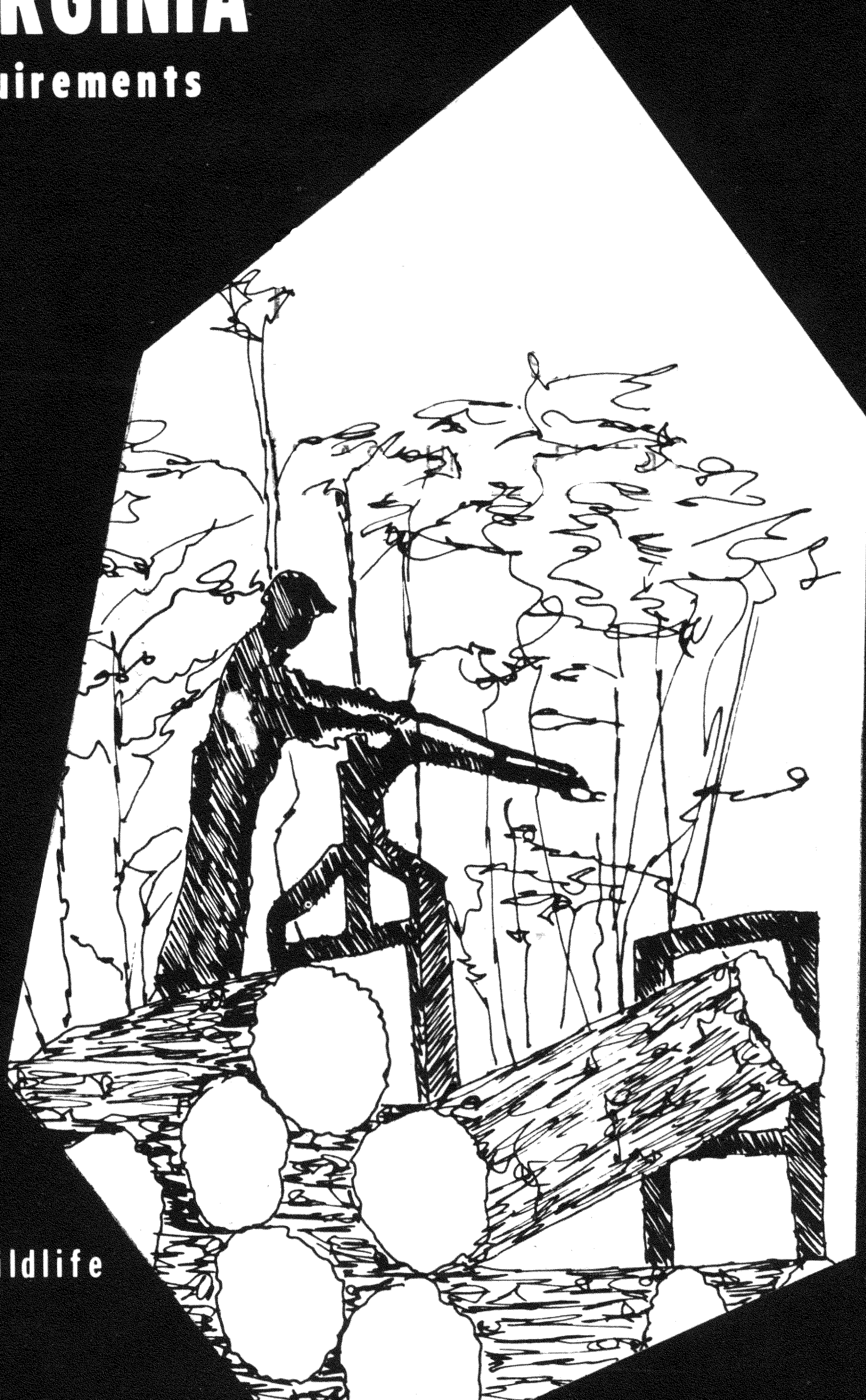
HARDWOOD PULPWOOD HARVESTING IN WESTERN VIRGINIA

costs and production requirements



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HARDWOOD PULPWOOD HARVESTING IN WESTERN VIRGINIA: COSTS AND PRODUCTION REQUIREMENTS

By

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INTRODUCTION

With recent developments in hardwood pulping, large acreages of unmerchantable small hardwood have become actual or potential economic resources to the economy of western Virginia and similar regions. Information on logging production requirements and costs is needed for defining the economic potential of these resources and for encouraging or planning expansion of the hardwood pulp and paper industry. Relatively little research has been done on hardwood pulpwood harvesting. Studies carried out in the mountainous Appalachian region have been concerned mainly with harvesting pine pulpwood and hardwood sawtimber (Schnell, 1960; Wallbridge, 1965).

