoided because of the danger of erosion. On lesser slopes, the cultivation should be with the contour to lessen the chance of erosion. The ease of cultivation would be greatly helped if the trees were planted on the contour also. Cultivation need not be continued after the second or third year.

The Length of Rotation:

The length of time that is necessary to mature a crop depends upon the site, the inherent growth rate of the tree, and size at which the tree can be marketed. This last factor has a marked effect upon the length of rotation.

There is now a growing demand for trees from one to three feet high, to be used as table trees in apartment houses and stores It takes from one to three years after planting to produce trees of this size. The largest demand is for trees from four to seven feet high. Norway spruce this size result in from four to six years after planting. Other species require two to three years longer. Trees of larger size find a ready market to lodges, schools, and churches at good prices. This crop is not perishable; trees not sold this year can wait for next year. The whole plantation does not mature at one time. A four year old plantation in the Middle West had trees on it as small as six inches and also marketable trees upon it five feet tall. In other words, they could start to market their crop after four years. It is probable that the rotation should not be longer than ten to twelve years.

Markets and Marketing:

Perhaps the best market is the local retail market. Small

plantations can be marketed entirely to the local people directly and thus realize the wholesale and jobbers profits also. In the Middle West, six foot Norway Spruce trees retailed at one dollar each in many of the larger towns(1930). In the same region and at the same time, trees from four to six feet tall brought ten to thirty cents and trees six to eight feet tall brought thirty to forty cents wholesale. This wholesale market is through stores and general produce markets. Grocery companies in the Middle West handle large numbers of trees each season.

The harvesting process is a simple one. Pruning saws or shears are used in cutting the trees. They are cut as closely as possible to the ground. It is desirable that a square cut be made so that the tree can be easily fastened to the stand.

As the stand begins to open up, and large holes appear here and there, it is often the practice to set out new transplants near the stump of the old tree.

Returns to be Expected.

The costs will vary with the manner in which the land is prepared, the efficiency in which the trees are set, the amount of cultivation that follows, the rate paid for labor and the distance from the market.

A quarter acre plantation in Ohio, which had been plowed, harrowed, planted to 2,720 four year old transplants per acre, and then cultivated for two years, had the very high gross yield of $1,258.00 for the ¼ acre. A little less than one half the trees remained on the area to be sold the following year. These trees were sold retail and averaged nearly a dollar a piece. The total cost of formation and marketing the trees was less than $200. (1923-1925)

This shows what may be expected on small areas where a local retail market can be tapped. On large plantations, this kind of marketing would be much more difficult.

In Michigan a plantation was established for $I42.88 per acre carried at 6% interest for seven years, the time of harvesting. At that time the trees were sold at an average wholesale price of 30¢ for a gross yield of $734.40. This gave a net yield of $59I.52 per acre over a period of seven years.

So far Christmas tree plantations have not been developed extensively. There has been considerable work done in the Middle West however. At the present time all indications point to large profits in this industry if in the proper location. Also, the tendency is toward bigger and more commercialized Christmases. More trees are needed each year.

Literature Cited

Ohio Agricultural Experiment Station Bul.392 44th Ann.Report

Ohio Agricultural Experiment Station Bul. I43 Mar.,April I930

Michigan Agricultural Experiment Sta. Special Bul. I45 Mar. I925

U.S.D.A. Farmer's Bul. I664

BLACK LOCUST AS A SHORT ROTATION CROP.

Black Locust, Robinia pseudoacacia, is a tree which originally had a rather wide range from Central and Southern Pa. on both slopes of the Applachian Mts. to northern Georgia. It also extended into southern Illinois. It is now widely naturalized throughout the portion of the United States east of the Rocky Mountains. It is also found to some extent in the West, mainly in plantations and roadside plantings.

With this wide extension of its range came many strong and conflicting claims for the tree.

It is generally noted for its ability to grow on rather poor sites. However, Mattoon advises against planting it on very sandy, very wet, or very acid soils. Meginnis says," It is not only particularly well adapted for growth on most eroded sites and clay subsoils much too poor for agriculture uses, but, like most legumes it also builds up the soil by contributing nitrogen. Contrary to current belief, Turner found that the tree made good growth on strongly acid soil at the Fruit and Truck Branch Experiment Station of Arkansas.

