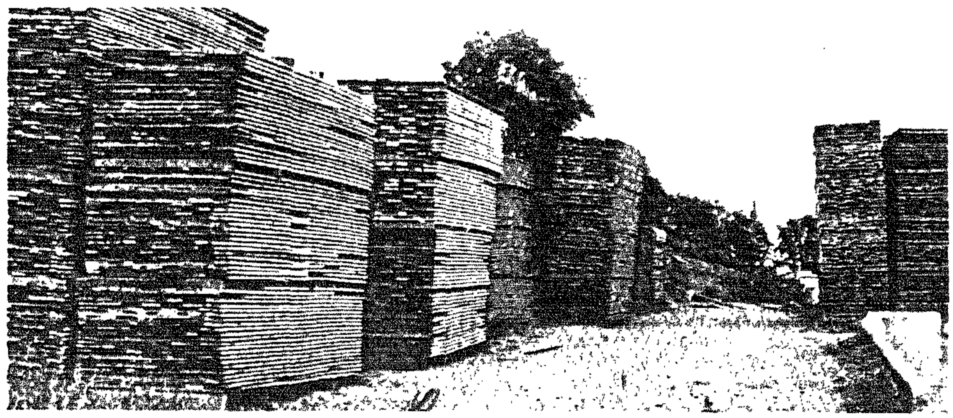
Air-Drying Practices In The Central Appalachians



An evaluation of commercial sawmill operations, with some recommendations for improvements to reduce lumber losses

by Donald G. Cuppett

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Air-Drying Practices In The Central Appalachians

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THE IMPORTANCE OF AIR-DRYING

THE air-drying process is particularly important in the central Appalachian region, where approximately two-thirds of all hardwood lumber produced is marketed air-dried. In a recent study of West Virginia sawmills, it was found that 69 percent of the lumber shipped was air-dried, 8 percent was kiln-dried, and 23 percent was green.[1] These proportions are believed to be typical of the central Appalachian region.

The efficiency of air-drying and the quality of air-dried lumber are important to both lumber producers and users. Poor air-drying practices cause seasoning defects that lower the grade and value of lumber; this degrade results in loss of income to the lumber producers and higher remanufacturing costs to the lumber users. Furthermore, improper air-drying causes large variations in moisture content, which results in excessive kiln-drying costs.

All these effects of poor air-drying create problems in marketing hardwood lumber. Therefore our Forest Products Marketing Laboratory made a study of commercial air-drying practices in

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[1]Reid, W. H., W. W. Christensen, and N. D. Jackson. MARKETING LUMBER PRODUCED BY SAWMILLS IN WEST VIRGINIA. W. Va. Agr. Exp. Sta. Interim Rep. on Reg. Res. Proj. NEM-24, Phase I and II, 20 pp., illus., 1962.

the central Appalachian region (1) to evaluate the different drying practices in terms of degrade losses and moisture-content variation of air-dried lumber; and (2) to determine what improvements in drying practices are needed at mills where seasoning degrade losses and moisture-content variation are excessive.

THE STUDY

A stratified random sample, including 18 of the sawmills in West Virginia, Virginia, Kentucky, and Tennessee, was selected for study. Ten of these were small mills that produce ½ to 3 million board feet annually; the other eight were large mills that produce more than 3 million board feet annually. Sawmills in these two classes account for an estimated 90 percent of all lumber produced in the region.

Seasoning degrade was determined by inspecting air-dried lumber in randomly selected shipments at each mill. The grade[2] and volume of each board were determined and recorded on the standard lumber-shipping tally form. An additional record was made for each board that contained seasoning degrade to show the grade with and without seasoning degrade, the air-dry volume of the board, the type of seasoning defect, and the probable cause of defect.

Degrade losses were computed in dollars per thousand board feet by applying the f.o.b. mill prices by grades to the actual air-dry grade and the potential grade of each degraded board. The total value losses for all degraded boards in a shipment, divided by the total volume in the shipment, gave the monetary degrade loss per thousand board feet.

