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WOOD AS FUEL

Harvesting and Using the Slack Season Crop

by

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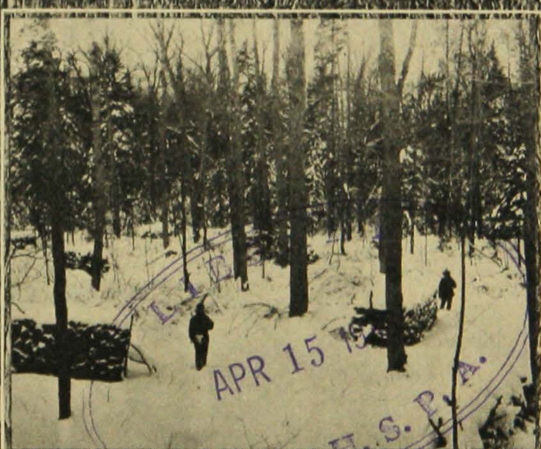

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WOOD has always been an important fuel in the United States. Probably the greatest value of the average farm woodlot lies in the firewood it will produce. It has been estimated that from 90 to 110 million cords of fuel wood are used annually in the United States. It is, therefore, probably safe to assume that more wood is used for fuel than for all other purposes combined. According to recent United States Census figures, 1,162,664 cords of wood were produced on 87,262 farms in Minnesota in 1929, an average of 13.4 cords per farm. Figures submitted by 88 farmers in southeastern Minnesota who kept complete records of all household and personal expenses during 1931 show that an average of about 7.5 cords of wood were burned per farm.[1] This wood had an estimated average value of about $4.00 a cord. The average value of the wood produced per farm on this basis was about $30. According to the figures submitted, an additional $31 was spent for other fuel, mostly coal. It is evident, in this case, that wood represents about half of the value of the fuel used per farm.

The lack of ready cash, especially during periods of depression or drouth, tends to increase the use of wood for fuel. During the coal shortage of the war time period, the consumption of fuel wood in various parts of the United States was increased from 10 to 500 per cent.

In general, more coal is consumed by the rural population where there is a plentiful local supply or where wood is relatively scarce. As wood is comparatively bulky, it is not economical to ship it to any great distance unless water transportation is available. It is, however, considered profitable to haul wood with a team for distances up to five miles and with a truck to 20 miles. These distances may be modified by variations in the cost of production and by the value of the material delivered. It is often assumed that it is cheaper to buy coal than to get out wood. Labor is needed to produce fuel wood, but on most farms there is usually plenty of time available during the slack season of the year for both men and teams. One way to cut the cost of living on the farm is to use the low-grade material from the farm woods as fuel.

ADVANTAGES OF WOOD AS FUEL

The use of wood for fuel in communities where wood is available has some decided advantages. Among these are:

1. Wood gives a quick hot flame, which makes it desirable for kitchen use.
2. Wood ignites readily, making it a desirable fuel for heating buildings used only occasionally, such as churches, schools, summer cottages, and halls.

[1] Ranney, D. P. and Pond, G. A. Annual Report of the Farm Management Service for Farmers in Southeastern Minnesota for the Year 1931. (From original data.)

3. Cheaper heaters can be used to burn wood.
4. Where available, wood may be more economical than coal.
5. Its use helps to keep cash at home, and may be made a source of income if the woodlot can produce more fuel than the owner needs. This income accrues from the standing timber and the labor of getting out the wood.

WHAT TO USE FOR FUEL

Fuel wood is not the most economical use for the better kinds of farm-grown timber. Only trees that have little or no other commercial value should be so used. Greater returns can generally be had by cutting timber of better commercial value into lumber, ties, or other forest products. Fuel wood should be cut under the careful supervision of the owner, with a definite plan for the future in mind, or with the aid of forest extension specialists.

The following are recommended for fuel: (1) all down timber; (2) dead standing timber; (3) trees broken by the wind and in poor condition; (4) trees attacked by fungi or insects; (5) the poorer trees in crowded areas; (6) trees that are short boled, crooked, or covered with limbs; (7) trees with little or no other commercial value, the so-called weed trees—ironwood, box elder, balm of gilead, and willow; (8) the slash remaining after logging; and (9) sawmill waste. By using the material indicated, the condition of the woodlot will be greatly improved, and the owner will save by using material that would otherwise go to waste.