The objective of this study was to determine production costs for hardwood pulpwood harvesting for the operations from felling standing timber through loading the truck at the wood's landing. A detailed study of transportation costs and overall producer profitability was not made nor can be inferred without qualification.

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2/ The junior author developed and conducted this study in partial fulfillment of the requirements for the Master of Science in Forestry degree at Virginia Polytechnic Institute. He is currently a forester with the Forstverwaltung in West Germany.

This study was developed in cooperation with and with partial financial support from the U. S. Forest Service, Jefferson National Forest, Roanoke, Virginia. Excellent cooperation from the Wood Department of the West Virginia Pulp and Paper Company, Covington, Virginia, contributed materially to the study.

STUDY PROCEDURE

Pulpwood Operators Sampled

The population of hardwood pulpwood producers considered was limited to producers delivering a minimum of 10 truck loads of wood per month to the West Virginia Pulp and Paper Company (Westvaco) mill in Covington, Virginia, or to the company's woodyards in Natural Bridge and Radford, Virginia, during July, August and September, 1965. Westvaco buys hardwood pulpwood in 5' lengths with a minimum diameter of 4" (dib) at the small end. The company paid 28¢ per 100 lbs. for hardwood pulpwood during the study period. Producers delivering over 10 truck loads per month to the Covington woodyard account for approximately 80% of all wood delivered.

Exploratory field trips suggested a rough stratification of the producer population according to skidding equipment and productivity (Table 1).

In May, 1965, there were 823 producers trucking wood to the Covington mill; 283 of these producers were furnishing more than 10 loads per month. Of these 283 producers, 201 could be classified by Westvaco or Forest Service personnel according to productivity and skidding method.

A sample of 40 producers was selected from the 201 classified producers. This sample size was adopted mainly for reasons of time and budget available for the research project. The sample was distributed according to the percentage of producers in the population with the restriction that each producer category contain at least 3 observations. This procedure for distributing samples was followed in the absence of any information about category variances.

Table 1: Stratification of pulpwood producers by skidding equipment and daily productivity.

	Productivity	
Skidding method	One load per day	Two loads per day
One horse or one tractor	A	C
Two horses or two tractors	B	D

Some deviation from the sample plan was required on implementation because the initial stratification did not accurately describe the population. Specifically, stump-loading operations had to be singled out of category "A" and described as a new category "E". Practical difficulties in locating operators in the woods necessitated some modification in the procedure for selecting operators. As the study progressed, most operators were contacted at the mill gate in Covington and then followed to the woods. Whoever, out of the respective operator category arrived at the mill first was contacted first. This method contains possible courses of sample bias. However, the operators were not selected on the basis of prior knowledge.

The resulting sample distribution is shown in Table 2. The geographic distribution of the sampled producers is shown in Appendix I.

Table 2. Distribution of the population and actual sample of hardwood pulpwood operators delivering to the Westvaco Covington mill

Producer Category[1/]	Total Population	Actual Sample
	----- number of operators	------
A	95 (28)[2/]	5
B	5	1
C	75	17
D	26	4
E	(unknown) (67)[2/]	12
	201	39

1/ Producer categories are defined as:

A. 1 skidder, 1 load per day
B. 2 skidders, 1 load per day
C. 1 skidder, 2 loads per day
D. 2 skidders, 2 loads per day
E. Stumploaders (no skidding), 1 or 2 loads per day

2/ The numbers in parenthesis indicate the distribution of the 95 operators in the original "A" classification into the "A" and "E" categories, assuming the population was distributed in the same percentage ratios as the observed sample.

Field Study Procedure

Production time was recorded using a systematic work sampling technique. Every 10 minutes the activity of each worker and piece of equipment was recorded. The actual time spent on each partial operation ("fell", "limb", "buck", "skid", "load", "delay") was then found by multiplying the number of interval observations by 10 minutes. The work sampling technique allowed the observer to remain unobtrusive and tended to minimize disturbance of the operation. It allowed one trained observer to simultaneously record the total operation.