The study was limited to red oak and yellow-poplar in 4/4- and 5/4-inch thicknesses, because these two species and thicknesses account for more than half the hardwood lumber produced in the region. Approximately half of this lumber was dried in the fall and winter, half in the spring and summer. Grades No. 3A Common and Better were included, and the average grade of lumber inspected was slightly better than No. 1 Common. A

[2]National Hardwood Lumber Association grades.

total of 195,838 board feet of red oak and 118,015 board feet of yellow-poplar were inspected at the 18 sample mills (table 1).

For determining moisture content, sample boards were selected from each sample shipment by striking a chalk line diagonally from the upper left to lower right corners of the end of the stacks. Beginning with the top layer, the chalk-marked boards in every other layer were tested with a resistance-type electric moisture meter. Measurements were taken at points in the middle and 1 foot from each end of the boards. The insulated pins were driven to one-third the thickness of the sample board.

Table 1.—*Number of shipments and volume of lumber inspected at different classes of sawmills, by species and thickness*

(In board feet. Numbers in parentheses show number of shipments)

Sawmill size-class	Red oak			Yellow-poplar		
	4/4	5/4	Total	4/4	5/4	Total
Small	68,619 (8)	34,543 (4)	103,162 (12)	33,799 (3)	19,758 (1)	53,557 (4)
Large	69,257 (3)	23,419 (3)	92,676 (6)	37,934 (3)	26,524 (1)	64,458 (4)
Total	137,876 (11)	57,962 (7)	195,838 (18)	71,733 (6)	46,282 (2)	118,015 (8)

Temperature, rainfall, wind speed, and relative humidity data for the study period were collected from U. S. Weather Bureau stations located near the sample mills. To pinpoint extremes that might have unusual effects on drying degrade or moisture-content variation during the study period, these data were compared with the Weather Bureau's normal data.

Descriptive data on yard layout and lumber piling and handling methods were collected for each sawmill lumber yard in order to compare the drying degrade and moisture-content variations that resulted from the different drying practices.

DEGRADE LOSSES IN RED OAK

Volume and Value of Degrade

Of the 195,838 board feet of red oak lumber inspected, 28,982 board feet, or 14.8 percent, were degraded. Degrade losses for red oak averaged $13.95 per thousand board feet, or 9.6 percent of the air-dry lumber value. Losses for individual shipments of red oak ranged from 35 cents per thousand board feet to more than $100 per thousand board feet. A detailed breakdown of degrade losses for red oak by lumber thickness and mill size-class is given in table 2.

Table 2.—*Average air-drying degrade losses for red oak lumber shipments, by lumber thickness and mill size-class*

Sawmill size-class	Average degrade loss per thousand board feet					
	4/4		5/4		Total	
	Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
Small	25.73	18.2	6.11	4.1	19.75	12.5
Large	9.90	7.6	2.96	1.9	8.15	5.9
Aver.	17.78	13.1	4.84	3.2	13.95	9.6

Past research has demonstrated that degrade losses from air-drying 4/4 red oak can be limited to less than 2 percent of lumber value.[3] These results are further substantiated by our study: at half the sample mills, average degrade losses for red oak were only 1.2 percent of lumber value; at the other half, average degrade losses for red oak were 18.8 percent of lumber value. Thus the better commercial air-drying practices are probably adequate for achieving acceptable control of drying degrade losses.

[3]Peck, E. C. AIR-DRYING 4/4 RED OAK IN WISCONSIN. Forest Prod. J. 9 (7): 197-203, illus., 1959.

Both large and small mills experienced significantly less average degrade losses in drying 5/4 red oak than 4/4 red oak (table 2). This is contrary to what might be expected, since the higher degrade losses usually occur in drying the thicker lumber. Observations at the sample mills indicated that the mill personnel recognize this and use greater care in piling and roofing the 5/4 lumber than the 4/4 lumber.

Types and Occurrence of Defects

The four types of seasoning degrade considered in the study were checks, splits, warp, and chemical stain. Table 3 shows the number of boards, volume, and percentage of degrade by each type of drying defect for red oak lumber.

