Properties and Uses of Iowa Hardwoods

Iowa landowners often have the alternative of using native timber for construction and other home uses. Iowa hardwoods are suitable for many purposes and can offer substantial savings in material costs compared with shipped-in lumber, but we need to understand the properties of hardwoods to use them efficiently.

Moisture

Freshly cut wood contains a lot of water. Green wood is extremely porous and is capable of holding a substantial volume of water. The moisture content of wood is expressed as a percent and relates the weight of water in a piece of wood to the weight of the piece after being completely dried in an oven. Native hardwoods range in green moisture content from 40 percent to more than 100 percent. The weight of a green log with a moisture content of 100 percent would be reduced by one-half if all the water were removed.

A substantial weight reduction also occurs from green to air-dry. A piece of wood thoroughly air-dried will have a moisture content of about 12 percent. Cottonwood weighs about 46 pounds per cubic foot when green but only 24 pounds per cubic foot when thoroughly air-dry. A cubic foot of white oak weighs approximately 62 pounds when green and 48 pounds when air-dry. For most purposes, wood should be dried prior to use.

As wood dries, several things occur. When wood reaches 25 to 30 percent moisture content, shrinkage begins. Shrinkage is not the same in every direction in a piece of lumber. Normally, wood shrinks very little in length (along the grain) but may shrink substantially in width and thickness (across the grain). A flat-grain board shrinks 1.5 to 2 times more in width than an edge-grain board because wood shrinks more along the annual rings than across them (figure 1).

Figure 1. End-view of flat-grain and edge-grain boards showing orientation of annual rings.

Flat-grain Board

Edge-grain Board

Table 1. Shrinkage of Iowa hardwood species.

High shrinkage		Moderate shrinkage
ash	hackberry	aspen
basswood	hickory	black locust
birch	maple	black walnut
cottonwood	oak	butternut
elm	sycamore	cherry
		honey locust

Species differ in the amount of shrinkage that occurs. Hardwoods characteristically shrink more than softwoods. Table 1 indicates which Iowa hardwoods have high shrinkage and which have moderate shrinkage. Species with high shrinkage can be expected to shrink 7 to 10 percent in volume from green condition to air-dry, while hardwoods that shrink moderately decrease about 4 to 6 percent in volume. Heavy, strong hardwoods typically shrink more than lighter woods.

Dry wood will increase in dimension when moisture is added. The amount of swelling will depend on the change in moisture content. Original green dimensions

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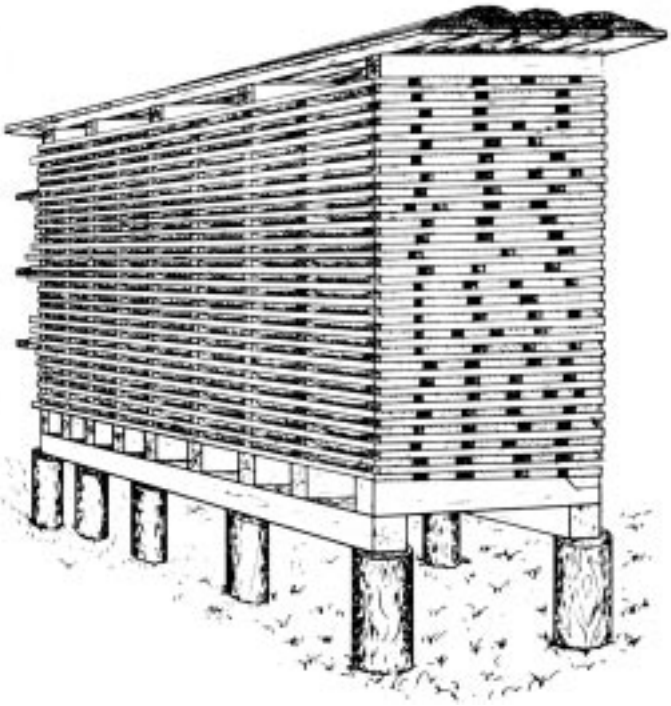
Pm-329 | Revised | October 1998

Figure 2. Proper piling of lumber for drying.



will be achieved if sufficient water is added to raise the moisture content to 25 to 30 percent.

As lumber dries, various types of warping may occur. Warpage may be reduced by proper piling of lumber during drying. Figure 2 shows piling techniques that can reduce warp in hardwood lumber. Use a proper foundation for the lumber pile. Air should be able to circulate beneath the pile. Stack the lumber in neat layers and separate each layer with dry, wooden spacers (stickers) 3/4 inch thick and 1 1/2 inches wide spaced 12 to 18 inches apart. Put a roof over the finished pile to minimize soaking from rain and melted snow.

