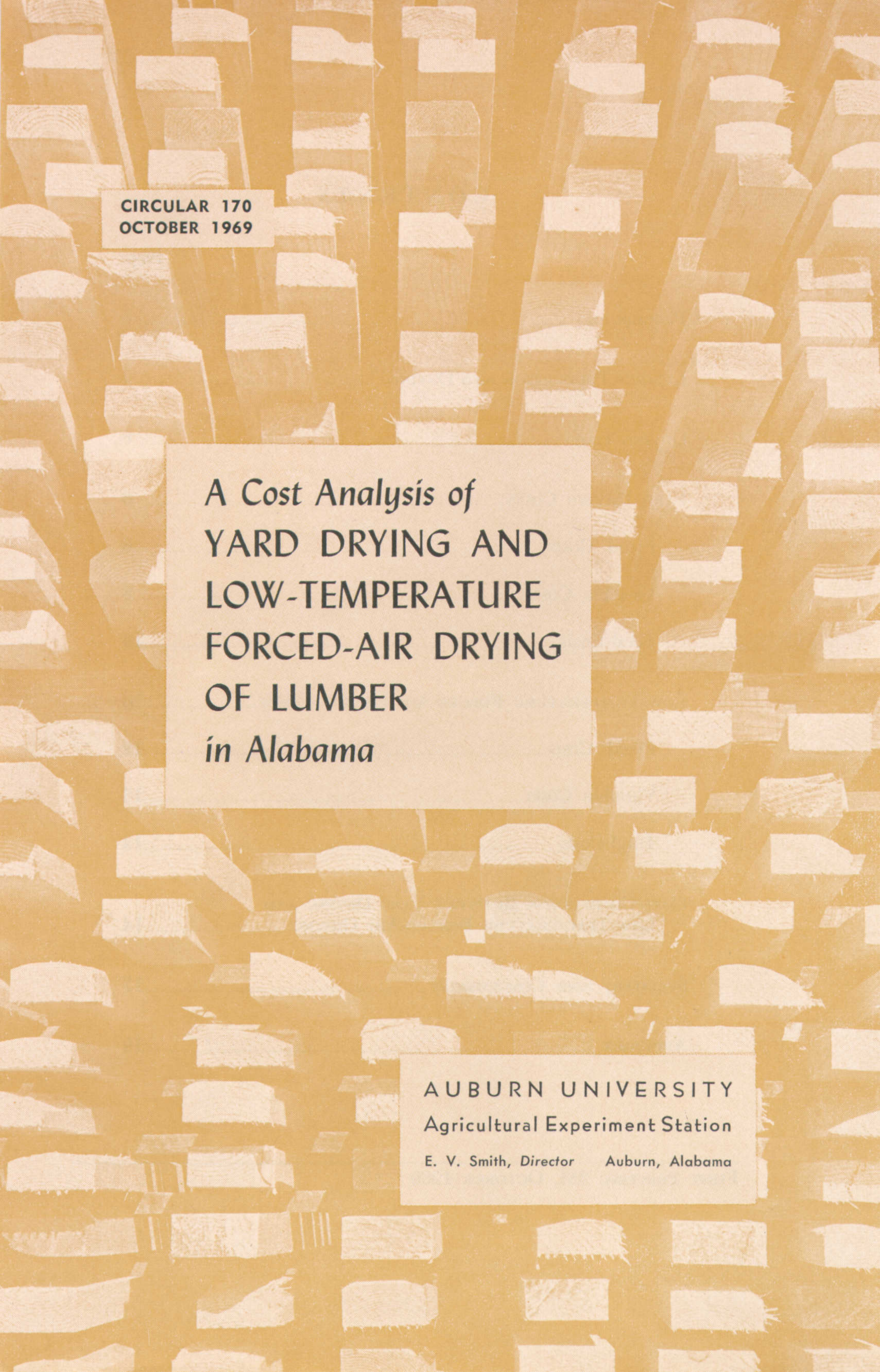

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A Cost Analysis of YARD DRYING AND LOW-TEMPERATURE FORCED-AIR DRYING OF LUMBER *in Alabama*

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A Cost Analysis of
YARD DRYING AND LOW-TEMPERATURE FORCED-AIR DRYING OF LUMBER
*in Alabama**

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TRENDS IN FURNITURE fashions and increased competition from lumber substitutes have caused lumbermen to evaluate seriously the market position of their product. In response to these developments, lumbermen are trying to improve product quality and reduce production cost. Seasoning is a costly step in lumber production, and this is believed to afford cost reduction alternatives.[1]

During the past decade, a new technique of drying has emerged. Referred to as low-temperature forced-air drying, it is capable of producing drying results comparable to those obtained by conventional yard drying. Since cost information concerning use of forced-air dryers and yard drying is limited, selection of a seasoning method is a difficult management decision.

The objectives of this Auburn University Agricultural Experiment Station study were to (1) describe methods used by mill operators in yard and low-temperature forced-air drying of lumber, and (2) develop cost functions and make cost comparisons of these drying methods.

PROCEDURE

Drying time varies among species and thicknesses of lumber. To simplify the method of analysis and yet arrive at meaningful

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* The research project on which this report is based was financed by funds of Alabama Project No. 1-040.