Table 3.—*Amount of degrade for red oak lumber, by type of drying defect*

Type of defect	Boards degraded	Volume degraded	Percent of degraded volume	Percent of total volume
	No.	*Bd. ft.*	*Percent*	*Percent*
Checks	1,989	16,505	57.0	8.5
Splits	556	5,477	18.9	2.8
Warp	496	4,394	15.1	2.2
Stain & other	333	2,606	9.0	1.3
Total	3,374	28,982	100.0	14.8

Checks caused more than half the degrade losses in red oak. They occurred mostly in stacks where roofing was not used. They also occurred where the edges of boards were exposed by bunk spaces in unit-packaged piles. More checks occurred in forklift yards than in dock yards: the wider stack spacing and larger alleys in forklift yards cause faster drying, and frequently increase degrade from checking and splitting. Average degrade losses for forklift yards were $20.00 per thousand board feet as compared with $3.49 per thousand board feet for dock yards (table 4). However, average degrade losses in 4 of 11 red oak shipments from forklift yards were less than $2 per thousand board feet.

Splits were prevalent in stacks that were not roofed. Splits also occurred in stacks where the end-stickers were not flush with the ends of boards, and elsewhere in stacks where board ends were not supported by stickers.

Most warp occurred in stacks where sticker and bunk alignment was poor. Warp also occurred in the top layers of unroofed stacks and between stickers where sticker spacing exceeded 36 inches. Minor amounts of sticker stain occurred where green or wide stickers were used.

Degrade losses for red oak lumber piled in the fall and winter

Table 4.—***Comparative air-drying degrade losses for red oak lumber, by type of yard and mill size-class***

Sawmill size-class	Average degrade loss per thousand board feet			
	Forklift yards		Dock yards	
	Dollars	*Percent*	*Dollars*	*Percent*
Small	42.50	29.3	3.93	2.8
Large	6.50	6.5	.70	.5
Average	20.00	14.2	3.49	2.5

Table 5.—***Air-drying degrade losses for red oak lumber by season of the year***

Season	Average degrade loss per thousand board feet					
	Small sawmills		Large sawmills		All sawmills	
	Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
Spring & summer[1]	5.35	4.1	4.53	2.4	5.18	3.7
Fall & winter[2]	35.50	22.3	8.78	6.7	18.78	13.3

[1]April 1 through September 30.
[2]October 1 through March 31.

averaged $18.78 per thousand board feet, or 13.3 percent of lumber value. Losses for lumber piled in the spring and summer averaged $5.18 per thousand board feet, or 3.7 percent of lumber value (table 5). The fall and winter shipments included lumber piled during October, when weather conditions favored checking and splitting. However, degrade losses for that portion of the fall- and winter-piled lumber that had been roofed averaged only $2.79 per thousand board feet, or 2.3 percent of lumber value.

The repeated wetting and drying of uncovered red oak lumber during the fall and winter months increases checking, the chief type of defect in the species. Although the temperatures are normally much colder during this period of the year, there are enough days of warm sunshine, low relative humidity, and high winds to cause damage to unprotected lumber.

DEGRADE LOSSES IN YELLOW-POPLAR

Volume and Value of Degrade

Of the 118,015 board feet of yellow-poplar inspected, only 654 board feet, or 0.6 percent of the volume, were degraded (table 7). Degrade losses averaged 21 cents per thousand board feet or 0.2 percent of lumber value. Losses for individual shipments ranged from zero to 73 cents per thousand board feet.

The relatively low air-drying degrade losses for yellow-poplar as compared with red oak indicate the relative difficulty in drying the two species. Practices that facilitate rapid drying tend to cause checking, which is a major type of degrade in red oak. On the other hand, rapid drying helps to prevent statin, which is the major cause of degrade in yellow-poplar. All of the sample mills used anti-stain treatment on yellow-poplar during the spring and summer months: otherwise the drying practices for yellow-poplar were the same as those for red oak. The air-drying degrade losses for yellow-poplar are shown in table 6.