ESTIMATING FUEL WOOD IN STANDING TREES

Altho wood is usually sold by the stacked cord, it may be desirable to know in advance approximately the number of cords that can be cut from a given number of trees or from the woodland. If the tract contains less than 20 acres, each tree should be estimated separately; if more, the trees on only 10 per cent of the area need be measured. Probably the best method of making the 10 per cent estimate is to lay out quarter-acre circular plots uniformly distributed throughout the woods—a 20-acre woodland will require eight quarter-acre plots. The number and location of the plots are shown in Figure 1. A straight line may easily be run without a compass by sighting in with three poles and locating the plots on the line by pacing.

A quarter-acre circular plot has a diameter of 118 feet. The plots can easily be laid out by attaching a piece of twine 59 feet long to a stake at the center of the plot. The boundary of the plot is located by extending the string in several directions. The string need not be used if the estimator can pace accurately.

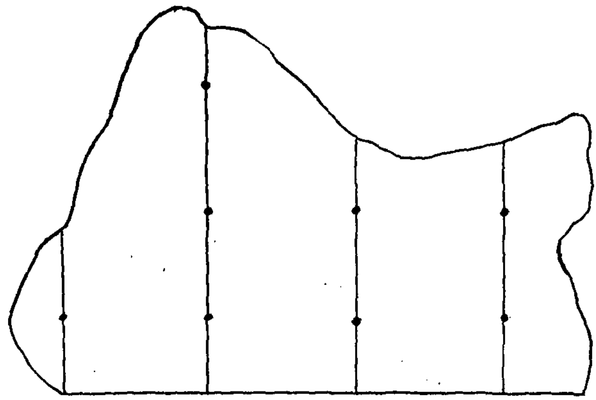
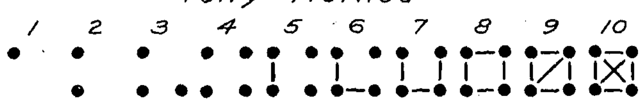


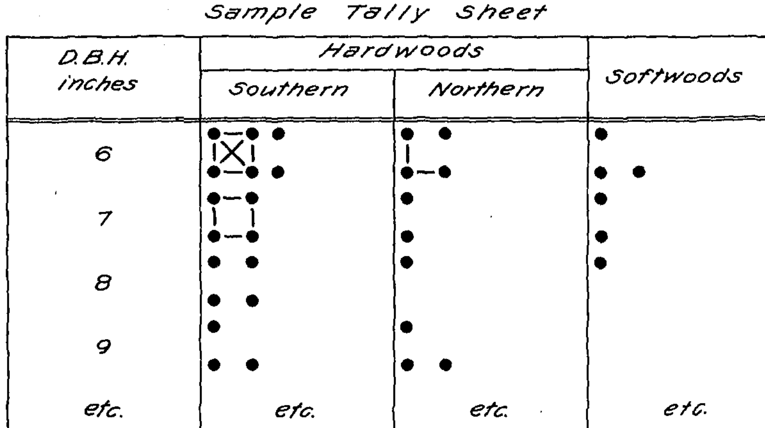
Fig. 1. Diagram showing the number and the approximate location of the quarter-acre plots to cover 10 per cent of the area of a 20-acre woodland of irregular shape.

Measure the diameter of all trees to be cut on each plot at breast height (d.b.h.), that is, 4.5 feet from the ground to the nearest inch. Tally each tree by diameter and species, or group, as shown in the sample tally sheet. To save space and time the trees should be tallied by tens, using dots and connecting lines as shown.

Tally Method



Sample Tally Sheet



The number of cords can easily be computed by multiplying the number of trees in each diameter class as shown on the tally sheet by the number of cords in a tree of the same diameter, as given in

Table 1 The method is illustrated in part by the computation of the total number of cords in the 8- and 9-inch southern hardwoods, as shown in this sample calculation.

Sample Calculation for Southern Hardwoods

d.b.h., inches	No. of trees	Cords per tree	Total cords
8	4	0.111	0.444
9	3	0.142	0.426
Total	..	....	0.870

Thus 0.87 cord of wood is produced by the 8- and 9-inch trees on 10 per cent of the area, or $10 \times 0.870 = 8.70$ cords on the entire area.