** Resigned.

[1] RUCKER, TINSLEY W. AND WALTON R. SMITH. 1961. Forced Air Drying of Lumber, Research and Experimental. Forest Products Journal. XI:390-391.

results, one species and one thickness of wood—1-inch yellow poplar (*Liriodendron tulipifera*)—were selected for study.

Determination of methods of drying was developed on the basis of personal interviews with lumber mill operators and observations of drying processes at firm locations.

Nine yard drying firms were selected at random from the 1966-67 Alabama Forest Products Directory. Cost information was obtained by use of a questionnaire and from records of the firms selected.

Only one low-temperature forced-air dryer was available for study in Alabama. Additional cost information concerning forced-air dryers was supplied by a manufacturer.

Cost functions for drying 1-inch yellow poplar by conventional yard drying and low-temperature forced-air drying were obtained by determining the volume of output and from physical inputs and cost rates determined from each firm.

LUMBER PRODUCTION AND DRYING

Once a tree in the forest is cut, the lumber manufacturing process begins. After logs are cut, they are transported to a sawmill and stacked on the log yard where they generally stay only a few days. In some cases, however, production needs and wood characteristics may require logs to be continuously wetted with water and kept for a longer period.

Eventually the logs are rolled or carried to the log deck of the sawmill. The logs are debarked and sawed, and the lumber is dropped into a stain preventive chemical vat. Lumber is removed from the vat by the green chain. (Referred to as a green chain since it transports green lumber.) The green chain is constructed of two parallel, power driven chains. As the lumber is moved along the green chain, the various thicknesses and lengths are separated and stacked by men stationed on both sides of the chain.

Stacks are then carried by fork lift trucks to a central stacking point near the green chain. Men stacking lumber place small sticks (called stickers), approximately 1-inch square, between alternate layers of lumber. Once the stickers have been placed between the layers of lumber, the stack is ready to be dried either in a conventional dry kiln, a forced-air dryer, or placed on a drying yard. If green lumber from the saw is placed directly into a conventional dry kiln the moisture content may be reduced below 10 per cent in approximately 10 days. Hardwood lumber may then be put to its final use without concern for further shrinking and swelling.

Drying green lumber in a dry kiln is a costly operation. Most lumber manufacturers place green lumber on a drying yard or in some type of forced-air drying system. Once the moisture content reaches approximately 25 per cent, lumber is placed in a conventional dry kiln. Or, it may be used or sold as well air-dried lumber.

In this study the assumption was made that lumber would be put into the kiln only when moisture content had been reduced to

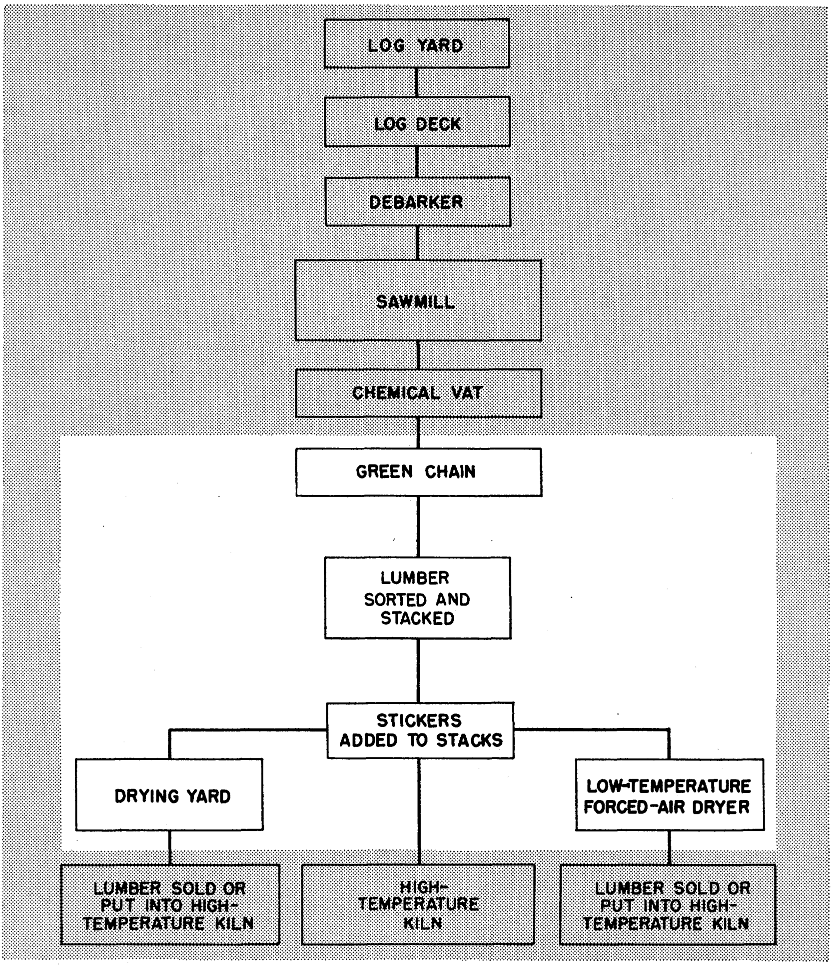


FIG. 1. In this flow diagram for lumber manufacturing, the non-shaded section indicates the segment of the manufacturing process studied for cost analysis.

approximately 25 per cent. The drying process was considered to begin as the lumber was moved along the green chain and to end when it was removed from the drying yard or forced-air dryer. Cost information was obtained from activities associated with the drying of lumber from the green chain until final removal from the drying yard or forced-air dryer, Figure 1.