Causes and Types of Defects

Stain, the principal type of degrade in yellow-poplar, occurred mostly in sections of yards where drying was retarded. And

Table 6.—*Average air-drying degrade losses for yellow-poplar lumber shipments, by lumber thickness and mill size-class*

Sawmill size-class	Average degrade loss per thousand board feet					
	4/4		5/4		Total	
	Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
Small	0.16	0.1	0.24	0.2	0.19	0.2
Large	.39	.6	.00	.0	.23	.2
Average	0.28	0.3	0.10	0.1	0.21	0.2

Table 7.—*Amount of degrade for yellow-poplar lumber, by type of drying defect*

Type of defect	Boards degraded	Volume degraded	Percent of degraded volume	Percent of total volume
	No.	*Bd. ft.*	*Percent*	*Percent*
Stain	56	323	49.3	0.3
Checks	24	145	22.2	.1
Warp	6	41	6.3	.1
Splits & other	12	145	22.2	.1
Total	98	654	100.0	0.6

Table 8.—*Comparative air-drying degrade losses for yellow-poplar, by type of yard and mill size-class*

Sawmill size-class	Average degrade loss per thousand board feet			
	Forklift yards		Dock yards	
	Dollars	*Percent*	*Dollars*	*Percent*
Small	0.23	0.2	0.14	0.1
Large	.23	.2	—	—
All sawmills	0.23	0.2	0.14	0.1

Table 9.—*Air-drying degrade losses for yellow poplar, by season of year*

Season	Average degrade loss per thousand board feet					
	Small sawmills		Large sawmills		All sawmills	
	Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
Spring & summer	0.23	0.2	0.02	—	0.09	0.1
Fall & winter	.19	.1	.73	0.09	.38	.4

usually it occurred in the lower layers of boards in stacks where ground clearance was less than 1 foot, and in stacks where there was little or no lateral spacing between boards.

Approximately twice as much degrade occurred in the lift-truck yards as in the dock yards (table 8). Degrade losses in yellow-poplar lumber piled in fall and winter were more than four times those of lumber piled in the spring and summer (table 9).

MOISTURE CONTENT OF AIR-DRY MATERIAL

Red Oak

Table 10 shows moisture-content data for 15 of the sample shipments of red oak lumber. The other three shipments of red oak contained some restacked lumber that was unusually dry, so they were not included in the data. Average moisture content in 9 of the 15 shipments was less than 20 percent, in 3 of the shipments from 20 to 23 percent, and in the remaining 3 shipments from 25 to 27 percent.

Moisture-content variation within the individual red oak shipments ranged from 8 to 22 percent. In 8 of 15 shipments it was 11 percent or less, and in 7 other shipments it ranged from 12 to 21 percent. Generally, less variation in moisture content occurred in shipments with low average moisture contents: only 2 of 10 shipments averaging 20 percent or less exceeded 11 per-

Table 10.—*Moisture content data for 15 shipments of red oak lumber*

Sample number	Type of yard	Thickness	Season	Days in stack	Average moisture content	Total moisture content variation
		Inches		*Days*	*Percent*	*Percent*
1	Dock	5/4	Year-round	480	13	11
2	Dock	5/4	Fall-winter	182	21	14
3	Dock	5/4	Fall-winter	99	25	12
4	Dock	4/4	Year-round	458	16	12
5	Dock	4/4	Fall-winter	305	16	9
6	Dock	4/4	Fall-winter	184	20	10
7	Dock	4/4	Fall-winter	181	17	11
8	Forklift	5/4	Spring-Summer	41	27	18
9	Forklift	5/4	Fall-winter	152	18	7
10	Forklift	4/4	Spring-summer	120	15	10
11	Forklift	4/4	Spring-summer	108	17	10
12	Forklift	4/4	Spring-summer	86	15	7
13	Forklift	4/4	Fall-winter	118	18	13
14	Forklift	4/4	Fall-winter	111	25	18
15	Forklift	4/4	Fall-winter	110	26	21