The claims for this tree have not all been favorable. The Alabama Experiment Station found that the tree failed on eroded or run down lands unless given frequent cultivations and unless a complete fertilizer was used. They preferred their native pines because of their ease of establishment and rapidity of growth.

This tree is viewed with favor in most localities where it grows well. It is generally believed to do well on most soils except very sandy, very acid, or poorly drained soils. It grows

best on sweet or non acid soils. In its ability to grow on well drained locations such as on banks and hillsides Black Locust ranks high among all native trees. Because of its ability to grow on poor well drained soils and because of its fiberous root system, it is much used in erosion control work.

The rate of growth varies with the site and the climate from very rapid to very slow. In favorable sites and climates it should grow one to two feet in height and from ¼ to ½ inches in diameter per year after the first 5 years. In Idaho, the claim is for two to four feet in height and one-third to ½ inches in diameter per year on the average.

On sites and in climates favorable to good growth of this tree, an ideal location on which to establish a plantation is on worn-out farm land or eroded lands. On sites of this kind you not only receive the value of the plantation itself, but also the value of check on erosion and the soil building qualities of the tree itself.

Technical Qualitees and Uses.

First, let us consider some of the qualities of this product, the wood. For convenience the qualities will be expressed in percentages, using White oak as the base. Black locust has a shrinkage of but I0.3%. This makes the wood very desirable for insulator pins, tree-nails and other uses where shrinkage and swelling must be kept to a minimum. It also has a "modulus of rupture" of I28%, a "maximum crushing strength" of I33%, strength as a beam or post of I63%, shock-resisting ability of I34%, and stiffness of I45%. In other words it is stronger than White Oak in every way.

Another of its very desirable characteristics is its durability. In contact with the soil the heart wood will last from 25 to 30 years. Further, the sap wood is but a very narrow band of perishable wood.

During I926 the five main uses of this wood in the order given were, fence posts, insulator pins and cobs, mine timber, wagon hubs, and poles. Tennessee, Kentucky, West Virginia, and Virginia supplied about 72% of this output.

Besides the commercial uses given above there are the farm uses. Farmers constantly make use of this wood for farm repair material as wagon tongues, double trees, reaches, etc.

To show just how much of a demand there is for this wood I quote what an Insulator Pin Manufacturer says of the production of Black locust in Idaho. "You cannot impress it too firmly upon the minds of the farming community to raise Black Locust, as there will be a strong market for it.

The Plantation.

There has not been a great deal of work done in the line of plantations except in Idaho. In this state a large number of experimental plantings have been made, through-out the whole state and it was found that it does fairly well in all parts of the state below 4000 feet elevation and where there is more than I5 inches of rain.

The Plantations are usually started by means of one year old seedlings but rooted sprouts may be used. It is found that the planting costs are much lower if the land is well prepared before planting. It was also found that better post production could be

obtained from planting rather closely in a 6 by 6 or 7 by 7 spacing This close spacing also serves to keep the Locust borer, Cylene robiniae, in check, This insect seems to require sunshine and warmth. By close planting, the boles are shaded and his work kept in check.

It has also been found that cultivation on young trees gave greater height growth, more leaf production, and greater resistance from the leaf miner damage. Generally cultivation is practiced the first 2 or 3 years after planting. On dryer sites this period is usually extended a year or two.

According to Mattoon, this tree can be prepetuated by means of sprouts on short rotations. The trees should be cut during the late fall to late winter in order to promote vigorous sprouting. The trees should be cut to very low stumps in order to force the sprouts to come from the root collar rather than from the top of the stump.

Trees of the sprout crop will grow faster and can be harvested at least 5 years sooner than those of the original crop. These trees are also less subject to insect attack than were the original trees due to their vigorous growth.

Returns to be Expected.

The only information available as to returns to be expected is that taken from the University of Idaho's Bulletins. This information is based on more than 20 plantations scattered throughout the state. Their returns are based upon fence post production.

In a farm woodlot study in the irrigated section of southern Idaho a I4 year old plantation in the vicinity of Parma was selected

as representative of the more than a score of plantations in that part of the state. This plantation yielded I,I79 first class, 785 second class, and 654 third class posts per acre. These posts were figured to sell at forty cents for the first class, twenty-five cents for the second class, and ten cents for the third class posts. This brought in a gross yield of $733.25 per acre in fourteen years.