Bow, crook, cup, or twist result from unequal shrinkage within a wood member (figure 3). The tendency to warp varies among species. Iowa hardwoods are extremely subject to warp if dried without restraint. Ash, birch, cottonwood, hickory, maple, and oak have a very pronounced tendency to cup and pull loose from fastenings. Edge-grain boards of all species tend to cup less than flat-grain boards. Birch, cottonwood, elm, and sycamore are likely to twist when exposed to the weather due to interlocked grain.

Checking also can occur during drying. Surface checking can be minimized by protecting the lumber from direct exposure to the sun. Put a roof over the lumber pile to shade the upper layers of boards. To reduce end checking and splitting, seal the ends of the boards with aluminum paint, asphalt, or paraffin.

The time required to air-dry properly stacked lumber varies with the weather during the drying period, the thickness of the lumber, and the species. The number and extent of seasoning defects will be reduced if the weather is mild during the early part of the drying period. Early spring is a good time to initiate drying; degrading should not be severe and drying time should be close to minimum.

Native hardwood timber that is 1-inch thick may require from 50 to 200 calendar days to dry to 20 percent moisture content, depending upon the time of the year drying is done. The U.S. Forest Products Laboratory has developed the concept of “effective air-drying days” for the upper Midwest. Each month is assigned a specific number of “effective air-drying days” as follows: December, January, or February—5; March or November—10; April or October—20; May or September—25; June, July, or August—30. Approximately 60 “effective air-drying days” are required to bring most 1-inch hardwood lumber down 15 to 20 percent moisture content.

Drying lumber thicker than 1 inch will require substantially more time; for example, 2-inch thick lumber may require 2 1/2 times as many ‘“effective air-drying days” as 1-inch lumber.

Additional drying and shrinkage will occur in air-dried lumber that is used in a heated building. Lumber used indoors for furniture or other applications should be kiln-dried to 6 to 8 percent moisture content.

Figure 3. Various types of warp.

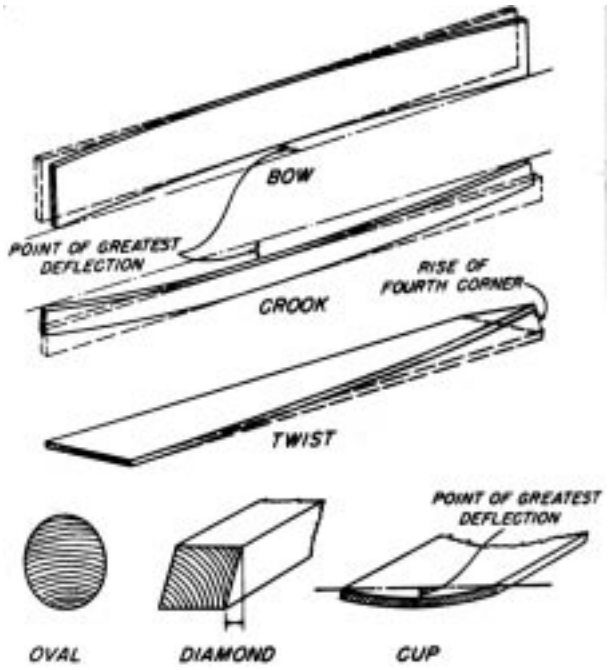


Table 2. Density of hardwoods with 12 percent moisture content.

Low 25-33 lb./cu. ft.	Moderate 34-42 lb./cu. ft.	High 43-51 lb./cu. ft.
aspen	ash	hard maple
basswood	paper birch	hickory
butternut	cherry	honey locust
cottonwood	elm	black locust
willow	hackberry	oak
	soft maple	osage orange
	sycamore	
	walnut	

Density and Strength

The density (weight per cubic foot) of different hardwood species is shown in table 2.

Strength and stiffness of wood are closely related to density. Table 3 indicates which species have high, moderate, and low strength.

The strength of certain hardwoods (ash, elm, hickory, and oak) varies with the rate of growth in diameter. Fast-grown material tends to be heavier and stronger than wood grown very slowly. Strength and stiffness tend to increase with decreasing moisture content below 30 percent.

In the selection of native framing lumber, several things should be noted. When possible, use clear wood or pieces with only small knots or knotholes. It is important to have a minimum number and size of knots and other defects in the middle half of a piece of lumber used as a beam, joist, or rafter. Knots are less objectionable in a beam or joist if they are in the upper edge of the member rather than the lower edge. Pieces with large numbers of sound knots should be used as posts or studs rather than as beams, joists, or rafters. Don't use pieces that show rot or cross grain.

Wood members can carry a greater load as a joist or beam if the depth rather than the width is increased. When you double the width of a beam, its bending strength is doubled. But if you double its depth, its bending strength is increased four times. A 2-inch by 12-inch member (bearing on the narrow face) is approximately twice as strong as a 4-inch by 6-inch member in bending strength even though both beams have the same board-foot volume.