Wherever possible, at least 2 full days, or the time needed for 2 complete production units (truck loads) were spent with each operator to minimize the effect of possible disturbances of the normal course of work which might have arisen on the first day due to the fact that studies were being taken. The amount of wood produced by an operator was measured in pounds and obtained from the Westvaco woodyard records or from the operator, who is paid by weight.

ANALYSIS

Variables measured in this study were the number labor minutes required to process 1,000 lbs. of pulpwood and the equipment cost required to process 1,000 lbs. of pulpwood. Within the harvesting operations observed, 4 distinct phases or partial operations could be operationally defined:

1) preparing-the-stick, including the operations of felling, limbing and bucking.

2) skidding, using either tractors or horses.

3) loading the truck, by either hand labor, or using a mechanical loader.

4) delay, classified as productive or rest.

The basic observation unit for this study was then defined as: the average labor time or equipment cost used per unit volume by an operator to process a full load of wood through one of the partial operations.

The number of man-minutes of labor required per 1,000 lbs. of wood was computed by multiplying the number of interval recordings within each partial observation by 10 minutes and dividing by the size of the load produced. The equipment requirements were computed in a similar manner but in order to compare operators within and between categories, the equipment minutes were converted to dollars to account for the wide diversity of equipment used. The cost per unit time for using the various kinds and models of equipment observed were calculated using 2 standard methods (F.A.O., 1956, Smith & Oliver, 1965) and were checked against the cost estimates of equipment dealers and costs observed for agricultural equipment. A summary of the per unit costs used in this study is given in Table 3.

Table 3: Average Cost of Hardwood Logging Equipment

Item	Make and Model	Cost ($)
Tractors	John Deere 440 D	2.34 per hour
	John Deere 420	2.39 per hour
	John Deere 1010	2.55 per hour
	John Deere 350	3.33 per hour
	John Deere 2010	3.45 per hour
	Allis Chalmers H3, HD3	2.55 per hour
	Caterpillar D2	3.78 per hour
	Caterpillar D4	4.68 per hour
Power saws	Price range $170 - 200	0.70 per hour
	Price range $230 - 265	0.78 per hour
	Price range $285	0.82 per hour
	Price range $319	0.86 per hour
	Price range $390	0.94 per hour
2 skidding pallets		1.35 per day
Working horse		2.65 per day
Loader	Tractor mounted hydraulic crane ("cherrypicker")	1.00 per hour
	Hydraulic frontend loader on tractor	0.66 per hour

Production Requirements

The production requirements per unit weight processed were averaged for each partial operation by operator category. A simple arithmetic average was used [1/] A summary of these basic empirical results is shown in Table 4. The average distribution of labor requirements by partial operation is shown in Table 5. A detailed breakdown of the results by operator category and partial observation is given in Appendix II. Sample variances for categories with at least 7 complete and comparable observations are also given in Appendix II.

The data show few statistically significant differences between the production requirements of the different operator categories. The weighted average requirements for all observed operations is 41.7 man minutes and $.255 of equipment cost per 1,000 lbs. processed through the loaded truck. Even allowing for potential bias resulting from the departure from pure random sampling, the geographic spread of the operators and the relatively low sample variances engenders some confidence in these overall averages for all producers. The differences in requirements between operator categories do not warrant detailed statistical analysis due to the sampling problems and the small number of observations within each category.

One difference between operator categories observed in the sample is worth noting. The 2-load operators (Class D) consistently used less labor per unit of product. On the average they required 29.3 minutes per 1,000 lbs., nearly a 30% lower labor requirement than the other (Class A, C and E) operators. In contrast, their equipment costs were approximately 50% higher. These results were predictable since essentially the same size crew was turning out more wood per day.