In another study of all the plantations of the state I7 were selected as being good samples. Plantations that showed extremely high or low yields were rejected. The information gathered from these I7 woodlots was averaged giving the following data. It might be said here that the 40, 25, and I0 cent prices used for the three grades of posts were considerably lower than the actual market price at the time. The average cost of establishing the woodlots was about $I8 and this was compounded at 5 % interest. It was the aim of this study to compare the yield of Black Locust with farm crops and because of this water, taxes and rent were omitted because it was felt that these expenses would be the same regardless of the crop.

Averages of I7 Black locust Plantations in Idaho.

Age	Trees per A.	Ave. height	Av. d.b.h.	Posts per A. #1	#2	#3	Total
12.9	782	48'	4.96"	856	659	841	2357

Value per A. Gross	Net	Annual Income (5% compound)
$591.50	$557.40	$ 31.88

In connection with this study, it was brought out that the average acre of Black locust land was probably poorer than the avera ge acre of farm land and also that the trees probably received much less care than did the farm crops. It is also probable that the yield should have been some-what higher since on three of the plots 5 to 6% of the material had been removed prexious to the sampling. On two other plots about 9 % had been removed before the data had been gathered, while plot No.II had 6I% of its material removed.

Growth of Black locust at Corvallis.

In order to see how the rate of growth of Black locust on the heavy acid soils about Corvallis compared with the rate of growth of the Idaho trees, I took the height and diameter measurements of 20 trees in the unfertilized row of Prof. T.J.Starker's plantation. These measurements were taken of the trees as they came in the row, eleminating only the few which were dying or which had been replaced by younger stock. This plantation had been established seven years ago of one year old seedlings. The trees were eighty inches apart in the rows with 36 feet between rows. This spacing is not good for post production. For this reason my comparison will not be an accurate one. Further more my sampling falls far short of being good because of the small number of measurements taken and because the samples are all limited to one universe. Measurements taken from the Local Plantation averaged 3.55 Inches d.b.h. and 16.9 feet for height.

Growth of Idaho and Corvallis Plantations Compared.

	Mean Annual Height	Mean Annual Diameter
Idaho Plantation	3.72'	.38"
Corvallis Plantation	2.10'	.44"

It is probable that the rate of growth of the local plantation is comparable to that of the Idaho plantation.

The lower height growth and larger diameter growth of the local trees may be due to the wide spacing which induced the tree to branch earlier than they would have, had they been more closely spaced.

Length of Rotation.

At the present time there is little data present to indicate the most profitable age at which to harvest this tree. Information gathered so far by the Forest School of Idaho seems to indicate a rotation over 20 years in length. A rotation of this length would require that the stand be thinned. These thinnings would supply the farmer with fence posts and other repair material.

Idaho Station Bul. I35

University of Idaho Bul. 2

U.S.D.A. Farmers Bul. I628

U.S.D.A. Circular I3I

Journal of Forestry May I934 The Effect of Cultivation on Young Trees

Alabama Station Circular 73 March I935

Cottonwood as a Short Rotation Crop.

Forty years ago, this tree, known as Cottonwood, Populus deltoides, had almost no value. Now, the demand is in excess of the supply. This tree makes very rapid growth on good sites, twenty years being enough to produce timber of fair dimensions.

Because of its rapid growth and good technical quality of the wood, this tree has claimed the attention of forest planters in many foreign countries. France, Germany, Belgium and the Argentine have all experimented with this tree. The French have developed varieties which grow more rapidly than the original species. In Argentina, at the mouth of Parana River, a very extensive and lucreative industry has been developed by growing cottonwood on land subject to frequent incindations. In that country, due to the scarcity of timber, boards two to three inches wide and six inches long find a market. Trees that are ten to twelve inches d.b.h. have a value for saw logs.

This tree is particularly well suited for a short rotation timber crop because it utilizes flood lands and new lands which can not be used by other crops. These flood lands follow the margins of all our larger slow moving streams and are composed of rich moist soils in the main. The Mississippi River is skirted by one hundred and fifty million acres of these flood lands, over a third of which are suitable for cottonwood culture.

