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**BASKET WILLOW CULTURE.**

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This bulletin discusses the different varieties of basket willows and methods of willow growing which have been found most satisfactory as a result of experiments formerly conducted by the Forest Service at Arlington, Va., and a study of willow holt established throughout the country. The opportunities for marketing the products of the holt, and the cost of establishment and maintenance, are also discussed.

**RANGE OF WILLOW GROWING.**

There are nearly 200 species of willows. A basket willow is any one of these that produces long, straight rods suitable for weaving baskets. A number of species have been used for this purpose, and in Europe, where willows have been cultivated for many years, some have shown a decided superiority over the others. Several of these cultivated European varieties have been introduced into the United States and are now widely distributed. As shown in figure 1, however, basket willows are not at present grown commercially over nearly so great a range as they might be. Willows can be grown in all parts of the country, except in the arid and semiarid regions, at high altitudes, and in portions of the South. Along the Mississippi, however, they have grown well almost to the Gulf.

**SELECTION OF A SITE.**

Special care should be used in selecting a site for a willow holt, since success very largely depends upon the proper situation. The points to be taken into account are discussed in the following paragraphs.

NOTE.—This bulletin is of interest to those engaged in or contemplating basket-willow culture, and is applicable to all portions of the country where willows are grown.

The first consideration is moisture. The ideal site is one where the water table is within from 2 to 6 feet of the surface, insuring a constant and sufficient water supply, while the surface remains dry enough to permit thorough cultivation. If a choice must be made

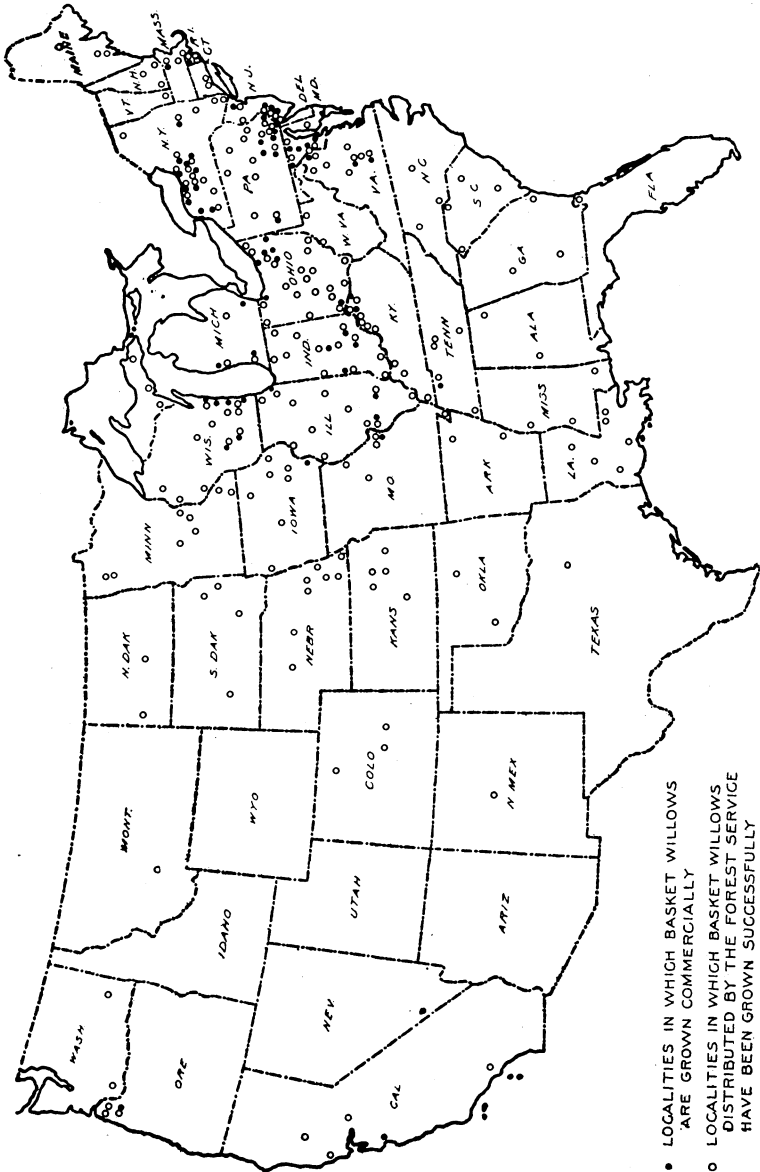


FIG. 1.—Range of basket-willow growing in the United States.

between a situation which is too wet and one which may be too dry at certain seasons, it is better to take the drier situation, unless it is actually subject to severe drought. The more uniform the supply of moisture the better the growth.

With favorable moisture conditions, basket willows will grow on a wide range of soils, though the ideal soil is a loose, sandy loam. They will not produce well on soils that are excessively acid or excessively alkaline. If the soil is either sour or alkaline, a sample should be sent to the State experiment station for analysis to determine the proper means of neutralizing it. Physical condition is usually much more important than fertility, since most soils contain the necessary food materials to supply the requirements of willows.

A holt situated in a stream bottom, partly or wholly surrounded by trees which check the winds and keep the dew on the willows until late in the day, presents almost perfect conditions for the attacks of insects and development of fungus diseases. The most successful holts in this country are placed so that they receive the full sweep of the wind. Fungi and insects are much less common and much less destructive in holts in which a free circulation of air is maintained. Proper circulation is difficult to obtain in close-spaced holts, especially where large-leaf varieties are used.

The likelihood of weeds springing up is another thing to consider in selecting a site for a holt. Situations near areas of waste lands in weeds should be avoided. The expense of keeping the holt clean will be much greater if there is a crop of uncut weeds in the vicinity to furnish a plentiful supply of seeds to restock the ground as fast as it is cultivated. It is very difficult to keep a holt free from dodder if it grows abundantly on near-by weeds, especially if the willows are dense and the situation moist.

The final thing to consider in connection with the site for a holt is convenience. A holt can be more economically worked when near at hand, but the most important reason for having it accessible is that it may be constantly under the eye of the grower. When seen in time, many insects, fungi, and weeds can be eradicated by a few minutes' work. If let alone for a week or two, however, serious damage is likely to be done, and measures of suppression will require considerable labor.

#### PREPARATION OF SOIL.

The majority of willow holts in this country are established on land which has not previously been cultivated. Willows planted in poorly cultivated soil are from the very start forced to contend with an abundant crop of strong-growing weeds, many of which come up from well-established roots. The soil, moreover, is usually root bound and in poor condition either for the growth of the plants or for cultivation. Many failures to establish holts are due to lack of proper preparation of the ground.

If new land is to be used for a willow holt, it should be broken the year before the willows are to be planted. Such work should be done

in the spring, and, if possible, the land planted to corn or potatoes or some other annual crop that requires clean cultivation. Potatoes are best, since they tend to thoroughly loosen the soil. If not sowed to a crop, the land should at least lie fallow and be free from weeds. Late in the fall it should be plowed, manured if necessary, and left to weather during the winter. The following spring it should again



FIG. 2.—*Salix amygdalina* (American green willow). FIG. 3.—*Salix amygdalina* (Silver skin).

be plowed, disked, and harrowed, care being taken not to leave any depressions in which water might stand later. Where there is a likelihood of excessive rain during the early spring, and the soil is heavy, the land should be made ready for planting in the fall. This would apply particularly to low areas subject to spring flooding, which would delay planting for a month or more. Early planting

is of the utmost importance, and any delay would mean a handicap not easy to overcome.