DRYING TIME

The time required to air dry lumber is dependent on outside climatic conditions as well as air drying practices of the lumber manufacturer. Outside climate is beyond control of the lumberman, so he cannot speed the drying process relative to these conditions. Ideal drying conditions usually persist only during late spring, summer, and early fall.

Variations in precipitation, temperature, and relative humidity were examined for four Alabama cities: Huntsville, Birmingham, Montgomery, and Mobile. For comparison purposes, climatic factors were converted into wood equilibrium moisture content values for the respective cities, Appendix Table 1.

When the moisture content of lumber is between 10 and 20 per cent, a normal range for construction use, variations within this range are not considered significant. The most extreme variation in equilibrium moisture content was 4.2 per cent; therefore, air drying firms in Alabama were considered to experience the same climatic conditions, and cost items relating to drying time were computed for firms as a group.

YARD DRYING COSTS

Factors affecting costs were examined for each of the nine yard drying firms. For purposes of analysis, costs were grouped into fixed, variable, and total costs.

Fixed Costs

Fixed costs were defined as costs that continued even when the firm was not producing. Fixed costs at each of the nine yard drying firms were considered to be comprised of depreciation, interest on investment, insurance, and property tax.

Depreciation was calculated using the straight line method. A 6 per cent interest rate was charged on average capital invested. (Original value, salvage value, and length of life are shown in Appendix Table 2 for each item subject to depreciation and in-

TABLE 1. ANNUAL FIXED COSTS AND PER CENT OF AVERAGE TOTAL COSTS FOR NINE YARD DRYING FIRMS, ALABAMA, 1968

Firm number	Fixed cost items									Av. fixed cost per 1,000 bd. ft.	
	Depreciation			Interest on investment		Insurance		Property tax			
	Amount	Pile foundations[1]	Pct. of av. total	Amount	Pct. of av. total	Amount	Pct. of av. total	Amount	Pct. of av. total	Amount	Pct. of av. total
	Dol.	*Dol.*	*Pct.*	*Dol.*	*Pct.*	*Dol.*	*Pct.*	*Dol.*	*Pct.*	*Dol.*	*Pct.*
1	2,600	.11	9.5	645	2.1	859	2.8	91	.3	1.79	14.7
2	4,000	.27	9.7	1,296	2.5	3,351	6.4	180	.3	2.47	18.9
3	3,500	.11	4.9	1,432	1.7	5,547	6.5	200	.2	1.89	13.3
4	6,750	.27	5.9	3,077	1.8	12,625	7.5	474	.3	2.18	15.5
5	5,625	.27	6.3	1,562	1.1	9,694	6.9	198	.1	1.69	14.4
6	6,000	.16	3.9	1,867	.9	19,314	9.1	267	.1	1.98	14.0
7	8,000	.23	5.0	2,894	1.2	23,600	9.6	203	.1	2.16	15.9
8	7,000	.11	3.3	2,093	.8	27,570	9.9	211	.1	1.95	14.1
9	8,000	.11	3.5	3,649	1.2	27,583	9.2	766	.3	1.93	14.2

[1] Annual fixed cost of depreciation for each firm, shown in the first column, excludes depreciation of pile foundations. Depreciation of pile foundations, shown separately, was calculated on the basis of cost per 1,000 board feet.

terest charges.) Insurance rates for lumber held in inventory and machinery and equipment were estimated by the Alabama Inspection and Rating Bureau. Property taxes were estimated from appropriate state, county, and city millage rates.

Fixed costs accounted for an average of 15 per cent of total cost, and firm averages ranged from $1.69 to $2.47 per 1,000 board feet, Table 1.

Insurance was the largest single fixed cost item for seven firms and depreciation was highest for two firms.

Variable Costs

Variable costs were defined as costs that vary with output of the firm. For air drying firms, these were carrying charge for inventory, labor, stickers, maintenance and supplies, degrade, social security tax, workmen's compensation, and unemployment compensation. Average variable costs per 1,000 board feet ranged from $10.09 to $12.28, Table 2.

Value of inventory was based on Grade No. 1 Common yellow poplar, $157 per 1,000 board feet, since actual grade distributions for each firm were not known. A 6 per cent interest rate was charged on value of average inventory, and this was the largest cost item for five firms.

All lumber yard employees worked a 40-hour week and were paid an hourly wage. Labor was the largest expense item for three firms.

Number of stickers used to separate adjacent layers of lumber depends on thickness and length of lumber in the pile, and spacing between stickers. To determine total number used by a firm, the percentage of annual output in each thickness and length category must be known. Mill operators were unable to give this information; therefore, cost of stickers per 1,000 board feet of 1-inch lumber dried was estimated for 2-foot and 4-foot spacing of stickers.