Botanical Characteristics: Let us consider briefly some of the botanical characteristics of this tree. Populus deltoides is commonly called Cottonwood but also is called Carolina Cottonwood, Yellow cottonwood, White cottonwood, Big

Big Cottonwood, Broad leaved cottonwood and Vermont Poplar.

The leaves are large, more or less triangular shaped and deciduous. The bark of the younger stems and branches is comparitively thin and light grayish yellow tinged with green. The older trunks are rough and thick having deeply furrowed and dark grayish bark. The flowers are dioecious and this fact is important in that it has an effect upon natural seeding practice. The female tree produces an abundance of seed every year. These seed are light of weight and due to a downy covering are able to travel a long way by wind.

Silvicultural Characteristics: The principal limiting factor of this tree is moisture. It requires an abundance of soil moisture. It may make very satisfactory growth however upon land lacking in surface moisture provided that the roots are able to penetrate deeply enough to reach water. This tree is not a swamp tree and will not do well on poorly drained areas. The quality of the soil effects the occurrence of Cottonwood but little. It thrives on poor sandy soils as well as on heavy clay soils.

This tree is very intolerant. At thirty-five years, with trees about twenty inches d.b.h. an acre will carry about fifty to seventy-five trees.

This tree is not very susceptible to injury. Windfall is common only on poorly drained areas where the long fiberous root system is forced to the top. On exposed situations, there is considerable wind breakage due to the brittle branches.

Cottonwood suffers from three diseases, two of which check the increment and the other which may kill the tree. A rust, Uredo melampson meduroe is a leaf disease which cuts down the amount of photosynthetic surface and hence checks increment. A mistletoe, Phoradendron flavescens taps the sap of the tree also cutting down the increment. A white rot caused by Fomes applanatus, attacking both heartwood and sap wood usually kills the tree. It enters the tree through scars in the bark.

The tree is rather free from insect damage but is damaged to some extent by animals and fire.

The chief source of animal damage is from rabbits, field mice and cattle. It was found that where grass or snow was deep around the young trees, girdling by mice and rabbits was greater.

Young trees are very susceptibel to fire injury due to their thin bark. Older trees have a fairly heavy bark and are quite fire resistant.

Technical Characteristics of the Wood; The wood of this tree is not relatively strong but it is strong in proportion to its weight. It is tough and extremely light when dried. It weighs 24.25 lbs. per cubic foot. The specific gravity is .38 89 (by Sargent). The fuel value is 51% of that of White Oak. The modulus of rupture is 84% of that of White oak, while the modulus of elasticity is 67% of that of White oak. The wood has a close even grain and is quite porous. It is moderately hard.

Care must be exercised in seasoning the wood or it will warp. The wood is almost tastless and odorless when seasoned.

Uses of the Wood.

This wood is used extensively for food containers of various sorts. It finds favor for this use due to its tasteless and odorless quality. It is also strong for its weight which is another desirable feature. Weight for weight, cottonwood boxes surpass all other boxes made of common box woods for strength."Bulk for bulk, it is surpassed only by red gum."

Another use to which it is put is in producing rotary veneer. This veneer is used for cores or fillings for built up lumber, for panels, drawer bottoms, sides, and backs, and for light weight veneer boxes, cases and egg cases.

It is used to some extent for flooring, partition, siding, and ceiling but it is not popular for these uses.

It produces an attractive wainscoting or door paneling if properly stained. If painted it makes a fair siding. It is used to some extent for slack cooperage.

Cottonwood has a ready market for pulp. The pulp is manufactured by all three processes. The soda process is the most common used in manufacturing pulp, but it is found that the sulphite process yields fairly well also. The mechanical process is used to some extent.

In the Pacific Northwest, mechanical pulp from the Black cottonwood is used in newsprint when mixed with 60% long fibered pulp such as Spruce. Mechanical pulp from Cottonwood is also used to some extent for magazine and book paper.

Considerable cottonwood goes into excelsior. It is very suitable for this use because of its light weight, and close even grain.

For fence posts this wood lasts from two to three years when untreated. Posts treated by the open tank process in creosote have lasted I7 years and all were still good. It costs about ten cents per post for treatment.