Production Costs

Woods labor is paid in a variety of ways, usually as a flat fee per day or as a percentage of the load value. Few workers are paid on an hourly basis. In order to examine total costs of producing wood, the labor requirements were assigned values and added to the equipment costs. Since hourly wage rates could not be established from

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1/ The average requirements were also computed weighting the production requirements by load size. A comparison showed the production requirement per unit processed to be independent of load size for the operators observed.

observation, 4 different rates ranging from $.75/hr. to $2.00/hr. were assumed for this analysis. The average costs for all categories of operators were determined through weighting the category costs by the percent of the population in each category. These calculations are summarized in Table 6. Running the risk of generalization, an average laborer received about $8.00 a day, and, assuming he actually worked for 5 hours, his wage rate <u>when working</u> was about $1.60 per hour. From Table 5, this would indicate an overall average harvesting cost of approximately $1.35 per 1,000 lbs for all operators. Depending on the labor payments, a different wage assumption would be appropriate for specific operators or localities. The 2-load-a-day operators (category D, Table 6) appear to have about 20% lower production costs.

Table 4: Average requirements for producing 1,000 pounds of hardwood pulpwood by operator category

Operator Category[1/]	Average total man-minutes per 1,000 lbs.	Average total equipment cost per 1,000 lbs.	Number of truckloads observed
A	46.34	$ .266	7
C	40.76	$ .316	23
D	25.74[2/]	$ .596[2/]	3[2/]
	32.07[3/]	$ .342[3/]	4[3/]
E	45.36	$ .137	15
All operators	41.7	$ .255	———

[1/] only one class B operator was observed

[2/] class D operators using a mechanical loader

[3/] Class D operators not using a mechanical loader

[4/] weighted by % of population in operator category

Key to operator categories

A = 1 skidder, 1 load per day
B = 2 skidders, 1 load per day
C = 1 skidder, 2 loads per day
D = 2 skidders, 2 loads per day
E = stumploaders, 1 or 2 loads per day

Table 5: Percent of total labor time required for each production operation; average for all operators observed

Production Operation	Percent of total labor time
Prepare-the-stick (fell, limb, buck)	22.6%
Skidding	11.8%
Loading	32.2%
Productive Delay (cleaning, maintenance, etc.)	9.5%
Rest	23.9%
	100.0%

Labor is predominant in the cost structure. Depending on the wage rate, from 67 to 85% of the production cost is tied up in labor.

Production Organization

The average load size observed in this study was 22,000 lbs., which required 15.3 man hours of labor. A typical 3-man crew which produced 1 load per day effectively worked about 5 hours. Some one-load crews were larger and spent even less time effectively working. From 3 to 7 additional hours of ineffective time were spent waiting in the woods or mill-yard or in transit.

Producers arranged their operations in several ways depending on the logging chance and the equipment at hand. The distribution of organizations observed is shown in Figure 2. The crews were generally small, ranging from 2 to 6 men. The average size of crew observed was 3.46 men. Custom or tradition seems to decree that the typical crew starts with an empty landing in the morning and leaves with an empty landing at night. Additionally, the crew normally has a fixed daily production goal of either a dollar value or quantity of wood. During the study, the crew usually arrived at the site between 8:00 and 10:00 a.m., and felled, skidded and loaded a truck load of wood by 2:00 p.m. The producer then transported the load to the mill and returned home. The crew either rode in with the truck or returned home using their own transportation. This could be depicted at the one-load-a-day procedure. The 2-load-a-day operators followed much the same system but put in a longer work day. Most operators in the study ceased work once the daily production goal was reached. This would generally be true even if a good logging site or better equipment had allowed the goal to be reached before noon.

A few of the operators had developed a more efficient organization. The day started by loading wood left on the landing and a truck load was sent to the millyard first thing in the morning. The crew meanwhile felled, bucked and skidded 2 loads of wood to the landing. When the truck returned, it was again loaded and the crew left the woods with the day's second load, leaving a load on the landing for the next morning. This system, using the same crew size and equipment, turned out the 2 loads with a correspondingly lower average labor requirement through reducing delays and by providing continuity in the operation. The crew worked harder but left and returned home at approximately the same time as one-load crews and made more money in the process.