At 8 cents per sticker, cost per 1,000 board feet for firms using 2-foot spacings was $1.90. Cost for the one using 4-foot spacing (Firm No. 2) was $1.09 per 1,000 board feet.[2]

Actual cost for maintenance and supplies was available from records of three firms, and mill managers estimated cost to the

[2] No degrade values were obtained from Firm 2; therefore, the effect of increased distance between stickers on degrade could not be determined. Four-foot spacings may lead to increased warping and higher degrade than 2-foot spacing.

TABLE 2. ANNUAL VARIABLE COSTS AND PER CENT OF AVERAGE TOTAL COSTS FOR NINE YARD DRYING FIRMS, ALABAMA, 1968

Firm number	Cost measure	Variable cost items								Var. cost per 1,000 bd. ft., av.
		Carry. chg. for invt.	Labor	Stickers[1]	Maint. and sup.	Degrade[1]	Social sec.	Work. comp.	Unemply. comp.	
1	Dollars	2,826	8,750	1.90	1,200	2.92	420	174	271	10.28
	Pct. of av. cost	9.4	29.0	15.8	4.0	24.2	1.4	.6	.9	85.3
2	Dollars	11,304	12,225	1.09	1,830	2.92	587	238	349	10.64
	Pct. of av. cost	21.5	23.3	8.3	3.5	22.3	1.1	.4	.7	81.1
3	Dollars	18,840	21,400	1.90	2,440	2.92	1,027	409	604	12.28
	Pct. of av. cost	22.2	25.2	13.4	2.9	20.6	1.2	.5	.7	86.7
4	Dollars	42,955	33,600	1.90	4,975	2.92	1,613	625	930	11.88
	Pct. of av. cost	25.4	19.9	13.5	2.9	20.8	1.0	.4	.6	84.5
5	Dollars	32,970	25,000	1.90	3,000	2.92	1,200	476	651	10.09
	Pct. of av. cost	23.3	17.7	16.1	2.1	24.8	.8	.3	.5	85.6
6	Dollars	65,940	34.350	1.90	7,500	2.92	1,649	639	976	12.23
	Pct. of av. cost	30.9	16.1	13.4	3.5	20.5	.8	.3	.5	86.0
7	Dollars	80,541	29,600	1.90	6,230	2.92	1,421	551	837	11.44
	Pct. of av. cost	32.9	12.1	14.0	2.5	21.5	.6	.2	.3	84.1
8	Dollars	94,200	37,550	1.90	6,860	2.92	1,802	698	1,070	11.93
	Pct. of av. cost	33.9	13.5	13.7	2.5	21.0	.6	.3	.4	85.9
9	Dollars	94,200	44,000	1.90	7,330	2.92	2,112	818	1,302	11.62
	Pct. of av. cost	31.6	14.8	14.0	2.5	21.5	.7	.3	.4	85.8

[1] Cost per 1,000 board feet.

other six. Items included in this cost category were gas, oil, tires, and repair parts.

Value of degrade losses was determined by "double-grading" as described by Cuppett.[3] Degrade information concerning 1-inch yellow poplar was available from only three firms. The average degrade loss, $2.92 per 1,000 board feet, occurred while drying 1-inch yellow poplar during May, June, and July. Average final moisture content was 14.7 per cent and drying time averaged 42.7 days. All firms were considered to experience the same degrade loss rate. Degrade loss was the largest expense item for Firm 5.

Mill operators were unable to give the exact cost of social security, workmen's compensation, and unemployment compensation for employees engaged in yard drying activities. These costs were estimated by determination of number of employees involved and from appropriate rate schedules.

Total Costs

Total costs were defined as the sum of fixed and variable costs. For comparison purposes, total annual costs were divided by annual output to derive average total cost per 1,000 board feet. Average total cost, shown below, ranged from $11.78 to $14.21 for the nine yard drying firms studied.

Firm	*Annual output, million bd. ft.*	*Av. cost per 1,000 bd. ft., dollars*
1	2.5	12.07
2	4.0	13.11
3	6.0	14.17
4	12.0	14.06
5	12.0	11.78
6	15.0	14.21
7	18.0	13.60
8	20.0	13.88
9	22.0	13.55

LOW-TEMPERATURE FORCED-AIR DRYING COSTS

Costs for drying 1-inch yellow poplar in low-temperature forced-air dryers were estimated for three levels of annual output, 4, 12, and 20 million board feet. Cost rates for some inputs were estimated from mutual cost items for yard drying. Additional cost information was obtained for a local low-temperature dryer, from previously published reports, and from a manufacturer of

[3] Cuppett, Donald G. 1965. How to Determine Seasoning Degrade Losses in Sawmill Lumberyards. U.S. Forest Research Note NE-32, pp. 1-5.