The Black Cottonwood, P. trichocarpa is very similar to P.deltoides and hence will be considered along with the latter. The principal use s of this species in I930 were paper and pulp, excelsor, furniture veneer, basket veneer, boxes and crates, and furniture in the descending order of importance.

Rate of Growth.

In Iowa, a study of a number of young plantations on average land revealed that the average growth for trees four years old was .65 inches per year, The maximum was 4 inches in four years. At I2 years the average growth was .55 inches The following year, after I75 trees had been removed, the average growth came up to .60 inches.

In plantations 20-30 years old, containing from II2 to 368 trees per acre, the average diameter of the trees was between IIand I2 inches.

Most of the plantations were made from cuttings. A measurement of one year old sprouts showed that 78% of all the sprouts planted had a height growth of from 3 to 7 feet. The average height of a three year old plantation was I7 feet or 4.25 feet per year from the time the cuttings were made

until the measurements were taken. After the trees had been set out 5 years, the average yearly height growth was 4.I feet. The maximum was 37 feet in 5 years.

Management: To maintain a stand of Cottonwood permanently requires some managment. In mixed stands, the weed trees must be removed when the area is logged. Weed trees and brush prevent the reseeding of the area to the light demanding Cottonwood. Cottonwood comes in only on the wide open areas.

Even in pure stands it is hard to get reproduction because the stand opens up at 40 to 50 years, inducing undergrowth and weed trees to come in. After logging, these undesirables control the area.

Cottonwood must be clear cut. Cutting the largest trees first and allowing a period of 3-I0 years before clearing the land allows the smaller trees to benefit from the added light. Usually where 2 or 3 cuttings are practiced, shrubs and vines come in and take the area preventing reproduction. Therefore it is believed that one cutting is desirable.

Natural reproduction can be relied upon in most cases where moisture is abundant and competition with weeds is at a minimum. Under adverse conditions, planting may be the only way out. In this case seedlings or cuttings may be used.

If natural seeding is to be depended upon it is necessary to leave about one tree(female) per acre. It will be necessary to leave about one male tree for four pistilate trees. These trees can be selected in the spring of the year and marked so that they will not be cut with the rest of the timber.

The seed of this tree will carry by the wind as far as 600 feet so that if there is standing timber within that distance and it is the right dirction in reference to the prevailing wind, it will be safe not to leave seed trees.

Preparation of the Ground. In stands which are opening up (after 30 to 35 years) it is necessary to cut out the weed species, vines and large herbaceous plants. These may be piled with the slash. If the slash is very dense, it may be burned, otherwise leave it, as it rots quickly.

No preparation of the ground is adequate which fails to leave the mineral soil exposed. Controled burning may be sufficient, but as a rule it will be necessary to drag the surface with a spike-toothed harrow.

Thinnings: Thinnings properly done will speed up the growth of the remaining trees and at the same time will make possible the marketing of small trees which would die anyway and be lost. In the course of natural development, cottonwood stands which averaged 700 trees per acre at I0 years decreased in number to 50 per acre at 40 years. There is also a great loss in growth rate due to competition.

Length of Rotation.

On the overflow lands of the lower Mississippi river, it was found that the best rotation for lumber production was about 35 years. A rotation of this length produces 29,400 bd. ft. of wood per acre or about 840 bd. ft. for the average annual yield per acre.

For pulpwood a rotation of I6 years seems best. This was determined as the time when the mean annual increment starts to decrease.

Yields: Accurate records of yields of Cottonwood are rather scarce and many of those that do exist are not complete.

Records are available for pulp wood returns in the Southern Mississippi Valley for I9I3. These records are as follows:

Interest on cost of land at $50.	
Interest for I2 years at 6%	$50.6I
Initial outlay (stock at $I.50, planting	
at 2.50, soil preparation at $2A.)- $6	
for I2 years at 6 %	I2.07
Taxes (2% on ½ value) or 50¢ per year	
I2 years at 6 %	8.43
Thinning at 8 years at $2 four years at	2.52
6% Cultivation $4per year for 2 years	75.64
	$ 89.27
Gross Returns were 47 cords at $2 per cord	94.00