Table 6: Average cost in dollars for producing 1,000 lbs. of pulpwood by operator category and labor wage rate when working

Wage rate	A	C	D	D'[2/]	E	All[3/]	Average % of cost in labor
	OPERATOR CATEGORY [1/] -------- dollars --------------						
$ .75/hr.	.81	.83	.74	.91	.70	.78	67%
$1.00/hr.	1.00	1.00	.88	1.01	.89	.95	75%
$1.50/hr.	1.38	1.34	1.14	1.22	1.27	1.30	80%
$2.00/hr.	1.77	1.67	1.41	1.43	1.65	1.44	85%

1/ Key to operator categories

A = 1 skidder, 1 load per day
C = 1 skidder, 2 loads per day
D = 2 skidders, 2 loads per day
E = stumploaders, 1 or 2 loads per day

2/ Class D operators using a mechanical loader

3/ Weighted by percent of population in each operator category

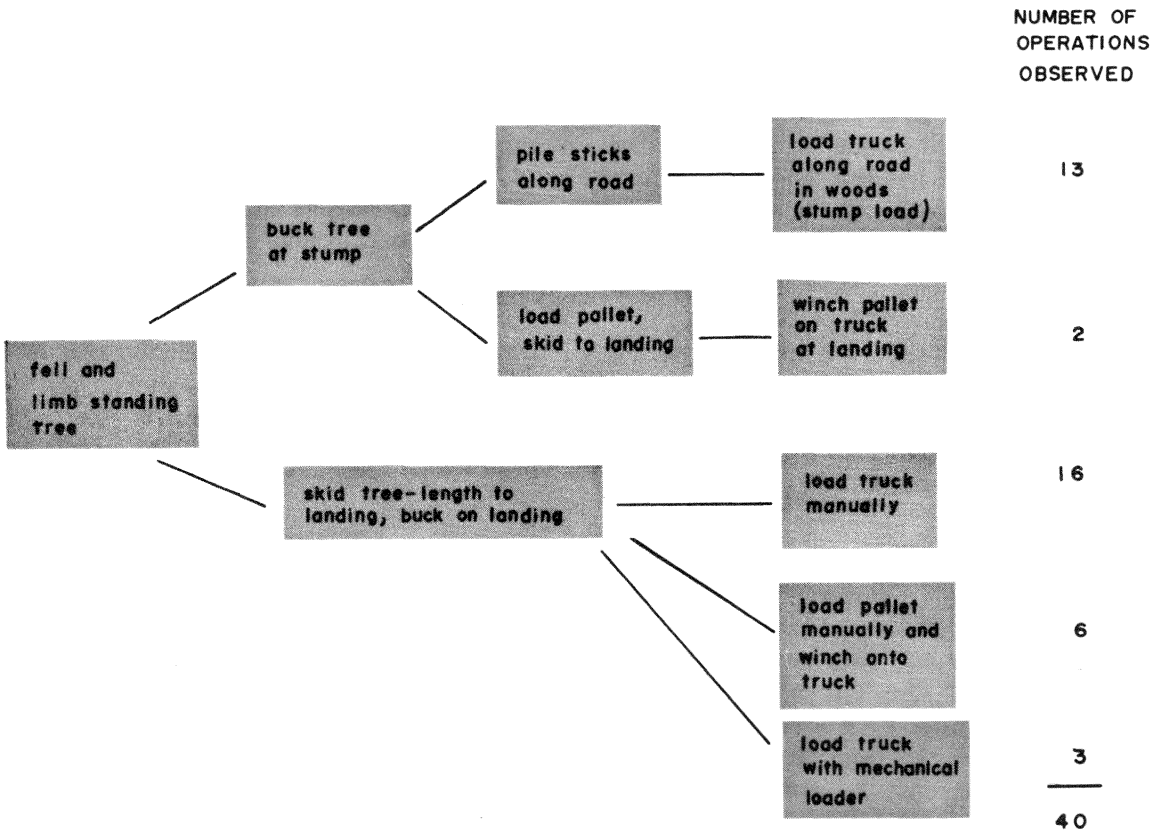

Figure 2. PRODUCTION ORGANIZATION-OBSERVED FOR HARDWOOD PULPWOOD OPERATORS IN WESTERN VIRGINIA

DISCUSSION

Perhaps the most striking result is the large amount of labor required per unit of product. An hour of labor time is required, on the average, to process 1,500 lbs. of wood. As a comparison, Smith and Gedney (1965) found that a man hour of labor produces about 6,000 lbs. of wood in the Douglas fir region.

In western Virginia, an hour of pulpwood logging labor in the woods produces a product worth $4.20 in the woodyard, with equipment, overhead and transportation costs yet to be accounted for. These results are not unexpected but do serve to indicate a low level of labor productivity and potential difficulty if wage rates rise or labor shortages exist.