Table 1

Approximate Number of Standard Cords One Tree Will Produce*

d.b.h., inches	Hardwoods		Softwoods§
	Northern†	Southern‡	
6	0.050	0.058	....
7	0.067	0.076	0.050
8	0.091	0.111	0.076
9	0.125	0.143	0.100
10	0.167	0.167	0.125
11	0.200	0.200	1.143
12	0.250	0.250	0.166
13	0.290	0.294	0.222
14	0.333	0.333	0.270
15	0.400	0.400	0.333
16	0.500	0.454	0.400
17	0.589	0.500	0.476
18	0.667	0.555	0.526
19	0.769	0.667	0.625
20	0.833	0.769	0.667
21	1.000	0.833	0.714
22	1.110	0.910	0.833
23	1.250	1.000	0.910
24	1.430	1.110	1.000

* Adapted from U. S. Dept. of Agr. Farmers' Bull. 1210, 1921. Measuring and Marketing Farm Timber, by W. R. Mattoon and W. B. Barrows.
† Northern hardwoods include birch and maple.
‡ Southern hardwoods include hickory, oak, ash, elm, basswood and others.
§ Softwoods include pine, spruce, balsam fir, cedar, and tamarack.

MEASUREMENT OF STACKED FUEL WOOD

Fuel wood is usually measured by the cord, of which there are several units, and all of which are often designated as a "cord." The standard cord is a pile of wood 8 feet long, 4 feet wide, and 4 feet high. The short, or stove wood cord often called a "run," is a pile of wood 8 feet long, 4 feet high, and 12, 16, or 24 inches wide. The long cord is a pile of wood 8 feet long, 4 feet high, and over 4 feet wide. Three stove wood cords 16 inches wide equal one standard cord. Actually, however, the three 16-inch stove wood cords contain more wood than the single standard cord, because the pieces are shorter and straighter and pack in tighter. It is usually customary to pile green wood two or three inches higher than 4 feet to allow for shrinkage and settling.

The number of cords in a given pile of wood can be quickly estimated by measuring the length and the height of the pile and multiplying these two figures together in order to get the number of square feet in the face of the pile. Divide the product by 32, the number of square feet in the face of one cord.

CUBICAL CONTENTS OF A STANDARD CORD

Altho a standard cord actually contains 128 cubic feet, the space occupied includes air as well as wood. The solid volume of wood of average size is only about 70 per cent of the total volume, or about 90 cubic feet. If the average diameter of the sticks is 4 inches or less, the amount of wood may be less than 80 cubic feet. If the sticks are 10 inches or over in diameter there may be as much as 100 cubic feeet of solid wood in a cord. Crooked, rough sticks of the type usually produced from limbs, can not be closely packed; so there is less wood substance in a cord of such material than in a cord of straight sticks. A cord of limb wood may contain as little as 65 cubic feet of solid wood substance. A standard cord of wood is usually considered the equivalent of 500 board feet of lumber.

WEIGHT OF FUEL WOOD

The amount of wood in a cord of different woods not only varies but the actual fuel value varies to a considerable extent, making the cord a rather unsatisfactory unit for measuring. The purchaser buys wood not for its bulk but for its heating value, which depends upon the weight of the actual wood substance. Any standard weight of thoroly seasoned wood is independent of the kind of wood as well as the shape and size of the sticks and the method of piling. The weight per cord of green and air-dry wood for most of the common woods grown in Minnesota is given in Table 2.

SEASONING FUEL WOOD

In order to get the most heat from wood it must be thoroly air-dried before it is used. The time required for thoro seasoning in this region is from 9 to 12 months. Wood cut in the winter and properly piled will be in good condition for use the next fall and winter. On the other hand, fuel wood will begin to deteriorate in value after the second or third year, so that it is better to have a supply on hand for not more than one or two years.

Table 2

Approximate Weights of Wood per Standard Cord, 90 Cubic Feet, Green and Air Seasoned, Based on Figures Published by the Forest Products Laboratory*