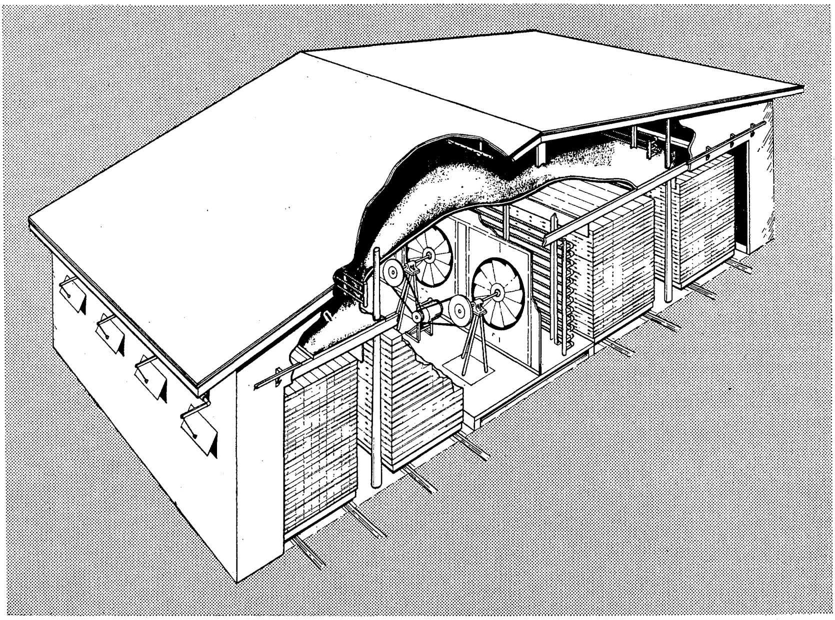


FIG. 2. This diagram shows details of a low-temperature forced-air dryer. (Used with permission of Moore Dry Kiln Co.)

forced-air drying equipment. All costs were divided into fixed, variable, and total.

The low-temperature dryers considered in the study had a kiln truck or track handling system. Each dryer building was relatively short in depth, having four or six tracks with a capacity of three stacked loads per track, Figure 2. Dryers were operated on a continuous basis, unloading and loading one track at a time as the lumber on that track reached the desired moisture content.

The building was pole shed construction with truss roof supports. Exterior surfaces were sheathed with two layers of one-inch tongue and groove lumber and covered with aluminum siding. To further insulate the building, each layer of lumber was well-painted and roofing paper added between layers.

Each dryer was equipped with a master recorder-controller to ensure temperature and humidity uniformity. The master recorder-controller was connected to overhead and center heating coils to automatically produce temperatures ranging from 90 to 120 degrees Fahrenheit. A humidity sprayer and vent flaps were automatically controlled to maintain an equilibrium moisture content of 10 to 20 per cent.

TABLE 3. SIZE, CAPACITY, AND NUMBER OF DRYERS REQUIRED FOR THREE LEVELS OF ANNUAL OUTPUT, LOW-TEMPERATURE FORCED-AIR DRYERS, 1968[1]

Annual output, million bd. ft.	Size of dryers length and width	Capacity of dryer	Dryers required
		Thousand bd. ft.	*No.*
4	52′ × 58′	72	1
12	52′ × 76′	108	2
20	52′ × 76′	108	3

[1] Information was supplied by Moore Dry Kiln Company.

Six fans, 72 inches in diameter with 10 blades per fan, were used to produce wind velocities of 550 to 600 cubic feet per minute. Each fan was equipped to reverse wind direction at 6-hour intervals. Three 10-horsepower motors were used to drive the six fans in each dryer.

With these conditions the local forced-air dryer dried 1-inch yellow poplar (50 per cent sapwood) from a green condition to approximately 25 per cent moisture content in 6 days. Dryers considered in the study were assumed to have a 6-day drying schedule and to dry 58 charges per year. Table 3 shows size, capacity, and number of dryers used for each volume of annual output.

Fixed Costs

Fixed cost items for low-temperature drying operations were depreciation, interest on investment, insurance, and property taxes. (Original value, salvage value, and useful life for items subject to depreciation and interest charges are shown in Appendix Table 2.) Average fixed costs ranged from $1.33 per 1,000 board feet for the 4 million board feet volume to $1.82 when annual volume was 20 million board feet, and accounted for an average of 14.8 per cent of total cost, Table 4.

TABLE 4. FIXED COSTS AND PER CENT OF AVERAGE TOTAL COSTS FOR THREE LEVELS OF ANNUAL OUTPUT, LOW-TEMPERATURE FORCED-AIR DRYERS, ALABAMA, 1968

Cost item	4 million bd. ft.		12 million bd. ft.		20 million bd. ft.	
	Total	Pct. of av. cost	Total	Pct. of av. cost	Total	Pct. of av. cost
	Dol.	*Pct.*	*Dol.*	*Pct.*	*Dol.*	*Pct.*
Depreciation	2,365	4.0	5,596	4.7	7,912	4.8
Interest on investment	1,179	2.0	2,925	2.5	4,299	2.6
Insurance	2,885	4.9	7,970	6.8	11,377	6.9
Property tax	845	1.4	2,100	1.8	3,081	1.9
Av. per 1,000 bd. ft.	*1.82*	*12.3*	*1.55*	*15.8*	*1.33*	*16.2*

Insurance covering buildings and equipment, inventory, and lift trucks was the largest single fixed cost item for all volumes of output. These costs were estimated from rates supplied by the Alabama Inspection and Rating Bureau, assuming all firms were located in a Class Seven fire protection rate zone. Rates were determined on the basis of a frame building with an operator or watchman present 24 hours a day.

Variable Costs

Variable costs for low-temperature forced-air drying operations were composed of carrying charge for inventory, labor, heat, electricity, maintenance, stickers and supplies, degrade, social security, and workmen's and unemployment compensation.