#### WHAT TO PLANT.

The farmer who contemplates planting willows should confine himself, as a rule, to the American green and to the patent Lemley or Lemley. These require much less cultivation than the purple willow, are easily peeled, and bring good prices. Perhaps after both have been grown for a few years one or the other may prove more desirable, and in that event the inferior variety may be gradually



FIG. 4.—*Salix amygdalina* (Külstermann willow). FIG. 5.—*Salix amygdalina americana* (American willow).

removed. In small holts, where insects and fungous pests can be controlled, American green is recommended. In large holts, however, it would be safer to plant the Lemleys, since there would be much less likelihood of loss by epidemic. In places where the cost of peeling would not be great the purple willow, which produces very high-class material, might be profitable.

#### THE AMERICAN GREEN WILLOWS.

The American green willows (*Salix amygdalina* L.) (figs. 2 to 5) have gained in popularity both in Europe and America in recent

years. As a whole, the group is much sturdier than the purple willows and will produce a paying crop under much more adverse conditions. They will also stand heavier soils and more moisture. They have grown well not only in the North, but also along the Mississippi as far south as lower Louisiana. In all parts of the South they have succeeded better than any other species.



FIG. 6.—Patent Lemley variety (*Salix pentandra* L.), taken in June.

American green willows are easy to peel, and on account of their large size the peeling can be done at a lower cost per pound. Under the most favorable conditions yields as high as 12 and 15 tons per acre have been obtained, though the average is from 6 to 9 tons. When open grown these willows have a tendency to branch. Close spacing is best in every case, since it lessens the need for cultivation and gives more and better rods. There is little danger of the plants becoming stunted through crowding.

American green is much in demand by makers of furniture and of the heavier and better grades of basket ware. It is by far the best basket willow grown in America, but unfortunately is subject to insect attacks and disease. The willow-shoot sawfly, the stool borer, and the leaf rust often invade a holt and do a great deal of damage. These pests can be controlled, though this often entails considerable expense. Even with this drawback, however, American green has been planted in a large proportion of recently established holts.

The American willow (*Salix amygdalina americana*) can generally be planted in any place where the American green will grow, and is

especially desirable when small rods are required. Except in such a case it is not advisable to plant this variety on very poor soils. The rods are not as uniform, nor is the yield as high as in the case of American green.

#### LEMLEY AND PATENT LEMLEY WILLOWS.

The Lemley (*Salix pentandra minor*) and patent Lemley (*Salix pentandra major*) varieties (figs. 6 and 7) are very similar in general requirements. Both grow best on a loose, sandy loam, with an abundant supply of moisture. Heavy clays should be avoided. If such soil is utilized, however, it should be deeply plowed, and should receive an application of lime if acid. These willows are strongly recommended on account of their comparative freedom from disease and insects. Though smaller than the American green, they are large enough for sap peeling.

Both Lemleys have a decided tendency to branch at the base, especially when open spaced. Some growers send children through a holt to pick off these lateral branches. The rods, especially of the Lemley, are inclined to curve at the base. This makes it necessary to prepare such rods for the market with particular care, but properly bundled they are well liked by manufacturers. Under favorable conditions the species should yield as high as 10 tons per acre, but the average is from 5 to 8 tons.



FIG. 7.—Lemley variety (*Salix pentandra* L.), taken in June.

#### PURPLE WILLOWS.

Of the several varieties of purple willows (figs. 8 to 11) grown in this country, the common variety (*Salix purpurea* L.) planted in western New York is perhaps the most satisfactory. While not recommended generally except for steam peeling, every willow grower should have a few plants in his holt, increasing the proportion as he is able to use the material. All the purple willows, especially the narrow-leaf variety, are very useful as cordage in tree nurseries and even in the willow holt itself.



These willows thrive best on moist, well-drained, sandy loams, but can be grown in a variety of soils. The rods are naturally tough and hard, and, unlike the American green, will grow on very fertile soil



FIG. 8.—*Salix purpurea latifolia* (Wide-leaf purple willow).



FIG. 9.—*Salix purpurea rubra* (Red purple willow).

without becoming soft and brittle. On poor soils the purple willow shows a decided tendency to become stunted, especially when close spaced, unless the ground is properly fertilized. Under favorable

conditions, purple willow yields as high as 8 tons to the acre, but when open spaced and poorly cultivated, the yield may fall to from 2 to 3 tons. Five tons is an average yield. The small size of these willows makes the per pound cost of peeling higher than for the American green or the Lemleys. Sap-peeled rods, well sorted and bundled, however, bring from 6 to 9 cents a pound.

#### OTHER VARIETIES.

Of the other varieties occasionally grown or advertised in this country, few give any promise of success. The Caspian willows (*Salix daphnoides* Vill.) (fig. 12) produce a very fine rod, tall, straight, and cylindrical, which is soft, and splits readily. Unfortunately, they do not yield well, and should not be planted except in a small way for experimental purposes. Both the white and black osier (*Salix viminalis* and *S. dasyclades* L.) are worthless in the Eastern, Central, and Southern United States, though both may do well in the Northwest. Küstermann willow (fig. 4), known to the trade in Europe as *S. fragilis triandra*, has been grown successfully in Wisconsin and Virginia. It does not produce as good rods as the American green, but is freer from branches and disease.

#### WILLOW CUTTINGS. -

All basket-willow holt are started from cuttings from shoots or branches. Too much care can not be taken in securing the best stock available for this purpose, since the plants should last for from 12 to 15 years, or longer. It is often a good plan to visit one or more near-by holt during the summer preceding the time of planting, in order to study the methods used and also to gather an idea of the kind of material produced. If it appears to be vigorous and thrifty, with no signs of insects or fungi, that particular holt will be a safe place from which to secure planting stock.

In case the nearest willow holt are too far away to permit of inspection, it is a good plan to send for samples of the average rods of the varieties wished. August is the best time for this. Much confusion exists in regard to the trade names of willows, and if there



FIG. 10.—*Salix purpurea* (Common purple willow).

is any doubt as to the identity of those received, specimens should be sent to the nearest State experiment station or to the Department of Agriculture for identification. If cuttings are purchased, very definite specifications should be made as to the length, age, and average weight per thousand cuttings. Many persons have begun the cultivation of willows with a few hundred cuttings, and then gradually enlarged their holts as their supply of willows and knowledge of willow growing increased.



FIG. 11.—*Salix purpurea gracilis* (Slender purple willow).

#### WHEN TO MAKE CUTTINGS.

The proper time to prepare cuttings will depend upon the region, and whether planting is to be done in the fall or in the spring. If in the fall, the cuttings can be made about 2 weeks after the last leaves have fallen from the shoots, or, better still, after several heavy frosts have ripened the wood. The usual time to plant, however, is in the spring, and in this case cuttings can be made at any time from early winter until growth starts. Cuttings made six weeks or more before planting time are better, as a rule, than those made later, since in the former case there is time for them to callous over at each end. Callous cuttings start growth much more quickly than freshly made ones. Cuttings made after growth has begun in the spring grow poorly, and many of them fail to survive the first year. Except under the most favorable conditions weak plants will not produce merchantable rods.