In other words, this pulpwood plantation paid 6% on the investment. The new crop was reproduced by sprouts. Instead of a planting cost, there was a cost of cutting back all the sprouts except those to be used. Cultivation was necessary to keep the weeds down which readily came into the more open stand. It was necessary to prune the trees because the greater distance between trees would not allow natural pruning. It was estimated that the more rapid growth resulting from the sprouts would shorten the rotation by two years. The new rotation would then be I0 years. The yield to be expected from this is as follows:

Int. on cost of land at $50.00 for 10 yrs.	at 8%	57.95
Cutting sprouts at $2.00 carried 10 yrs.	at 8%	4.32
Taxes (2% on ½ value) $.50, 10 years	at 8%	7.24
Cultivation $4.00 per year for first 2 years	"	16.63
Pruining when 4 years old	"	7.93
Total costs carried at 8% interest to end of rotation		$94.07
Gross returns, 47 cords of pulpwood at $ 2.00 per cord		$94.00

In this case the owner earned wages and 8% upon his money.

There is the partial data available on the yield of a plantation near Oregon City, established by a paper company. This plantation was started on good bottom land in 1905 and was harvested in 1926 and 1927.

1 yr. nursery stock and cost of planting in 10x10 spacing $8.75 per M

The plantation was cultivated during the first two years of establishment. The yield of the 4.1 acres cut during 1926 was 169 peeled cords. The next year 4.15 acres yielded 178 peeled cords. This is an average of 2 cords per acre per year. The yield was somewhat reduced by cutting 3 foot stumps. Assuming the following figures,we have:

Cost of Planting @ 3.81 per acre carried at	6%	$ 11.14
Cultivation costs @ 10.00 per acre, 2 years	6%	29.25
Flood lands @ 25.00 per acre	6%	73.13
Taxes at .625 per acre	6%	20.06
Total costs carried to end of rotation		$133.58

From the above data we can assume 42 cords per acre in 21 years at $5.00 per cord $210.00

Cost of logging, peeling, and transportation @ 1.80 -75.60

$133.58

This plantation not only paid its own expenses but also six percent on the investment. Six percent is a very reasonable rate to expect, since the risk on cottonwood plantations is very low. Disease, insects and fire damage is low. With the annual flooding of the land, any accumulated debris is carried away or covered with silt thus reducing the fire hazard.

Conclusion: Cottonwood should be a very profitable crop for farmers who own large areas of flood lands which can not be cropped in other ways. Paper companies have already tried these plantations with good results. All floodlands are not equally valuable in this respect as they vary in reference to the market and as to transportation means.

Literature Cited.

Cottonwood in the Mississippi Valley U.S.D.A. Bul. #24

Northern Black Cottonwood Herman M. Johnson

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Cottonwood Iowa Staion Bul. 223

Cascara as a Short Rotation Crop.

Cascara, Rhamnus purshiana, is a shott rotation forest crop that is being tried here in Oregon. The leader in this field is a Mr. Miller of Brownsville. In this plantation there is about 5 acres of Cascara varying from 3 years of age, up to I2 years of age.

The Cascara tree is a native of the Pacific coast and does very well in the North West. Due to laxative properties contained in various parts of this tree, it is used as a laxative. Several years ago, gathering Cascara bark was a thriving industry in Western Oregon and Washington. During the best day in this industry, a period duting the war, thirty cents per pound was paid for the dried bark. A few years later the price had dropped to I5¢ and I6¢ per pound. At the present time the price for dried Cascara bark is 4¢ per pound. The question is whether the price will go up or not. It may be that new laxatives on the market have killed the market for Cascara.

I would like to tell you a little about the Cascara industry as Mr. Brown conducts it.

Planting: After the land has been plowed and harrowed, it is laid out in rows which are 8 feet apart. Seedlings which have been grown on another part of the farm are dug and transported to the rows. Here by means of a spade they are planted 2½ feet apart. In some cases they have been planted as close as I¼ feet apart. This latter spacing gives 4,I60 trees per acre, while the former spacing is 2,084 trees per acre.

Care: After planting, the trees are cultivated several times each year in order to conserve moisture and elininate competition. After the trees are about four years old they receive their first pruning. The prunings are saved as they are used in making cascara extract. The trees are pruned at later intervals also.