Table 11.—*Moisture-content data for 8 shipments of yellow-poplar*

Sample number	Type of yard	Thickness	Season	Days in stack	Average moisture content	Total moisture content variation
		Inches		*No.*	*Percent*	*Percent*
1	Forklift	5/4	Fall-winter	67	19	31
2	Forklift	4/4	Fall-winter	135-143	13½	10
3	Forklift	4/4	Spring-summer	28	13	16
4	Forklift	4/4	Spring-summer	64	13	10
5	Dock	5/4	Fall-winter	45	16	17
6	Dock	5/4	Fall-winter	33	24	28
7	Dock	4/4	Spring-summer	26	13	17
8	Dock	4/4	Fall-winter	33-48	16	13

cent total variation, whereas all 5 shipments averaging more than 20 percent exceeded 11 percent total variation.

Commercial kiln-drying costs are estimated by the lumber industry at approximately $1.25 per thousand board feet per day. At this rate, the added kiln-drying costs for 4 of the 7 shipments exceeding 11 percent total variation in moisture content would be $1.25 per thousand board feet; and for the other three shipments the added costs would be $2.50 per thousand board feet.

Yellow-Poplar

Table 11 shows a summary of moisture-content data for yellow-poplar. Seven of the 8 shipments of yellow-poplar had average moisture contents of less than 20 percent, and one shipment averaged 24 percent. Moisture-content variation within 2 of 8 individual yellow-poplar shipments was 11 percent or less; in the other 6 shipments it ranged from 13 to 31 percent. The yellow-poplar lumber at or near the equilibrium-moisture-content (EMC) condition had the least total moisture-content variation.

Although there was more total variation in moisture content in yellow-poplar shipments than in red oak shipments, the faster kiln-drying rates for yellow-poplar made this less of an economic factor than for the red oak.

WEATHER CONDITIONS

Weather data were collected for stations near the sample sawmills to see if conditions during the study period varied significantly from normal conditions. Because the most complete data were available for the Charleston, West Virginia, Weather Bureau Station, a thorough evaluation of conditions at this station was made for the calendar year 1963, which included most of the drying period in this study.

From mid-march to early November was found to be the active drying period. During the remainder of the year, temperatures averaged below 50° F. and relative humidity above 65 percent. Although equilibrium-moisture-content under these conditions is often low enough for drying to take place, the temperatures are so low that the drying rate is very slow. While 4/4 red oak in lift-truck yards dried to an average moisture content of less than 20 percent in 90 days during the spring and summer months, 150 to 180 days were required for this amount of drying during the fall and winter months.

Average Charleston monthly temperatures for 1963 were near normal except for August and September when they were, respectively, 4 and 9 degrees above normal.

Total precipitation for the entire year was 30.53 inches as compared with a normal total of 44.43 inches. Precipitation was below normal for all except 2 months of the year, March and November. April had only 1.21 inches and October 0.09 inches of

Table 12.—*Summary of air-drying practices used at 18 sample mills*

Practices	Sawmill size-class					
	Small sawmills		Large sawmills		All sawmills	
Yard system:	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
Forklift	4	40	6	75	10	56
Dock	6	60	2	25	8	44
Pile foundations:						
Adequate ground clearance	4	40	2	25	6	33
Adequate number of vertical supports	5	50	5	62	10	56
Proper alignment	8	80	6	75	14	78
Stickers and bunks:						
Proper number and spacing	5	50	6	75	11	61
Proper alignment	6	60	5	62	11	61
Proper size and quality	6	60	6	75	12	67
Stack roofs:						
Tight portable	0	0	2	25	2	11
Tight shed	1	10	0	0	1	5
Loose boards	6	60	4	50	10	56
None	3	30	2	25	5	28
Yard layout:						
Proper orientation and spacing	9	90	6	75	15	83
Adequate drainage	5	50	7	87	12	67
Adequate vegetation and debris control	3	30	4	50	7	39
Roads well-constructed of suitable material	6	60	6	75	12	67

precipitation, as compared with normal precipitation of 3.68 inches and 2.58 inches, respectively.