Over the range of the derived cost curve, average variable cost ranged from $6.87 to $12.95 per 1,000 board feet, with labor as the highest item, Table 5. Number of laborers used in the stacking operation for low-temperature drying operations was calculated from the average daily stacking capacity per man determined from yard drying. These men were assumed to be paid the minimum hourly wage, $1.60, and work a 40-hour week. A total of 168 man-hours per week was assumed to be required for a kiln operator. A wage rate of $2.50 per man-hour was assigned this employee.

Costs for heat, electricity, and maintenance and supplies were

TABLE 5. VARIABLE COSTS AND PER CENT OF AVERAGE TOTAL COSTS FOR THREE LEVELS OF ANNUAL OUTPUT, LOW-TEMPERATURE FORCED-AIR DRYERS, ALABAMA, 1968

Cost item	4 million bd. ft.		12 million bd. ft.		20 million bd. ft.	
	Total	Pct. of av. cost	Total	Pct. of av. cost	Total	Pct. of av. cost
	Dol.	*Pct.*	*Dol.*	*Pct.*	*Dol.*	*Pct.*
Carrying charge for inventory	1,356	2.3	4,069	3.5	6,104	3.7
Labor	28,400	48.1	39,000	33.1	45,900	28.0
Heat	7,327	12.4	19,576	16.6	28,274	17.2
Electricity	2,655	4.5	5,310	4.5	7,965	4.9
Stickers[1]	1.90	12.9	1.90	19.4	1.90	23.2
Maintenance and supplies	2,067	3.5	4,934	4.2	7,042	4.3
Degrade[2]	0	0	0	0	0	0
Social security tax	1,363	2.3	1,872	1.6	2,203	1.4
Workmen's compensation	528	.9	725	.6	854	.5
Unemployment compensation	496	.8	806	.7	1,008	.6
Av. per 1,000 bd. ft.	*12.95*	*87.7*	*8.26*	*84.2*	*6.87*	*83.8*

[1] Cost per 1,000 board feet.
[2] No degrade cost was assigned to low-temperature drying firms.

estimated by Moore Dry Kiln Company and from local utility rates. Heat required to produce temperatures stated earlier was estimated as 25 B.T.U. per hour per board foot of holding capacity. Electrical energy consumption was rated as 1,800 K.W.H. per month per dryer. Annual cost of maintenance and supplies was estimated as 5 per cent of investment cost.

Vick[4] obtained degrade information for 1-inch yellow poplar at various temperatures and EMC values. His research showed yellow poplar can be dried from the green condition to approximately 25 per cent moisture content at temperatures of 120 degrees and EMC of 14 per cent in 6 days with no degrade.

Since dryers considered in this study were operating within these limits, no degrade cost was assigned to volume units 1, 2, and 3.

Total Costs

Average total cost for drying 1-inch yellow poplar by low-temperature forced-air dryers was $14.77 per 1,000 board feet for 4 million board feet volume, $9.81 for 12 million, and $8.20 for 20 million board feet volume.

Fixed cost decreases with volume as this cost is spread over more units of output. Average fixed cost for low-temperature drying firms did not decrease as rapidly as average variable cost; therefore, the percentage of total cost accounted for by fixed cost increased as volume increased.

The decrease in average variable cost relating to total cost mainly resulted from labor economies. Each volume unit required the use of a kiln operator at all times. Three kiln operators working 8-hour shifts were assumed for each firm. Expanding annual output from 4 to 20 million board feet did not require additional kiln operators. Cost items associated with labor, social security, workmen's compensation, and unemployment compensation also decreased and contributed to lower average variable cost relative to total cost. As a percentage of total cost, items unrelated to labor increased as volume increased.

COST COMPARISON BETWEEN YARD DRYING AND LOW-TEMPERATURE FORCED-AIR DRYING

When costs for both types of drying were compared, savings were shown at higher outputs by use of low-temperature forced-

[4] VICK, C. B. 1965. Drying-Rate Curves for One-Inch Yellow Poplar Lumber in Low-Temperature Forced-Air Dryers. Forest Products Journal. XV12:500-504.