Harvesting: The exact age for harvesting the crop is not known It probably depends a lot upon the market. Mr. Brown told me that if the price should go up to 15¢ he would harvest the whole plantation, young trees as well as the old.

In harvesting, the trees are cut. Then the bark is peeled from the trunk and all the larger limbs. The bark brings the highest price. All of the twigs and brandhes are also saved as they bring the next best price. The wood is saved also, but the price is relatively low for it.

The bark is dried and then broken into small chips for shipment. The twigs are also dried and then ground into small particles in which form they are sold. The wood is chipped up and sold in that form. The cost of this harvesting work is not known as none of it has been done.

It is easily seen that this crop can be quite profitable if the market price of the product is reasonable. Just assume that the dry weight of each tree when it is harvested is about 15 pounds and an average price of 3.3¢ per pound is paid for the tree.

Assuming the wide spacing with 2,084 trees per acre, the gross returns would be over $1,000 in twelve years.

Assume further that the land costs $100 per acre, cultivation costs $10 per acre per year, planting at $10 per acre.and taxes at $2.50 per acre per year. Figured at 6% compound interest the net yield per acre per year would be $40.84 These assumptions may be wrong and they are certainly low so we can see what can be expected with a martet price around 15¢ per pound.

No Literature Sited.

Possible Short Rotation Crops.

Other trees which may prove valuable as short rotation crops are Blue Gum and Red Alder. As these trees have not definitely proven their worth we shall consider each briefly.

Blue Gum, Eucalyptus globulus has been planted extensively in the coast regions of Central and Southern California where it makes very good growth. Plantations in the Sacramento and San Joaquin Valleys have not been so successful In the interior good growth is made only when there is an abundance of soil moisture.

On the bases of 67 groves measured through state, the mean annual growth was 271 cubic feet per acre, which equals 3.02 cords per acre. The highest volume growth recorded was in a 8 year old grove on fertil silt swamp land of Alameda County. This plantation was spaced 5 by 5 feet and the trees averaged 5.8" d.b.h. and 60 feet high. The mean annual growth had been 736 cubic feet, or 8.17 cords per acre.

The tree is used mainly for fuel, charcoal, insulator pins, and other turned articles. The lumber produced is not satisfactory because of excessive checking and warping during seasoning.

An attempt has been made to extract the oil from the leaves. This attempt was a failure because the resulting oil would not come up to the U.S.P. standard. Furthermore it costs as much to produce this inferior oil as the superior Australian oil can be shipped into the country for.

The value of the standing trees has varied from $I to $4 a cord, according to the location and character of the trees. The value is about the same for fuel, charcoal or insulator pins.

This crop can be produced in very short rotations because it is used in small dimensions. Information is not available concerning the proper length of rotation for the maximum production of cubic volume.

The fact that this tree needs good soil and an abundance of soil moisture is not in favor of this tree, as such sites are usually more valuable for agricultural purposes.

Red Alder.

Red Alder, Alnus rubra, is the leading hardwood of the Pacific Northwest. As the most important hardwood tree it supplies the demand for furniture wood, chair stock, wooden ware, and novelties, veneer, paper plugs, fixtures, and other small articles. Most of these uses can utilize trees of small dimensions. The tree makes fairly rapid growth on moist sites. The growth culminates within 50 years and then declines slowly.

Under present price conditions it is doubtful whether this crop can be made to pay under management. However as the present supply of Merch. Alder, over one billion feet in I923, diminishes, the value will go up and management will become profitable.

Alder will do well along the streams and overflow lands in our numerous shoestring valleys. This type of land is usually useless as far as agriculture is concerned.

Literature Cited.

I. University of Calif. Experiment Station Bul. 380

2. Red Alder Department Bul. I437

Conclusion.

With the varying economic and market conditions for various localities it is possible that other forest crops may be used on short rotations. With the changing market as the years go by, new short rotation crops are bound to appear. This paper has by no means exhausted all of the possibilities. With the cutting out of the virgin timber in this country, there will be a tendency toward shorter rotations and closer utilization of poorer material. With the tendency toward pulp and cellulose products, the probability that an incressing numberof tree species will be in their manufacture is great. Pulp and cellulose products can use small trees.