During April the average relative humidity at 1:00 p.m. was 38 percent (10 percent below normal), and during October it was 37 percent (15.5 percent below normal). The number of clear and partly cloudy days for the year was near normal; however, in October there were 29 days in this category as compared with a normal of 19. The resulting solar heating conditions and the low relative humidity during October could cause severe checking and splitting in uncovered red oak lumber. Of the sample red oak lumber included in this study, seven shipments were stacked or were drying during October 1963. Four of these were roofed; they averaged $3.38 per thousand board feet in degrade losses. The other three were not roofed; they averaged $15.50 per thousand board feet in degrade losses.

So, while extreme weather conditions can cause extra degrade, most of the effect of these conditions can probably be controlled by proper air-drying practices.

CURRENT PRACTICES

The air-drying practices used at the 18 sample sawmills are summarized in table 12. Ten of the 18 sample mills used forklift yard systems, and three other sample mills converted to forklift systems while the study was in progress. Unfortunately, much of the potential advantage of forklift trucks in lumber handling is being lost through degrade caused by improper use of the trucks at many sawmills (fig. 1). Forklift systems require more yard space per unit of production, better yard roads and drainage, and better lumber piling than the older dock-type yards.

Generally, the yard orientation and spacing of lumber piles was satisfactory. Twelve of the 18 yards had good roads and drainage, but only 6 had adequate vegetation and debris control. Pile foundations were constructed of adequate materials at all yards, but only 4 vertical supports per foundation were used at 8 of the 18 yards. Ground clearance at 12 of the yards averaged less than 12 inches. Sticker and bunk quality was satisfactory at 12 of the

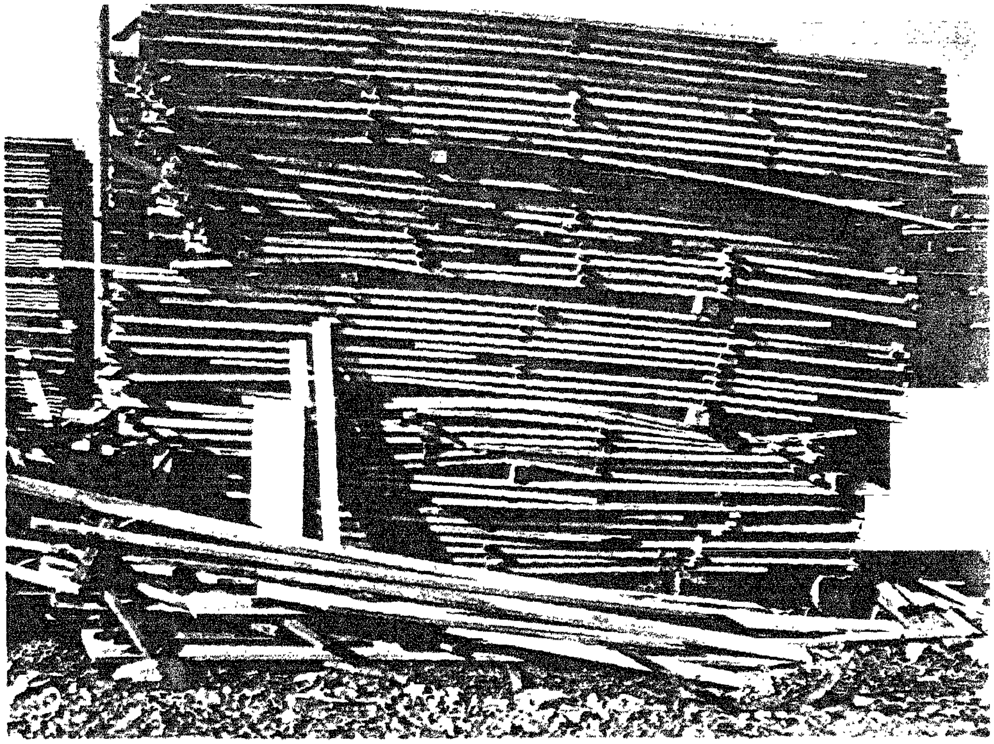

Figure 1.—An example of poor air-drying practices in a forklift-type of drying yard. Much of the lumber in this stack has been degraded by warp, splits, and checks.

yards, and stickers and bunks were properly spaced and aligned at 11 of the yards.