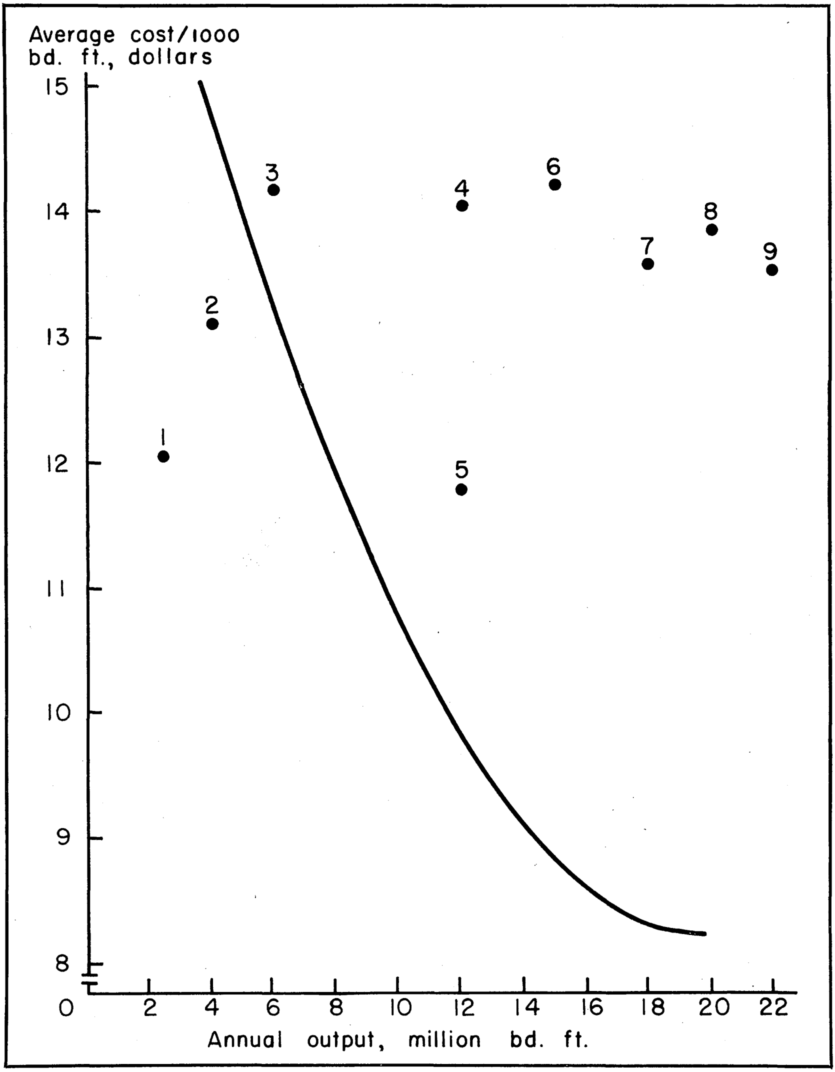


FIG. 3. Shown here for the Alabama firms in 1968 is the average cost for nine yard drying lumber firms, along with an average cost curve for low-temperature forced-air drying, on the basis of annual volume of lumber dried.

air dryers. Since only three forced-air drying outputs were considered, an average cost curve (represented by equation $Yc = 18.486 - 1.035X + .026X^2$, with a standard error of estimate $\pm$ \$0.13) was developed to compare with yard drying outputs, Figure 3. Cost for each yard drying firm was compared to the estimated cost of low-temperature forced-air drying. Lower cost

Table 6. Lower Cost Method and Amount of Savings for Drying One-Inch Yellow Poplar, Alabama, 1968

Firm	Yard drying: Annual output, million bd. ft.	Yard drying: Av. cost per 1,000 bd. ft.	Forced-air drying cost per 1,000 bd. ft.	Lower cost method	Savings per 1,000 bd. ft.
		Dol.	*Dol.*		*Dol.*
1	2.5	12.07	15.60	Y.D.	3.53
2	4.0	13.11	14.77	Y.D.	1.66
3	6.0	14.17	13.22	F.A.D.	.95
4	12.0	14.06	9.83	F.A.D.	4.23
5	12.0	11.78	9.83	F.A.D.	1.95
6	15.0	14.21	8.83	F.A.D.	5.38
7	18.0	13.60	8.27	F.A.D.	5.33
8	20.0	13.88	8.20	F.A.D.	5.68
9	22.0	13.55	8.20	F.A.D.	5.35

methods and amount of savings are shown in Table 6. (The derived cost curve for low-temperature forced-air drying extended to only 20 million board feet; therefore, cost for Firm 9, operating at 22 million board feet, was compared to the 20 million volume for forced-air drying.)

The annual output at which low-temperature forced-air drying becomes more economical could not be stated in exact terms because of varying costs among yard drying firms. However, a range for the intersection of cost for the two methods can be stated. A second degree curve fitted to cost data from all nine yard drying firms would show low-temperature forced-air drying more economical for annual outputs exceeding approximately 7 million board feet.

Most of the variation in costs occurred with Firms 1, 2, and 5 and may have been the result of errors in estimates by mill managers for particular cost items. When Firms 1, 2, and 5 were excluded, and a second degree curve[5] fitted to the remaining data, forced-air drying was more economical for annual outputs exceeding 5 million board feet. However, this second degree curve resulted in an atypical average cost curve. At low output this curve showed increasing costs that reached a maximum at 8 million board feet, then declined with further volume increases.

A second degree curve[6], exclusive of only Firm 5, showed forced-air drying to be more economical above 6 million board feet. This curve was similar to the one described above. Costs

[5] This curve was represented by equation $Yc = 13.975 + .046X - .003X^2$ with a standard error of estimate $\pm$ \$0.29.

[6] This curve was represented by equation $Yc = 11.715 + .369X - .013X^2$ with a standard error of estimate $\pm$ \$0.61.

first increased with volume, reached a maximum, then declined with further increases in volume.

Thus, the range of intersection for the two cost functions was between 5 and 7 million board feet, with low-temperature forced-air drying being more economical above this range and yard drying more economical below the range. As volume increased beyond the intersection point of the two cost curves, amount of savings increased.