Loading was done by hand and was the most physically exhausting part of the operation observed. The loading operation took almost one-third of the total labor requirements and appeared to be the operation offering the greatest potential for mechanization. Of the 7 loading operations observed under the "D" category, 3 of the operators used a mechanical loader and approximately doubled the output per man hour of labor. While these data are not sufficient to establish the amount of increase, they do indicate the mechanization of this operation has some possibilities.

Delays occupied a third of the total labor requirement. Delay time covered only the period when the logging operation was underway. Of the delay time, approximately one-third was productive (brushing, moving equipment, etc.) and two-thirds was either necessary or unnecessary rest.

It is tempting to prescribe more equipment as a cure to low labor productivity, as suggested by the higher productivity and lower cost of category "D". Additional equipment, however, generally demands larger crews, a larger scale operation, attention to cost accounting and requires the operator to be in a good financial position. For many traditional, economic and cultural reasons, much of the pulpwood logging in mountainous Virginia will continue to be labor intensive and done by small 3 and 4 men crews. Pragmatically, increases in productivity should be attempted through better production organization of existing crews and equipment with only modest attention to increases in crew size and mechanization. Encouraging more producers to pre-cut a load for the next day would appear to be one of the best approaches. Any re-organization which would allow the crew to effectively work a large part of the day should be encouraged. Arranging crew transportation independent of the hauling truck would be one of the biggest problems to such re-organization. Another and more fundamental problem must be overcome before any real increases in productivity will be forthcoming. This is the observed tendency of the operators to set daily production goals too low. Production goals must either be raised or an income-maximizing goal substituted. One result of the failure to raise production goals has already been observed at the Covington mill. A random-length wood system has recently been introduced with the realized expectation of greater logging productivity. Several operators who shifted to this system did not raise their daily production goals and effectively negated their higher productivity by working fewer hours per day. From the mill point of view, no more wood was forthcoming, and the operators were not significantly increasing their income. Currently the desparity between "daily productivity" and "hourly productivity when working" is large. When actually working, a crew member can earn from $1.50 to $2.00 per hour. Since he only works part of the day, his daily earnings are still low.

SUMMARY

Hardwood pulpwood logging in western Virginia was found to be a highly labor-intensive production process. The average production requirements for the 40 producers observed were 41.7 minutes of labor and $0.255 of equipment cost to produce 1,000 lbs. of wood from the stump to the loaded truck. Assuming a wage rate of $1.60 per hour when working or $8.00 per average day, average production costs were $1.35 per 1,000 lbs. of wood. Production organization was generally inefficient, the crew of the typical 1-load-a-day operation spent less than 5 hours of actual working time per day. Of the operations observed, loading appears to have the greatest potential for mechanization. The most pragmatic approach to increasing productivity and worker income appears to lie in improving the production organization so that the average crew can produce 2 loads of wood per day. More use of intermediate storage of pre-cut wood on the landing or in the woods should help achieve greater production. The tendency of operators to set daily production goals too low must be overcome to permit major productivity increases.