The one major deficiency at most yards was in stack roofing practices. Only 3 of 18 yards used either tight-portable or shed-type stack roofs, and 5 mills used no roofing at all. The loose-boards used for roofs at 10 of the yards did not entirely prevent rain and snow from rewetting the lumber and thus were not so effective as tight-portable or shed roofs. Loose boards are also more expensive to use, because they must be moved by hand labor. However, they are effective as sun shields and are better than no roofing at all.

Most of the improvement needed in air-drying practices could be achieved without significant additional capital expenditures. Rather, better use of existing yard space, materials, and equipment is needed. For example, the 10 mills that use loose boards for roofing lumber stacks could construct tight portable roofs from these boards; the cost of building the roofs would include only labor and nails, which would quickly be offset by savings in degrade losses and handling costs.

SUMMARY

A study of the efficiency of commercial air-drying practices was conducted at 18 randomly selected sawmill lumber yards in the central Appalachian hardwood region. Air-drying degrade losses averaged $13.95 per thousand board feet for red oak, and 21 cents per thousand board feet for yellow-poplar. Degrade losses were within acceptable limits for all sample shipments of yellow-poplar; but losses in half the sample red oak shipments were excessive.

Greater degrade losses occurred at the smaller sawmills than at the larger ones, at forklift-type yards than at dock-type yards, and in fall- and winter-stacked lumber than in spring- and summer-stacked lumber. Less drying degrade occurred in 5/4 lumber than in 4/4 lumber.

The chief types of defects in red oak were checks and splits, and in yellow-poplar, stain and warp. Checks in red oak occurred mostly in stacks where roofing was inadequate, and near the edges of boards adjacent to bunk spaces; splits occurred in unroofed stacks and in stacks where too few stickers were used. Stain in yellow-poplar occurred mostly in the bottom layers of stacks that had inadequate ground clearance.

Variation in moisture content within individual shipments exceeded 11 percent in 7 of 15 shipments of red oak and in 6 of 8 shipments of yellow-poplar. Time of year or type of yard seemed to have little relationship to variation in moisture content in either species. Lumber of both species at or near the equilibrium-moisture-content condition had the least variation in moisture content.

Weather conditions during the study period were near normal except for total annual rainfall, which was 13.9 inches below normal for the year, and for average relative humidity, which was 10.0 percent and 15.5 percent below normal during April and October respectively. These conditions probably contributed significantly to the degrade in red oak.

RECOMMENDATIONS

Many of the sawmills in the central Appalachian region could increase their *net* income from red oak lumber by $10 or more per thousand board feet by improving their air-drying practices. At the same time they could help make finished wood products more competitive because air-dried lumber that contains minimum degrade and relatively uniform moisture content costs less to kiln-dry and remanufacture (fig. 2).

Special precautions should be taken in drying red oak in forklift yards. The forklift yards are more open than dock yards, and the resulting exposure causes faster drying and more checking and splitting, the chief types of degrade in red oak. The essential practices for air-drying red oak with minimum degrade losses in the central Appalachian region are:

1. Pile foundations should have at least 5 vertical supporting members per 16 feet of length, and the minimum ground clearance should be 12 inches.
2. Lumber should be box-piled or sorted by lengths for drying, and end stickers should be flush with the ends of boards.
3. Stickers should be of uniform thickness, 1½ to 2 inches wide, and should be dried below 20 percent moisture content before use; except for the lower grades of lumber, stickers should be spaced on 24-inch centers.
4. Both stickers and bunks should be aligned vertically over the pile foundation members. Blank spaces in the packages should be blocked with small trim-ends to prevent sticker damage and warped lumber.
5. The No. 3A Common and Better grades should be covered with tight stack-roofs; this should be done immediately after