Species	Weight per standard cord Green	Air-dry	Species	Weight per standard cord Green	Air-dry
	lb.	lb.		lb.	lb.
Ash, black	4,800	3,200	Maple, red	4,500	3,300
Ash, green	4,400	3,800	Maple, silver	4,050	3,200
Aspen, trembling	3,900	2,600	Maple, sugar	5,050	3,950
Aspen, largetooth	3,900	2,550	Oak, black	5,650	4,050
Basswood	3,700	2,350	Oak, bur	5,600	4,100
Beech, blue	4,800	4,100	Oak, northern red	5,650	3,900
Birch, paper	4,500	3,550	Oak, swamp white	6,200	4,450
Birch, yellow	5,150	3,850	Oak, white	5,600	4,250
Butternut	4,150	2,550	Poplar, balsam	3,600	2,100
Cherry, black	4,150	3,350	Walnut, black	5,200	3,450
Cherry, pin	3,000	2,600	Willow, black	4,500	2,450
Cottonwood, eastern	4,400	2,600	Cedar, eastern red	3,350	3,100
Elm, American	4,850	3,250	Cedar, northern white	2,500	2,100
Elm, rock	4,850	4,000	Fir, balsam	4,050	2,600
Elm, slippery	5,050	3,400	Pine, jack	4,500	2,900
Hackberry	4,500	3,300	Pine, Norway	3,800	3,150
Hickory, bitternut	5,700	4,150	Pine, northern white	3,250	2,500
Hickory, shagbark	5,750	4,450	Spruce, black	2,900	2,700
Hop hornbeam	5,400	4,400	Spruce, white	3,150	2,650
Locust, black	5,200	4,500	Tamarack	4,250	3,400
Locust, honey	5,500	4,200			

* Markwardt, L. J. Comparative Strength Properties of Woods Grown in the United States. U. S. Dept. of Agr. Tech. Bull. 158. February 1930.

When stacking wood for seasoning, a place should be selected that is well drained and where air can circulate readily through the pile. If the seasoning period is six months or more, the usual practice is to lay the wood on skids in order to prevent the bottom of the pile from coming into contact with the ground, thus preventing deterioration. Best results are obtained if the pile is covered with boards, old roofing paper, or bark to aid in shedding rain.

HEAT VALUE OF FUEL WOOD

Theoretical Heating Value

In theory, equal weights of the various woods will produce the same amount of heat—thus 100 pounds of dry aspen should produce as much heat as 100 pounds of dry hickory. In bulk, however, the aspen will occupy nearly twice as much space as the hickory because the density of hickory is nearly twice that of aspen. Actually, there are variations in the heat value of woods owing to oils, gums, tannins, pigments, resins, and water. For example, the heat value of a highly resinous wood is much greater than that of an equal weight of a non-resinous wood, because of the high heating value of pitch. The presence of water, or "sap," as it is generally called, reduces the heat value.

The bark also has some influence on the amount of heat produced. The bark of shagbark hickory has a high heat value; that of northern white cedar is comparatively low and produces a large proportion of ash. In the subsequent discussion it has been assumed that the bark has the same fuel value as the wood.

In general, the lighter the wood the more readily it will burn. The softwoods give off a quicker, hotter flame and are consumed in a shorter time than most of the hardwoods. Hardwoods such as hickory, oak, maple, and elm burn slowly and produce a steady heat for a considerable time. A few species, such as butternut, tamarack, and spruce, are not desirable for use in a fireplace as they throw off sparks, thereby increasing the danger of fire.

Other factors besides fuel value affect the usefulness of the various woods for heating. Pine has a comparatively low heat value, but it ignites readily and gives off a quick hot flame that soon dies out. This wood is a favorite for kindling and for kitchen use on hot days.

Effect of Moisture on the Fuel Value of Wood

As stated, the amount of water, or sap, in the wood cells has some influence on the fuel value of the wood. The amount of moisture in wood when it is first cut varies considerably with the species. This ranges from about 42 per cent in the green wood of white spruce to 138 per cent in the green wood of willow. The average moisture content of the green wood of common species grown in Minnesota is about 72 per cent, based on the oven-dry weight of the wood.[2] The water replaces an amount of wood substance equal to its own weight; in addition, it requires heat to raise the temperature of this water to the boiling point, to evaporate it, and to raise the temperature of the resulting steam to the temperature of the flue gases before it is driven from the fire box. The heat necessary to drive off this water is supplied by the wood substances and is lost for heating.

The comparative fuel values of various woods, green and air-dry, are shown graphically in Figure 2. The fuel value of green white spruce is 97 per cent of that of the air-dry wood, in willow the heat value of the green wood is only about 79 per cent. The average fuel value of the green wood compared to that of dry wood is represented by red oak, in which the green wood will produce about 92 per cent as much heat as air-dry wood.

Air-dry wood not only produces more heat, but it ignites more readily and it is easier to keep burning. Green wood is satisfactory for a slow

[2] Wood is oven-dry when it is heated at 212 degrees Fahrenheit until it ceases to lose weight.

fire when only a small amount of heat is required or to aid in holding the fire overnight.