#### SELECTION OF MATERIAL.

Any defect or injury in the shoot which is planted may later develop into a serious trouble. If the injury is merely mechanical, and consists only of a spot from which the bark has been removed, the wound may heal over with the vigorous growth of the new plant. There is always the danger, however, that it may not heal over, and so provide a point of entrance for some organism of decay. Shoots which have any diseased parts should be discarded

or the diseased portions removed. The base of a willow rod often shows a discolored center, which indicates the presence of a rot which has entered the rod from a diseased stool. Cuttings from such material will start as well as any others, but the disease remains and gradually spreads until the productivity of the stool is destroyed. Selected cuttings—that is, those from tall, dominant shoots—give the best results, and any extra expense involved is more than made up in the larger yields for the first two years and in the relatively fewer fail places in the holt. Experiments made at Arlington with selected and unselected cuttings of American green, Lemley, and patent Lemley willows showed the plants from selected cuttings to be better in almost every way than those from the unselected ones. The only experience which contradicts these observations was that obtained from planting a few tip and butt cuttings of a strain of American green very late in May after growth had begun. In this case the tip cuttings made a better growth, due to the fact that at that time of the year the base of the shoot contained much less food material than the tips.

#### SIZE AND AGE OF CUTTINGS.

For planting on a good, well-drained, sandy loam that has been under cultivation and carefully prepared, cuttings of 1-year-old shoots, from 10 to 12 inches long, give good results. For planting on poorly prepared ground, where weeds or other plants are already established, or where the soil is in poor physical condition, better results can be obtained with cuttings from 2-year-old shoots, from 12 to 18 inches long. Under any conditions 2-year-old planting stock makes a thriftier growth at first than cuttings from 1-year-old shoots, though this difference is not great on favorable sites, and disappears entirely after the second year.



FIG. 12.—*Salix daphnoides* (Casplan willow).

## NUMBER OF CUTTINGS OBTAINED FROM DIFFERENT WILLOWS.

The number of cuttings which can be secured from a given weight of willows varies with the species and, to some extent, with the crops of different years. Shoots produced in a favorable season are often 20 per cent larger than those of a season with an early drought. American green cuttings invariably weigh more than other kinds, although patent Lemley sometimes weighs almost as much. Purple willow cuttings are generally the lightest. Table 1 shows for different varieties of willows the average number of 1-foot cuttings which can be made from 50 pounds of rods. To secure the data given in the table only first-class material was used, all small and injured shoots, as well as the tips of the rods, being discarded.

TABLE 1.—Average number of 1-foot cuttings made from 50 pounds of rods.

Variety.	Weight of rods.	Number of cuttings made from 50 pounds of rods.	Weight of these cuttings.	Weight of cuttings per 1,000.	Amount of waste.	Per cent of waste.
	<i>Pounds.</i>		<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	
Purple willow.....	50	3,000	33.25	11.08	16.75	33.5
Lemley willow.....	50	2,450	42.5	17.7	7.5	15.0
American willow.....	50	2,225	38.5	17.3	11.5	23.0
Patent Lemley.....	50	2,125	39.4	18.5	10.7	21.75
American green.....	50	1,525	44.3	29.6	5.7	11.25

Table 2 shows the number of 1-foot cuttings which it is possible to make from 50 pounds of material, discarding nothing but crooked or split butts and short tips. The figures given were obtained in 1911, a normal season for basket willows.

TABLE 2.—Number of 1-foot cuttings possible from 50 pounds of rods.

Variety.	Weight of rods.	Weight of discarded portions of shoots.			Weight of cuttings made from 50 pounds.	Number of cuttings made from 50 pounds.	Weight of 1,000 cuttings.
		Tips.	Butts.	Total.			
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>		<i>Pounds.</i>
Purple willow.....	50	4.5	3.0	7.5	42.5	4,500	9.2
American willow.....	50	6.5	4.5	11.0	39.2	4,000	10.0
Lemley.....	50	10.0	4.0	14.0	36.0	3,000	12.0
American green.....	50	3.25	3.25	6.5	43.5	1,289	35.0

Table 3 shows the relative number of first, second, and third class 1-foot cuttings obtained from 50 pounds of American green rods, the per cent each class formed of the total number, and the per cent of the weight of each class of the total weight.

TABLE 3.—Relative number of first, second, and third class 1-foot cuttings obtained from 50 pounds of rods.

	Number of cuttings made from 50 pounds of rods.	Weight of these cuttings.	Weight per 1,000 cuttings.	Per cent of total weight.	Per cent of total number.
		<i>Pounds.</i>	<i>Pounds.</i>		
Class I.....	243	16.0	67.8	32.0	18.9
Class II.....	772	23.0	29.3	46.0	59.8
Class III.....	274	4.0	14.6	8.0	21.3
Total.....	1,289	43.0	33.0	100.0	100.0

<sup>1</sup> Seven pounds of the 50 pounds of rods were waste.

<sup>2</sup> Average weight per thousand.

Table 4 shows the relative weights of 3-foot cuttings from different species of willow. Except in the case of American green, the waste entailed in making 3-foot cuttings is always greater than that from making 1-foot cuttings.

TABLE 4.—Weight of 1,000 3-foot cuttings.

Species.	Weight of 1,000 cuttings.	Species.	Weight of 1,000 cuttings.
	<i>Pounds.</i>		<i>Pounds.</i>
American green (butts).....	74	Patent Lemley.....	65.5
American green (tops).....	56	Purple No. 2.....	59.5
American green (mixed).....	64	American.....	63.5
Purple <sup>1</sup> .....	36.5	Lemley.....	53.0

<sup>1</sup> Rods rather short. In a normal season they would weigh about 40 pounds per thousand.

HOW TO MAKE CUTTINGS.

Where only a few cuttings are to be made an ordinary knife will do the work satisfactorily. For making a few thousand, pruners, a corn knife, or a hatchet can be used. Using the ordinary type of large orchard pruners, two men can easily cut, count, and tie in bundles 5,000 American green or 7,000 purple-willow cuttings in 10 hours. By strapping one handle of the pruners to a bench, in which a groove is cut to hold the lower jaw of the instrument, one man can accomplish almost as much as two. Where large quantities of cuttings are to be made each year, a special cutting machine, such as shown in figure 13, is desirable.

Cuttings can be made very rapidly by tying the rods tightly in bundles and sawing them. Unless very carefully done, however, the ends of the cuttings are likely to be torn or bruised, causing the tips to rot and preventing the ends from callousing. In making cuttings the aim should always be to have the ends clean and smooth, with their surfaces nearly at right angles to the axis of the rod.