Table 3. Strength and stiffness of hardwoods.

High	Moderate	Low
white ash	black ash	aspen
hickory	paper birch	basswood
locust	cherry	butternut
hard maple	elm	chestnut
oak	hackberry	cottonwood
black walnut	soft maple	
	sycamore	

Fuel Value

The fuel value of wood is primarily determined by its moisture content and density. Many Iowa hardwoods make excellent firewood. Properly dried higher density hardwoods such as oak, hickory, hard maple, ash, birch, and black locust produce a high amount of energy per unit volume.

More information on burning wood as a fuel is contained in extension pamphlets Pm-1291, *Fuelwood Production and Use*, and Pm-802, *Wood Burning Stoves, Furnaces, and Fireplaces*, available from county extension offices.

Durability and Preservation

A cross-section of a tree or log contains both sapwood and heartwood. The outer shell of "sapwood" is physiologically active while the inner core of "heartwood" is inactive. Sapwood and heartwood often are a different color, the moisture content may differ, and ease of chemical treatment may vary.

Sapwood of any species is not resistant to attack by decay fungi. The resistance of the heartwood varies with species (table 4).

Table 4. Decay resistance of the heartwood of hardwoods.

High resistance	Moderate resistance	Low resistance	
black walnut	honey locust	ash	elm
black locust	white oak	aspen	hackberry
chestnut		basswood	hickory
osage orange		birch	maple
		butternut	red oak
		cherry	willow
		cottonwood	

Dry wood (below 20 percent moisture content) that is kept dry in service will not decay; wood in contact with the ground or other sources of moisture may be subject to deterioration. Use only preservative-treated wood or heartwood of durable species in severe exposure conditions.

Proper treatment of wood with preservatives such as chromated copper arsenate (CCA) will protect wood from attack by decay fungi and insects. Pressure processes are the most effective methods for protecting wood with chemicals, but it is an industrial process requiring expensive equipment and technical expertise. A modest amount of protection can be provided by brushing or soaking wood in commonly available wood preservatives (such as copper naphthenate) or in “water repellent preservative” formulations. However, wood exposed to severe decay conditions, such as contact with the ground or water, should be pressure treated with appropriate chemicals.

Working Qualities

lowa hardwood species differ in the ease with which they can be worked with hand tools (table 5).

The heavy hardwoods are harder to nail and they split more easily, especially when dry. Ash, elm, hickory, maple, and oak are difficult to fasten with nails or screws. The problem of nailing such species has sometimes been solved by using green lumber. Use of green lumber is not recommended because of shrinkage, splitting, warping, and loosening of fastenings. Dense hardwoods may be nailed by boring holes in the members prior to nailing. Splitting may be reduced by blunting the nail tips, using smaller diameter nails, and waxing nail points. Start nails as far from the end of the board as possible to reduce splitting.

Table 5. Working qualities of lowa hardwoods.

Easy to work	Moderately easy	Least easy
basswood	black walnut	ash
butternut	cottonwood	cherry
chestnut	paper birch	elm
	sycamore	hackberry
		hickory
		locust
		maple
		oak

Finishing

For interior applications, hardwoods may be finished with either a penetrating-type finish or with a film-forming finish. Penetrating finishes are generally sold as "oil" finishes; these types of finishes are easy to apply but provide little protection for the wood surface. Film-forming finishes are either transparent finishes such as lacquers or varnishes or paints of various types. These finishes may be more difficult to apply, but do generally offer better protection for the wood surface. Perhaps the most durable transparent finish that can be applied in home workshops is polyurethane varnish. For more information on this topic request Forestry Extension Note F-367, *Interior Finishing of Wood*, from Forestry Extension, 253 Bessey Hall, Iowa State University, Ames, IA 50011-1021.

For exterior applications where hardwoods are exposed to the weather, the preferred choice is a semi-transparent, oil-base penetrating stain. Generally, two coats are recommended with the second coat applied before the first coat has completely dried. If paint is to be applied to hardwoods outdoors, the following procedure is recommended. First, treat all exposed surfaces, edges, ends, and joints with a paintable water-repellent or water-repellent preservative. Second, prime exposed surfaces with a high quality exterior primer paint. Third, apply two coats of a top-of-the-line exterior acrylic latex paint. Paint only when the temperature is between 50 and 90 degrees F. and do not allow more than two weeks of time to elapse between successive coats. For more information on exterior finishing, ask for extension pamphlet Pm-362, *Finishing Exterior Wood Surfaces*, at your County Extension Office.

Prepared by Dean R. Prestemon, extension forester (wood products).

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