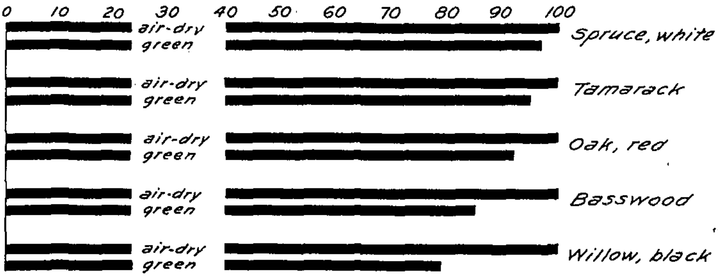


Fig. 2. Fuel value of green wood expressed as a percentage of the fuel value of the wood when air-dry.

Air-Dry Fuel Value

When wood is thoroly air-dry it will still contain from 20 to 25 per cent of moisture. At a moisture content of 25 per cent one pound of wood and water combined will contain 0.8 pound of wood substance and 0.2 pound of water. The loss of heat because of this water amounts to approximately 1,850 heat units. One pound of absolutely dry wood will produce on the average about 8,000 heat units. The heating value of one pound of wood at a moisture content of 25 per cent is 8,000 — 1,850 = 6,150 heat units. Thus air-dry wood is about 77 per cent as efficient as an equal weight of absolutely dry wood.

The fuel values per standard cord of the common Minnesota woods and at a moisture content of 25 per cent are indicated graphically in Figure 3. The values are in percentage of the heating power of soft coal, which produces approximately 27,000,000 heat units per ton. The values indicated are approximate, but they afford a good comparison between the fuel value of the various woods and the amount of heat they will produce in comparison to that of soft coal.

HOW TO USE WOOD FUEL[3]

Coal has been used so universally that most furnaces are designed to burn this type of fuel. However, wood can be burned in the ordinary coal furnaces or stoves by making a few simple adjustments. The size of the firebox is the greatest drawback to the use of wood, as the wood must be cut short. This can be done at a small additional expense. A little experience will teach the best method of burning wood, and it can be used very satisfactorily for most heating purposes.

[3] The Use of Wood for Fuel. Compiled by Office of Forest Investigations. U. S. Dept. of Agr. Bull. 753. 1919.

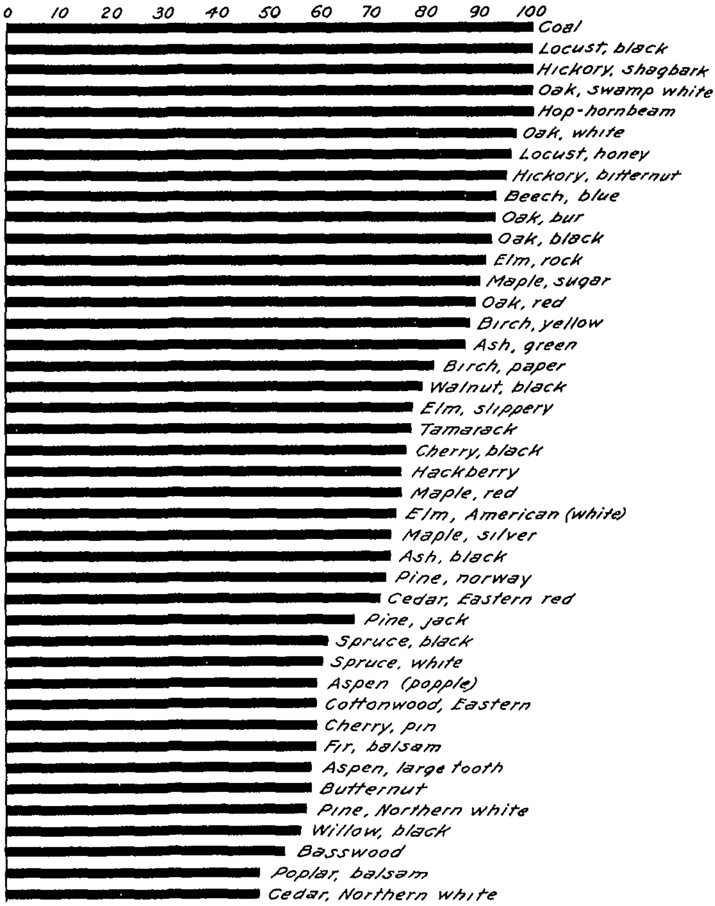


Fig. 3 Approximate fuel value of one standard cord of air-dry wood expressed as a percentage of the fuel value of one ton of a good grade of soft coal.