## STORING, PACKING, AND SHIPPING CUTTINGS.

Cuttings can be stored in a number of ways to insure their being in good condition at planting time. The chief consideration is to keep them from drying out. The ideal storage place is a room or cellar with a low, even temperature. Freezing does not injure the cuttings as long as they remain dormant, but may cause injury at any time after they show signs of growth. Repeated freezing and thawing should be avoided. Packing the cuttings in an upright position in moist sand, with a surplus of 2 or 3 inches over the tops, will keep them in first-class condition. They will callous properly if only partially covered with sand, though it is always advisable in

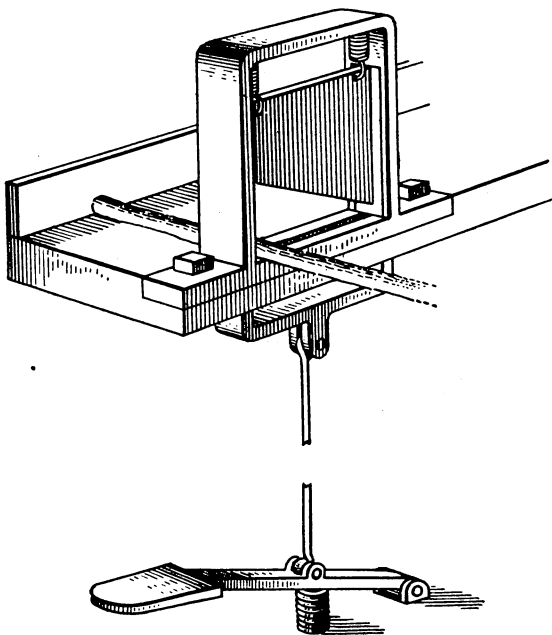


FIG. 13.—Machine for making willow cuttings.

such cases to cover the tops with burlap or sacking, especially if the temperature of the air is comparatively high. Soil, sawdust, ground cork, hay, straw, or leaves can be substituted for sand, though where material other than sand or soil is used there is some danger of heating, especially in warm, moist places.

The best time to pack cuttings for shipment is during cold weather. Practically half the fail-

ures in planting willow holts for the first time are due to the use of cuttings shipped late in the spring. Even if properly packed, cuttings will sprout vigorously within a few days after being removed from storage, if shipped during warm weather. Those packed tightly in very wet moss will produce tiny rootlets along their entire length, while those packed loosely, with moisture only at the ends, will produce young shoots. In either case, part of the vigor of the cuttings is lost, and they are also in a condition in which they may be easily injured.

A number of different materials can be used for packing. In cold weather a little dry hay or straw or slightly dampened moss is sufficient. Even in warm weather, if the cuttings have not yet shown

signs of growth, it is better not to give them much moisture, since this hastens sprouting. If growth has started, however, it will be necessary to keep the cuttings somewhat moist, and for this purpose sphagnum moss is best. The moss should be thoroughly soaked and as much of the water squeezed out as possible. Lining a box or crate with burlap or oiled paper will aid greatly in keeping the cuttings in proper condition. Cuttings should be packed tightly together to prevent bruising, especially if the ends are calloused. Packing in sawdust or ground cork is recommended for shipping long distances in warm weather.

Cuttings shipped from a holt infected with insects or fungous diseases should first be sterilized. This should be done before the rods are cut up by dipping them for several minutes in a weak solution of formaldehyde. Another sterilizing solution is copper sulphate, 3 pounds; water, 50 gallons. This solution should be used before the buds have swelled and the ends of the cuttings calloused; otherwise, it may cause injury. Fumes of burning sulphur form another sterilizing agent, but should be used only when all growth is dormant. Still another is the modified "Eau Celeste":

Copper sulphate .....	pounds..	4
Ammonia .....	pints..	3
Sal soda .....	pounds..	5
Water to make .....	gallons..	45

The rods should never be left in this solution more than 10 or 15 seconds, and afterwards should be so placed that the liquid will run off rapidly.

#### HOW TO PLANT.

The best time to plant is very early in the spring, when the weather is cool, the soil moist, and the cuttings show little if any growth. At this season of the year cuttings can be carried about the field in bundles and exposed to the air without danger of injury. If the cuttings have pushed out tiny rootlets, and the buds are bursting open at the upper nodes by the time planting begins, they should always be protected from the sun and air while being carried about the field. Placing them in buckets filled with water and covering them with wet sacks will serve the purpose.

Tools necessary for planting are very simple and easily made. Where only a few cuttings are to be planted, and the soil is soft, a sharpened stick can be used for making the holes, though a sharpened iron rod is better. This rod should be of three-eighths, one-half, or five-eighths inch material, depending upon the diameter of the cuttings to be planted. The point should be an abrupt rather than a long one, since otherwise a space will be opened up too narrow to permit the cutting to reach the bottom, thus creating an air space beneath



the plant. The rod should be 3 feet long and bent at the upper end or, even better, have an 8-inch crosspiece welded on at the top. Where the soil is very rocky and hard, a crosspiece 1 foot from the sharpened end will allow the planter to force the rod down with his foot. The only other equipment necessary for planting is a cord on which are marked off the spacing distances.

When set in the holes cuttings should not protrude more than 2 inches above the surface of the ground. In all cases there should be one or perhaps two buds near or above the surface. As a general thing it is best to plant the cuttings in a vertical position, though foreign growers advocate a slanting one, on the ground that the cuttings root more freely. Experience in this country, however, has failed to confirm this belief.

The hole should be barely large enough to receive the cutting and never deeper than necessary. After the cuttings have been placed in position the soil should be firmly packed about them by the heel of the planter, care being taken not to bruise or break them. In a soil filled with springy, undecayed roots packing is best done with a tamper. Planting should be done soon after the holes are made, otherwise the latter are apt to dry out or fill up with loose soil.

#### SPACING.

The right spacing for a willow holt needs to be carefully considered. Close spacing produces a better quality of rod and insures greater yields per acre, especially for the first few years. For any of the varieties of American green close spacing can be unreservedly recommended under all conditions. Once well established, a close-spaced holt will virtually keep the weeds in check or crowd them out altogether. Under such conditions little or no cultivation is necessary, and in the case of American green there is little danger that the rods will become stunted. On fertile soils, in fact, this species, unless closely spaced, tends to produce rods that are too long, and which lack somewhat in toughness. (See fig. 14.)

With the purple and Lemley varieties close spacing, although it has often been recommended, presents serious disadvantages. Both of these species at the end of 6 or 8 years show a decided tendency to produce short rods, a characteristic which is greatly intensified in a closely spaced holt. On fertile, loose, sandy soil this tendency may not become evident for from 10 to 20 years, or even longer, but on heavy, clay soils the rods become stunted very early in the life of the holt. Purple willow, even when closely spaced, will not produce enough shade to keep weeds in suppression, making cultivation necessary. In a closely spaced holt this must be done by hand. For this reason many growers have found that on soils of only

average fertility a spacing for purple willow of 6 by 30, 9 by 30, or 12 by 30 inches gives the best results in the long run. The shoots produced with such spacing are somewhat crooked, but never badly branched. Purple willow holt with this spacing have maintained their productivity for from 15 to 25 years, while in closely spaced holt on the same soil the rods have become very short in half this time.