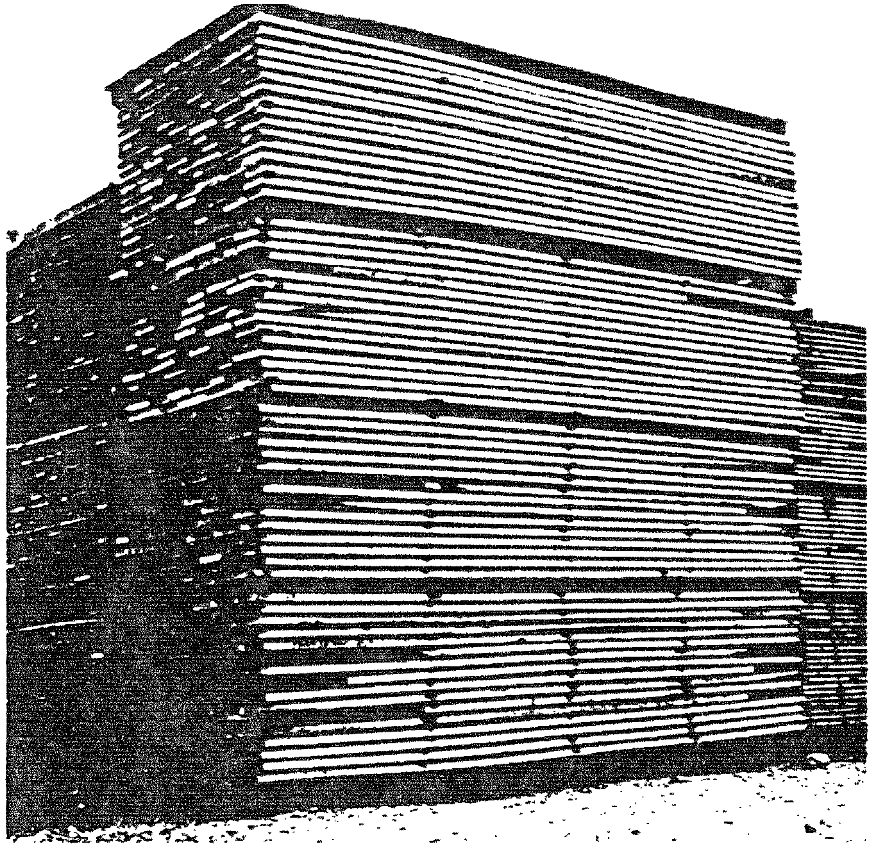

Figure 2.—An example of good air-drying practices in a forklift-type drying yard. Note the sticker and bunk alignment, portable stack-roof, and absence of vegetation or debris around the lumber stack.

the lumber is placed in the yard because serious checking may occur within 24 hours on warm dry days.

6. The yard surface should be kept free of weeds and debris; it should also be well-drained, and alleys should be paved with crushed stone or other suitable material.

7. The No. 1 Common and Better grades should be placed in the more protected areas of the lumberyard. In yards where rapid drying conditions exist, lumber stacks should be oriented with the boards parallel to the prevailing wind. Six and eight-quarter lumber should be end-coated, or the ends of the stacks should be covered with paper or cull boards.

Items 1 to 6 above apply equally to drying yellow-poplar in all thicknesses. However, to prevent stain, yellow-poplar should be placed in those yard areas where rapid drying will take place. In yards where drying is normally slow, the minimum ground clearance for lumber in stacks should be increased to 20 inches or more.

Chemical anti-stain treatment should be used for yellow-poplar from May through September. Several commercial brands are available, and all are effective when used according to the manufacturer's directions. Personnel handling treated lumber should wear long-sleeved shirts, gloves, and goggles (or glasses) because the chemical solutions are irritating to the skin and eyes.

Individual sawmill operators should determine the extent of air-drying degrade in their lumberyards at regular intervals in order to pinpoint the drying practices that need improvement. U. S. Forest Service Research Note NE-32[4] provides instructions for doing this.

[4]Cuppett, D. G. How to determine seasoning degrade losses in sawmill lumber yards. U. S. Forest Serv. Res. Note NE-32, 7 pp., illus., 1965. NE. Forest Exp. Sta., Upper Darby, Pa.

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