Burning Wood in Stoves

A coal-burning stove can be converted into a wood-burning stove by removing the fire bricks and substituting lighter ones at a nominal cost. The grates need not be changed. If the grate is too coarse, this difficulty can be overcome by placing a sheet iron covering over part of the surface. Wood grates are made so they can be inserted through the fire door and placed over the old grate. The average cook stove can be converted to a wood-burning stove by following these simple directions.

Burning Wood in Furnaces

The wood furnace is built to accommodate pieces three or four feet long. Shorter lengths can, however, be readily burned in the ordinary coal furnace, altho it is claimed that this is wasteful of fuel. Most furnace manufacturers make a special wood grate for use in most of their furnaces, and if wood is to be used entirely, it may be more economical to install one of these grates, altho this is not necessary. In order to burn wood in the small firepot of the coal furnace, it is necessary to have the wood short enough to lie flat in order to pack in tightly. Such hardwoods as hickory, oak, and elm make the best fire, but such softwoods as tamarack, Norway pine, and jack pine can be used if hardwoods are not available. The softwood fires need replenishing more often than those of hardwood. Medium sized pieces can be burned but larger pieces hold the fire longer.

The firebox should be kept full of wood at all times in order to keep a bed of hot coals beneath. Banking the fire at night requires the addition of several large blocks and attention to closing the dampers tight.

One of the most economical furnaces designed for burning wood is known as the "Wilson Heater." The ordinary furnace can be made into this type of heater by removing the grates and covering the bottom of the ash pit with fire brick. The wood fire is built on the fire brick and the ash door is kept tightly closed at all times. The ventilator in the fuel door is kept open. A wood fire can be made to burn very slowly in a heater of this type.

Probably the most effective way to burn wood in the ordinary coal furnace is to combine it with coal. The method of firing consists in filling the firebox with wood to about the level of the fire door and then adding coal to the top. A charge of fuel of this kind will produce good heat, but will not last so long as a firepot full of coal, hence it will require more attention. Wood or coal of any size is adaptable to burning in this way. If the finer grades of coal are used, CARE should be taken to prevent possible explosions by leaving a flame burning above the coal in some part of the firebox; in other words, do not cover the whole fire with fresh fuel at one time.

Burning Wood in Fireplaces

Fireplaces may be used for heating in fall and spring. It may also supplement the furnace during cold weather. A fire can be kept continuously with very little attention and with a small consumption of wood.

When using a fireplace, the ashes should be kept to the level of the andirons; this allows the glowing coals to accumulate in this bed of ashes. These coals burn slowly and assist in igniting fresh pieces of wood placed on the andirons. To check the fire, ashes are shoveled over one or more of the blocks, covering lightly all the burning parts. This will not put the fire out, but will check it. Any kind and size of wood can be used, if it is well seasoned. A banked fire will keep from 10 to 12 hours and will throw out some heat all the time from the hot bricks. A well-managed fireplace will be found an addition to the heating system in any home.

MARKETING FUEL WOOD

It may be claimed that no market exists for fuel wood. This may be partially true under present conditions, as both rural and city people have been accustomed to the use of coal. If, however, the advantages through the use of wood can be brought to the consumers the demand for wood will be increased.

Probably the most profitable method of selling fuel wood is for the woodland owner to sell direct to the consumer. This method, however, requires some effort on the part of the producer, in order to locate responsible buyers. This can best be done by a house-to-house canvass, the orders to be filled at some definite date. A few cases of this sort will probably take care of the production for one season, and probably for several seasons, if all transactions have been satisfactory to both parties. The problem of selling fuel wood is comparatively simple in communities in which wood dealers are located. These men know local conditions and are able to distribute the wood much more easily. There is also the possibility of distributing wood through lumber dealers.

FUTURE WOOD SUPPLIES

When cutting wood from the farm woods, care should be taken not to deplete the supply for the future. In the hardwood forest areas, it requires from 20 to 50 years to grow timber for fire wood. A few species, such as willow and cottonwood, yield fire wood in 10 to 15 years, but these species are not particularly high in fuel value.

The owner who cuts fuel wood in order to improve the woodlot by utilizing material of low commercial value will in the long run receive the greatest returns. In general, it is not desirable to use good agricultural land for the production of fuel wood. Generally the poorer lands will supply all the wood needed. Farms with inferior lands are numerous throughout the state. That land may be advantageously devoted to the production of fuel.