The Lemley and patent Lemley, on account of their tendency to branch badly when open spaced and their ability to shade the ground

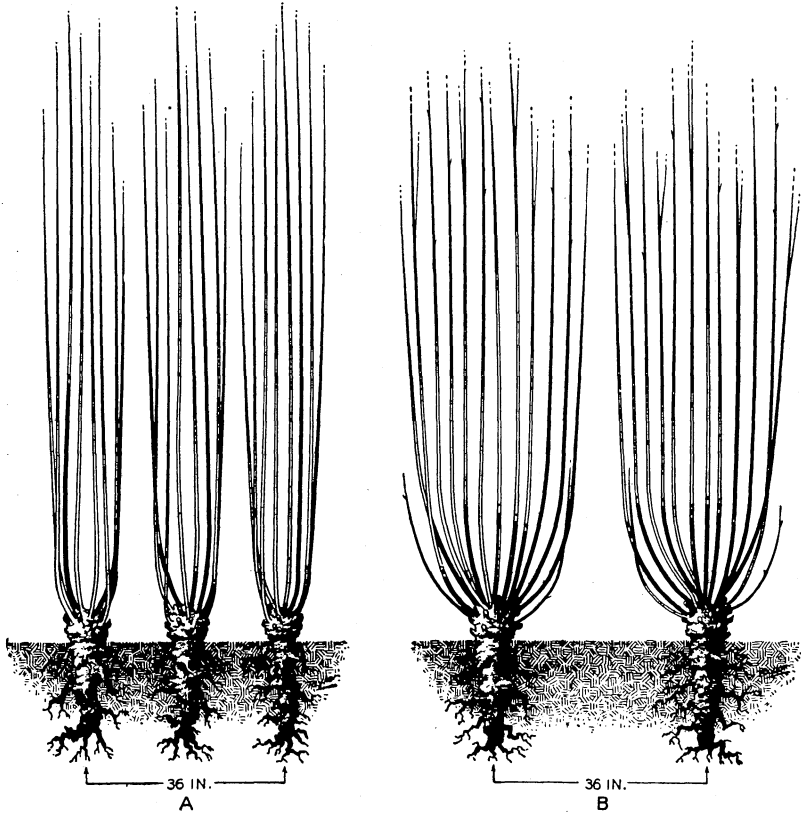


FIG. 14.—Form of open-grown and close-spaced willows.

when closely spaced, should be closely planted on all but the very poorest soils. If a holt of Lemley or patent Lemley becomes too crowded, the weaker plants will die out, while the survivors make a thrifty growth. The same thing is true, even to a greater extent, of American green, but purple willow fails to thin itself, and the rods in a too closely spaced holt generally become stunted.

In the case of American green, differences in width of spacing have very little effect upon the length of rods produced. With the

purple willow, on the other hand, a 12 by 36 inch spacing results in the production of much longer rods. In the case of both species the weight per plant is proportionate to the width of spacing. With American green the width of spacing has but little effect upon the total yield, but with purple willow the yield is much greater in open-spaced plots.

The results of experiments at Arlington and observations in the field indicate the spacings, shown in Table 5, as best for the species listed.

TABLE 5.—*Proper spacing for basket willows on rich, medium, and poor soil.*

Variety.	Rich soil.	Medium soil.	Poor soil.
	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
American green.....	6 by 18	6 by 18	9 by 20
Patent Lemley.....	6 by 18	6 by 24	9 by 24
Lemley willow.....	6 by 18	6 by 24	9 by 24
Purple willow.....	6 by 18	12 by 24	12 by 36

### CULTIVATION.

The basket willow must be kept free of weeds from the start. The first two years form the critical period in the life of a holt, since the young plants are not vigorous enough to keep down the weeds, even if closely spaced. If the willows are closely spaced, cultivation will have to be done with a hoe or, if carried on early in the spring, with a small garden cultivator. In open-spaced holts a horse cultivator can be used, although some handwork will be necessary.

Unless a grower is sure that he can give his patch at least one hoeing in the spring for the first two or three years, it is better to space the willows wide enough to permit horse cultivation, since a well-kept holt widely spaced will produce much better than a close-spaced holt in which weeds and grass have gained a foothold. This is especially true of the purple willow. In the case of American green, close spacing, with perhaps a little cultivation in the spring, will suppress the weeds. In holts which are not cultivated frequently the roots of the willows are near the surface of the soil, and are likely to be injured when the holt is cultivated. Cultivation should never be deeper than 2 or 3 inches, but must be thorough. The results of imperfect cultivation are scarcely noticeable two weeks after it has been given, but when thoroughly done the weeds will not begin to reappear until at the end of that time. In a holt where weeds, especially grass, have gained a foothold, it is better entirely to remove a thin layer of sod than to chop up the surface and leave it on the ground for the grass to take root again if wet

weather follows. After a layer of sod is removed, the soil beneath should be loosened up somewhat, even at the expense of cutting a few roots. Only by such treatment can grasses be thoroughly eliminated from a holt when once firmly established. Frequent and regular inspection of the holt is necessary to discover and stamp out at once such pests as dodder, morning glory vines, and caterpillars.

#### A NEW SYSTEM OF CULTURE.

To insure the best success of a willow holt with the smallest cost of establishment the following practice is suggested: The willows should be widely spaced at first to permit of horse cultivation. Spacing might be 6 by 36 inches, or even 12 by 36 inches, according to the soil and moisture conditions. Horse cultivation can be given at any time during the first year, since the rods are then small. This does not keep the holt absolutely free from weeds, of course, but very little trouble is entailed in removing the weeds within the row with a hoe. During the second year the holt can be cultivated by horse, at least until late summer, while the willows will produce enough shade to keep down weeds in the row. In the spring following the second year, cuttings should be set between those already established and similarly spaced in the row. These later cuttings, however, must be 5 or 6 feet long in the case of American green, and from 3 to 5 feet long in the case of purple and Lemley, since they compete for light with the plants already established. If the holt has been kept clean up to this time, the cost of cultivation will not be large, even though it must be done by hand. Thorough cultivation before planting the new sets will save at least one hoeing. The new sets should be allowed to grow for two seasons before being cut back to the ground. This method is especially desirable for a large holt in localities where the cost of hand labor is high.

#### MULCHES.

Where weeds are especially troublesome mulches can often be used to advantage. They not only serve to check the growth of weeds but also prevent the surface soil from becoming hard and difficult to cultivate. At Arlington mulches of sand and stable manure were applied to sections of the holt after the entire holt had been hoed. When the holt was cultivated for the second time very few weeds had made their appearance in the area covered with sand, and those that had appeared were easily removed. Weeds were more numerous in the manured areas, but less so than where there was no mulch at all. They were removed with comparative ease, leaving the surface loose and dry, with poor chances for their further establishment. During the early part of the season the

willows which received the mulch fell somewhat behind the others in height growth. Two weeks later, however, they had actually forged ahead.

Sand mulches can often be placed on a holt at a reasonable cost, according to the accessibility of the mulch. Unless manures are well rotted there is a possibility of carrying to the holt a large amount of weed seed, which will offset the beneficial effects of the application.

Mulches also serve to prevent heaving of the young plants during the first year or two of growth. While it is often possible to push cuttings back into the ground, they are always slow to recover. The Lemley and patent Lemley are especially susceptible to this sort of injury.

#### FERTILIZERS.

The average willow holt, situated on bottom land, seldom needs fertilizers. If willows fail to produce rods of sufficient size, it is much more likely to be due to poor drainage or acidity or poor physical condition of the soil than to lack of plant food. Very alkaline soils, however, should be heavily manured before planting. Light, sandy soils which have been cropped for many years respond very quickly to the application of fertilizer by increased yields. The greater portion of such soils in the coastal plain region of New Jersey and Delaware needs fertilizing to produce basket willows in large quantities. Well-rotted barnyard manure is the most satisfactory material, since besides its value as a plant food it improves the physical condition of the land and acts as a mulch to keep out weeds and grass.