SUMMARY AND CONCLUSIONS

Over the range of the derived cost curve for low-temperature forced-air drying, average cost varied from $8.20 to $15.60; mean average cost was $13.36. Average cost for yard drying ranged from $11.78 to $14.21, with mean average of $13.38.

When costs for both types of drying were considered, low-temperature forced-air drying was more economical for firms with annual outputs above 5-7 million board feet. At this volume level, yard drying costs ranged from $0.95 to $5.68 per 1,000 board feet higher than cost of low-temperature forced-air drying. For firms with lower annual outputs, yard drying costs were $1.66 to $3.53 per 1,000 board feet less than for forced-air drying.

On the basis of these data, low-temperature forced-air drying can be an economical method for drying 1-inch yellow poplar or similar thicknesses and species provided annual output exceeds 5-7 million board feet.

In view of the variation in yard drying costs, additional research is needed before these results can be considered conclusive. Further research is needed since data from the Alabama Forest Products Directory (1967-68) shows 24 of the 395 members of the Alabama Forests Products Association have annual outputs within the range of intersection for the two cost curves. These 24 mills produce approximately 20 per cent of the total lumber volume manufactured in the State. Ninety-five members have annual outputs exceeding 10 million board feet, and these produce approximately 70 per cent of the state's total volume of lumber.

On the basis of observations at yard drying firms, mill managers should be concerned with reducing cost of yard drying before considering investment in low-temperature forced-air dryers. Some yard drying firms could substantially reduce drying cost by improving factors relating to yard organization. Proper yard drainage, level transportation alleys, eradication of weeds, and properly stacked lumber are factors that could lead to savings.

APPENDIX

APPENDIX TABLE 1. MEAN MONTHLY WOOD EQUILIBRIUM MOISTURE CONTENT VALUES AT HUNTSVILLE, BIRMINGHAM, MONTGOMERY, AND MOBILE[1]

Month	Moisture content, by location			
	Huntsville	Birmingham	Montgomery	Mobile
	Per cent	*Per cent*	*Per cent*	*Per cent*
January	13.7	13.7	13.3	13.4
February	13.7	12.7	12.7	12.2
March	11.5	12.2	12.2	12.7
April	11.6	12.1	13.3	13.7
May	11.6	12.5	13.7	14.0
June	12.3	12.8	13.8	14.9
July	13.2	13.4	15.5	15.7
August	13.2	13.2	15.5	15.5
September	12.9	13.5	14.9	14.3
October	13.3	13.8	14.4	12.5
November	12.7	13.4	14.0	13.9
December	13.7	14.0	14.4	14.2

[1] Means were established during the following periods: Huntsville 1959-66, Birmingham 1942-64, Montgomery 1964-67, and Mobile 1963-64.

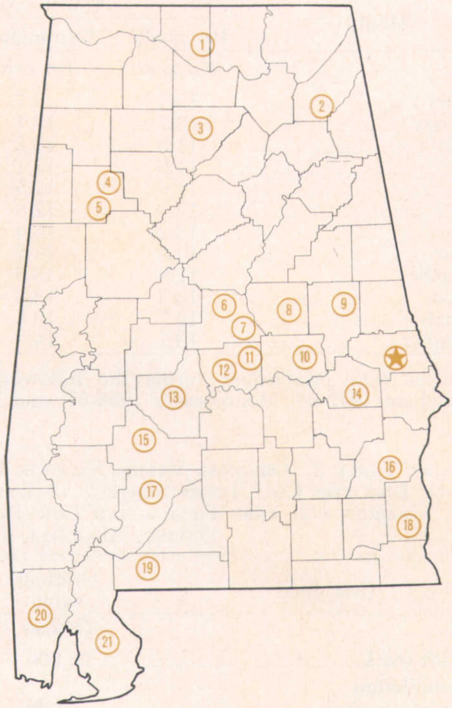
APPENDIX TABLE 2. ORIGINAL VALUE, SALVAGE VALUE, AND ESTIMATED LENGTH OF LIFE FOR COST ITEMS SUBJECT TO DEPRECIATION AND INTEREST CHARGES FOR YARD DRYING AND LOW-TEMPERATURE FORCED-AIR DRYING, ALABAMA, 1968

Cost item	Original value	Salvage value	Useful life
	Dollars	*Dollars*	*Years*
Fork lift truck	20,000[1]	4,000	4
Pile foundation			
Concrete members	3.48[1]	0	20
Treated timber members	16.32[1]	0	8
Untreated timber members	15.96[1]	0	3
Forced-air drying building[2]			
4 million bd. ft.	15,000	0	15
12 million bd. ft.	40,000	0	15
20 million bd. ft.	60,000	0	15
Environmental control equipment[2]			
4 million bd. ft.	10,000	5,000	15
12 million bd. ft.	24,000	12,000	15
20 million bd. ft.	36,000	18,000	15
Kiln trucks and tracks[2]			
4 million bd. ft.	2,000	1,000	15
12 million bd. ft.	6,000	3,000	15
20 million bd. ft.	9,000	4,500	15

[1] Represents average value for all yard drying firms.
[2] Calculated on the basis of annual volume.

AGRICULTURAL EXPERIMENT STATION SYSTEM OF ALABAMA'S LAND-GRANT UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.