The soil of most holts, even if well plowed, is usually packed quite hard by the time planting is completed. At best only the surface is stirred each year by cultivation. Moreover, the soil of a holt may be subject to a period of drought, and so become more or less baked. The physical damage done the soil each year is apt to be cumulative, since there is little chance to restore it to the proper condition. In such cases it may easily become sour, a condition which seriously affects the yield. This can be remedied by the application of lime. Not more than a ton per acre should be applied in one season. Sour soils are also often the result of poor drainage, which can be improved by constructing a ditch or a tiled drain.

#### REPLANTING FAIL PLACES.

Individual plants are continually dying out in a willow holt as a result of physical injuries or disease. The percentage of loss for any one year is so small, however, that it is not likely to be noticed until the accumulated losses of several years make themselves evi-

dent. It may not be until the end of 10 or 12 years, when many holt show a tendency to decline, that the grower realizes that his holt is poorly stocked. Replants made at this time are slow to become productive. A cutting establishes itself in an old holt much more slowly than if planted on new ground simultaneously with the other cuttings. For this reason fail places should be planted up each year. Neither the amount of material needed nor the labor involved will be large. The long 2-year-old stocks of the replants at the end of the second season furnish the very best material for cuttings. They are straight, free from branches, and grow vigorously when planted.

The difficulty of establishing new plants in old holt is due to root crowding and lack of direct sunlight. To determine the effect of root crowding five rows of 1-foot American green cuttings were planted beside a well-established plot of American green. The new plants were placed on the south side of the established ones, and a wire stretched along the edge of the old plot to further eliminate shading. Soil and moisture conditions being uniform, this left only root crowding to account for any differences in behavior of the young plants.

In row No. 1, which was 18 inches from the old plants, 63 per cent of the cuttings failed to survive the first year. In row No. 2, which was 36 inches away from the established willows, 23.5 per cent of the plants failed to survive, indicating the influence of root crowding, even with open sunlight, at this distance. In the three other rows the loss was 11, 12, and 10 per cent, respectively, indicating that at a distance of  $4\frac{1}{2}$  feet or more the influence of established plants is not felt. Similar observations in New Jersey on patent Lemley and Lemley gave almost identical results, but with purple willow the influence of the established plants is not evident beyond a distance of 3 feet.

In planting fail places within a holt it can be assumed that the effect of root crowding will be practically the same in the case of each new plant, and that differences in development by cuttings of various lengths are due primarily to the amount of shading they receive. To determine the size of cutting best adapted to withstand shading, American green willows were replanted with cuttings of different lengths. This willow was selected because its dense foliage makes it more difficult to replant than any other species. Fail places in a large holt, set out in 1904, were planted with 1, 3, 5, and 7 foot cuttings. The 1 and 3 foot cuttings were planted 10 inches deep, and the 5 and 7 foot cuttings from 14 to 15 inches deep. In all cases selected material was used.

The 5-foot and 7-foot cuttings established themselves very successfully, but the 3-foot cuttings did not do so well. The 1-foot

cuttings failed completely. The 7-foot cuttings made a better growth than the 5-foot ones, but the difference was not enough to justify their use, except under the most unfavorable conditions, since they are subject to injury by wind-shaking, especially on sandy soils. Longer cuttings have from three to five times as much leaf surface as 1-foot cuttings, which, with their greater height, form their superiority.

Replants should be set out as soon as the holt is cut, in order to give them an early start. Replanting late in the spring is apt to result in almost total failure. If the new cuttings are planted after they have put out leaves, it is better to pull these off and allow others to take their place when the plants become rooted. The replants should be allowed to grow two years before cutting. Rods cut from 8 to 10 inches above ground after one season's growth produce thriftier plants the second year, but the high stool resulting from this practice is very undesirable. If the replants are left two years, and are very numerous, it is best to cut them back to the original size the second season; otherwise they may actually shade the old, established plants.

### HARVESTING THE CROP.

#### WHEN TO CUT.

The time for cutting willows will be governed largely by the size of the holt and the amount of labor available. One thing to be borne in mind, however, is that the cutting should be finished before the buds begin to swell. Cutting late in the spring after growth has started almost invariably results in decreasing the vitality of the stools and consequently the size of the succeeding crop. It also retards the new growth, since sprout buds do not form, as a rule, until after the cutting is done. Willow rods that are to be steam peeled may be cut from the holt as soon as the leaves fall and the wood has matured. Rods which are to be sap peeled or used for cuttings should not be cut from the holt, as a rule, until December or January, unless storage facilities are available. Cutting shoots before they are fully mature tends to make them soft and brittle.

#### HOW TO CUT.

The best tool for cutting willows from the holt is the ordinary hook knife. This is made in many shapes and sizes (figs. 15, 16, and 17). For general use, however, where both large and small rods are to be cut, the shape shown in figure 15 is the best. The bulge at the end of the handle is a great help in keeping a firm grip. In cutting exceptionally large rods a leather thong attached to the handle and fitting over the hand or around the wrist will make cutting easier. Pruning shears, either small or large, are scarcely practicable for cutting willows where a quantity of rods is to be handled,

since their operation consumes from one-third to one-half more time than cutting with a hook knife. Where the holt is so small that the time element need not be considered, pruners may be used to advantage, since they make it possible to cut the rods very close to the stool. Another case in which pruners are useful is with young plants which have been exposed to heaving during winter or which are being cut when the ground is soft. Under such conditions the upward stroke of the knife is likely to loosen the plant or actually to lift it from the ground.

The use of a scythe, brush hook, or hay or corn cutter is not advisable, since they leave the stools in a ragged condition and, as a rule, several inches too high.

#### HEIGHT OF STOOLS.

Stools should be cut as low as possible. Where cutting is reasonably low, and the new growth is from the juncture of the shoot and the stool, the stump of the old shoot dies back, while the height of the stool is not appreciably increased. New growth from the collar is straighter than that from stumps of old shoots, since the latter are really lateral branches which must turn upward. Long sprout stumps are likely to have one or more lateral buds from which branches are sent out. The bases are thus kept alive, and the height of the stool much increased. Low-cut stools also offer the least chance for mechanical injury or disease.

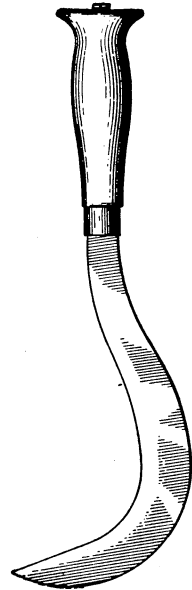


FIG. 15.—Knife for cutting willows.

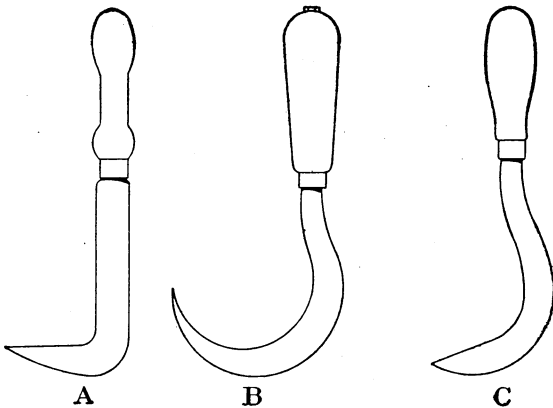


FIG. 16.—Other forms of cutting knives.

#### COST OF CUTTING.

If the labor is carefully handled the cost of cutting rods from the holt can be kept within

reasonable limits. Carelessness in this operation means a serious inroad upon the profits in willow growing.

#### BUNDLING AND PITTING.

Rods should not be left on the ground for any length of time after being cut, especially if the weather is dry and warm. They should be bundled according to size and shape. Straight rods are easier to handle, and can be tied in larger bundles. Rods which curve sharply



at the base are more difficult to handle, since it is essential to keep the butts uniform, and so can best be tied up tightly in small bundles. Either binder twine or a willow rod can be used for tying. For a novice the cord is easier to handle, but an expert can tie up a bundle with a rod much more tightly and in less time than with twine. Purple willow rods are the best for this purpose.

After the leaves come out in the spring it is necessary to keep the cut willows in water until they are peeled. If out of water even for a day or two they die, and the bark can not be removed. A pit should be provided in which the water is of uniform depth and fluctuates as little as possible. The water in the pit should only be



FIG. 17.—Cutting purple willows with the hook knife. The willows are held in one hand and cutting is done with the other. The rods are piled as they are cut.

deep enough to be sure that the ends of all the rods are submerged. It is best to place the rods in a vertical position in the pit, for if they are allowed to lean, the butts on one side of the bundle are lifted and may be exposed to the air. Bundles pitted upright soon settle into the soft bottom of the pit, and after the rootlets have started there is little danger of their being overthrown by wind. It is a good plan to drop the bundle on the end several times before pitting in order to even up the butts (fig. 18).

The location of the pit will depend, of course, upon the available supply of water, but an effort should be made to have it where the willows will be protected from the wind and near a spot where peeling can be conveniently done. Provision should be made against the pit filling up to an undesirable depth during a freshet. If there is no running water near the holt, the surface run-off can often be used.

A shallow pit fed by a reservoir or pond is better than a deep one which fills up during a rain. A reservoir for a pit can often be made by merely throwing up a low bank of earth across a depression located somewhere above the pit. The water can then be let into the pit as needed. Deep mud or slime at the bottom of the pit should be avoided, since it discolors the base of the rods, although these portions under water are always somewhat discolored. It is seldom a good plan to pit rods in running streams, since it is hard to obtain a uniform depth of water, and there is always danger of the rods being carried away by freshets.

#### PEELING.

Hand peeling is done by drawing the rods between two steel plates or bars which have spring enough to break the bark, but not enough to crush the wood. These are made in a variety of forms, several of which are shown in figure 19. The one shown in figure 19, A, is easily made and gives good service. Figure 19, C, shows a very effective brake for peeling the Lemley willows which can be made from a wagon spring.

Peeling presents the most difficult problem in basket willow culture in America, since it is always hard to secure labor at a cost which will allow a profit to the grower. At times it is almost impossible to get the necessary labor at any price. This condition has been responsible for the abandonment of many willow holts. The actual difficulties of peeling are comparatively few; it is the high cost of hand labor and the difficulty of securing it which handicaps the willow grower. What is needed is a peeling machine to cost not over a hundred dollars. Several good machines have, in fact, been designed, but those so far manufactured are, perhaps with one exception, very large and cumbersome, and can not be sold for less than several hundred dollars. They have been designed, moreover, for peeling steamed willows rather than sap willows, which seems a mistake, since the latter will bring more per pound and have a much more extensive market. The use of the present machines by the average willow grower could be likened to the use of a large power corn sheller by farmers who raise only a few bushels per year. The basket-willow industry calls for a machine to parallel the small hand corn sheller now found on every farm where corn is a minor crop. A successful peeling machine of the kind described should have a large sale. Its appearance on the market would give a stimulus to willow growing, while every farmer with a willow patch could be sure that it would repay him for the time bestowed upon it. Willow growing would then become a common practice rather than the specialty of a few.

It is unfortunate that steam peeling is so much practiced in this country. It tends not only to put the bulk of American-grown rods

into the second class, but, through the necessary centralization which the practice entails, control of the willow industry in certain localities has come into the hands of a few dealers and out of those of the small grower and basket maker.



FIG. 18.—Pitting American green willows.

**DRYING, DRAFTING, AND BUNDLING.**

Peeled willow rods should be thoroughly dried before bundling. One or two days in the hot sun will suffice for this, if the rods are well spread out on racks. They should be kept out of the rain, and covered at night to protect them from the dew. Otherwise they lose their whiteness.

Rods are often drafted, or sorted, as soon as they are cut from the holt, but it is better if they are fairly uniform in size to sort them while peeling. With a little practice a peeler can divide the rods into several piles, according to size, without the expenditure of extra time and with very little additional labor. (Figs. 20 and 21.)

Where there are a large number of rods, bundling should be done by a machine. (Fig. 22.) Willows well sorted and bundled are much more salable than those which have been poorly prepared for the market. Rods which have a decided curve at the base, like the

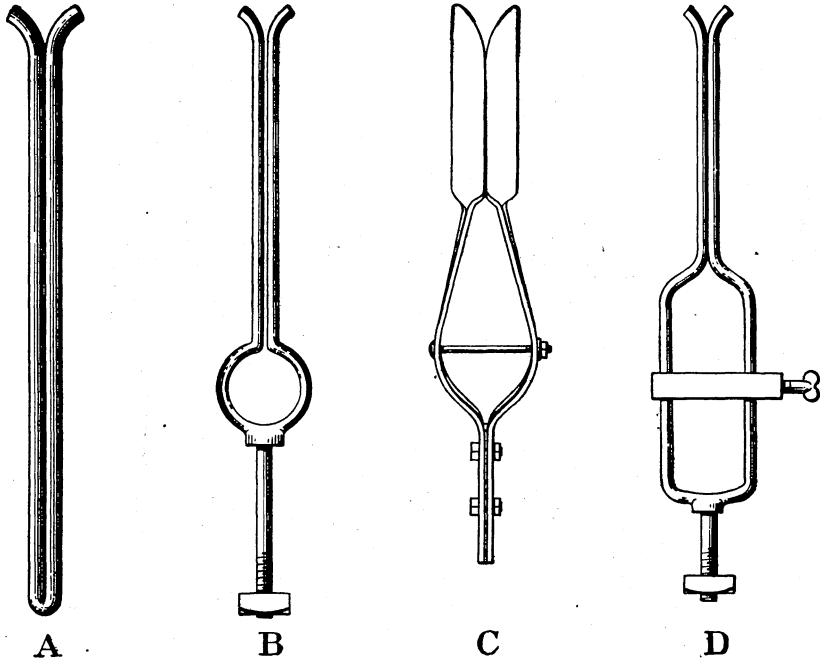


FIG. 19.—Hand peeling devices.

Lemley, should be bound with the ends pointing uniformly in one direction. This results in a much neater and more compact bundle, and also permits of better stacking.

#### RETURNS FROM WILLOW GROWING.

The cost of establishing and preparing a basket-willow holt varies much more than in the case of the ordinary farm crop; consequently there is also a wide variation in the net returns per acre. The one thing to keep in mind in willow growing is that a poorly managed holt, even if well situated, will not pay, while a well-managed holt, even under less favorable conditions, will return a good profit. Willow growing requires a certain amount of exact knowledge, and for this reason the costs for the beginner are generally higher than for the experienced grower.

MARKETS AND MANUFACTURE.<sup>1</sup>

In Europe every grade of basket, from the finest to the coarsest, is made of willow. The heaviest farm baskets and receptacles for handling rough merchandise are made out of unpeeled rods, while peeled rods go into market, clothes, and fruit baskets, furniture, hampers, and trunks. In Europe, too, the finest examples of split willow ware have been developed.

In America the market has a different aspect. A large number of baskets are made of wood, some of woven pine, oak, ash, and elm strips; others from broad veneers laid together at the bottom and fastened at the rim by a strip. Wood goes into market, clothes, and



FIG. 20.—Drafting basket willows.

laundry baskets, and willow is forced to be content with a limited share of the general trade. Reed and rattan, too, have a permanent place in the American market.

Though willow is less easy to work than rattan, its durability, lightness, and beautiful color have brought it into favor with manufacturers of furniture, several of whom have given up rattan entirely in favor of willow. To-day there is a steady demand for willow furniture, where light, attractive, and durable goods are desired (fig. 23).

The willow-furniture industry in America is centered in New York, Boston, and Rochester. Small concerns are located in other places,

<sup>1</sup> Revision of material contained in Forest Service Bulletin 46, "The Basket Willow," by W. F. Hubbard.

but most of the wholesale supplies come from large houses in the three cities named. The extension of the industry is limited not so much by the lack of raw material, though in some cases there is such a lack, as by the scarcity of skilled workmen. At present all manufacturers use far more imported willow than they do American, because the imported willow rods are better sorted and easier to get in small sizes. The average American grower does not seem to appreciate the value of small stock, which is more difficult to peel, and consequently more expensive to produce.

The best quality of American-grown willow comes in four sizes. The smallest size is hard to get, and the other sizes are seldom well



FIG. 21. Drying the peeled rods.

sorted. The American-grown willow is regarded favorably by furniture makers, and whatever objections they may have can be removed by greater care in culture and in preparing the rods for the market.

The makers of high-grade willow basket ware (fig. 24) are generally located in the larger cities throughout the North and in the Mississippi Valley. There are also several establishments in San Francisco and Sacramento. In the South basket makers are found only in Richmond, Charleston, and New Orleans. Practically no attempt is made by any of these manufacturers to compete with makers of cheap baskets.

In the East both foreign and domestic willows are used. Even in this section, however, the manufacturers say that they would use

more American-grown willows if they could get them, since they are heavier and more durable than the French. All willow used for fine baskets and for furniture must be a brilliant white, and for this reason only sap-peeled rods are considered. In the Middle West and West transportation costs increase the price of foreign-grown willows and limit their use. All the manufacturers seem to prefer the American-grown willow if it can be obtained.

Upon the manufacturer of low-grade basket ware falls the burden of the competition with wooden baskets and with cheap willow products imported from Europe. The manufacture of low-grade baskets is centered in western New York and in the larger cities throughout the country. The basket-willow industry about Syracuse, Roches-

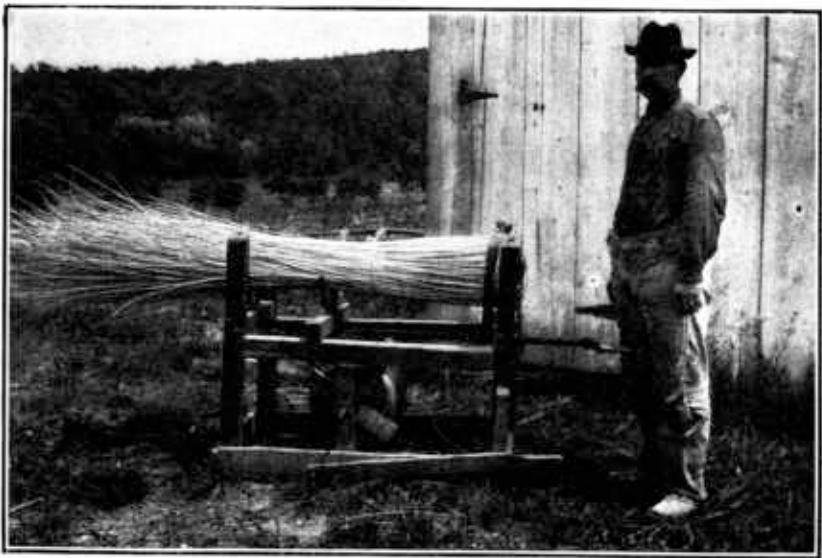


FIG. 22.—Bundling the peeled rods.

ter, and other points in western New York differs from that in any other part of America, more nearly approaching the industry in certain sections of Europe. It is carried on in the midst of an important willow-growing district, and is mainly in the hands of a few large dealers who buy the willows and give them out to basket makers. These latter work at home, receiving a specified sum per dozen for the baskets, according to the size. The willows are steam peeled, a process which turns the rods a red-brown color and ruins them for all fine work. Besides the industry in western New York, willow-basket makers are scattered through the country districts of Pennsylvania and the middle western States as far as the Mississippi. Conditions are very much the same as those in New York, though, as a rule, sap-peeled willows are used.

## SUGGESTIONS FOR BASKET MAKERS.

In Europe basket ware is used for many purposes practically unknown in this country. In bakeries and dairies, on the Continent and in England, eggs, buns, rolls, etc., are displayed in very delicately woven, shallow baskets of the best quality, which add a real attractiveness to the store. Grocers often use willow hampers for dried fruits, nuts, etc. Such hampers are made with one side higher than the opposite one, so that the wares can be better seen. The hamper is set on short feet.



FIG. 23.—A well-made willow chair.

In England great quantities of split basket ware are used. Screen doors and even office window screens are beautifully fashioned in willow, and even hotel washstand splashers are made of willow. Small mats for hot dishes at table are also made of split willow, as are also very dainty bread baskets. A half-bushel basket is made in England and Holland which is singularly durable for its weight. The bottom is arched, giving the whole basket great strength. Nurserymen ship their trees in baskets of unpeeled willow, the uprights of which project and are tied over the top of the plant for its protection. A very beautiful and light basket is made in Germany, with



the lines formed simply of uprights, strengthened with one or two lines of weaving.

In England commercial travelers' sample boxes are made of willow, the corners and edges being bound with rawhide. These boxes or trunks are very light, and will stand almost any kind of usage. Parcel trunks on the English railways are almost always of willow, and seem to give the best service. Willow trunks and hampers are a feature of railway traffic, and their use, especially in suburban service, might become more general in this country.



FIG. 24.—High-grade willow ware.

#### EXPERIMENTAL PLOTS.

Very little attention has been given in America to keeping up the quality of the willow stock, though the basket willow to-day is the result of a long selection. More growers of willows on a large scale should maintain an experimental holt, in which new varieties can be tried out, and selections from the heaviest-yielding and best-formed plants used as planting stock. Reproducing willows by seedlings seems to increase the vigor of the plants, and experiments in this line also can be carried on. Such experimental work breaks up a variety of willows into several groups of individuals with similar general characteristics which form a basis for still further selection.