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APPENDIX I

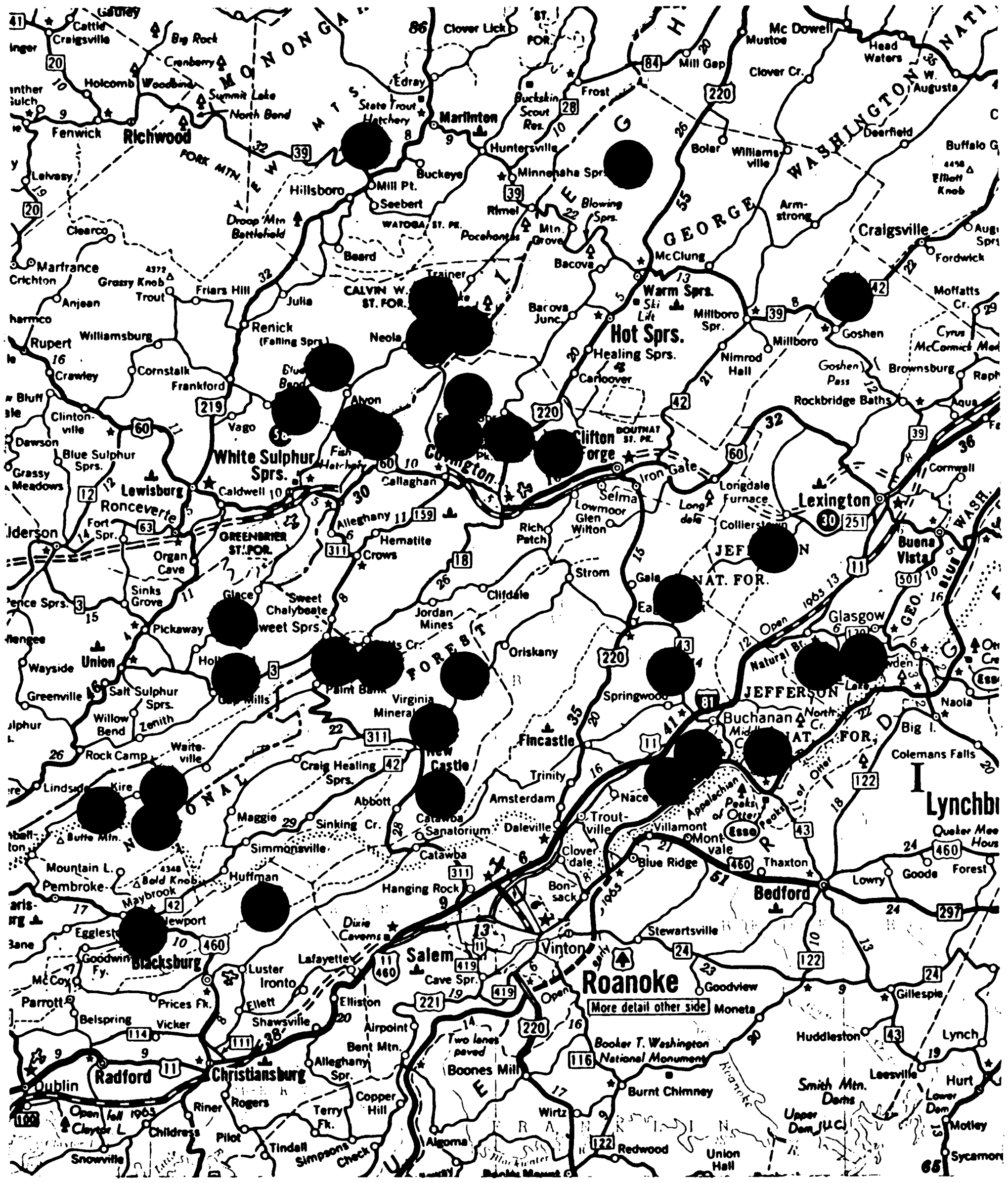

FIG. I GEOGRAPHIC DISTRIBUTION OF PULPWOOD LOGGING OPERATIONS OBSERVED IN WESTERN VIRGINIA

Appendix II

Requirements for producing 1,000 lbs. of hardwood pulpwood by operator category and partial operation

OPERATOR CATEGORY

ITEM	A $\bar{x}$[1]	A s^2[2]	A n[3]	B $\bar{x}$	B s^2	B n	C $\bar{x}$	C s^2	C n	D $\bar{x}$	D s^2	D n	E $\bar{x}$	E s^2	E n	All[5] oper-tors	Ave. per-cent of total labor require-ment[5]
Production Operation																	
Prepare-the-stick																	
man minutes	9.50	482	7	4.5	-	1	9.51	38.9	23	5.88	-	5	11.08	11.8	15		22.6%
equipment cost	\$.103	\$.27	7	\$.052	-	1	\$.119	\$.1	23	.077	-	5	.137	.740	15		
Skidding																	
man minutes	10.02	233	7	13.0	-	1	5.52	15.0	23	5.08	-	5	1.51	-	24		11.8%
equipment cost	\$.163	\$.02	7	\$.597	-	1	\$.197	1.59	23	.265	-	5	-	-			
Loading																	
man minutes	10.18	-	7	9.44		1	11.75	15.0	32	12.61 6.28[4]	- -	4 3	17.37	60.6	24		32.2%
equipment cost	-	-	-	-	-	-	-			- .253[4]	- -	4 3					
Delay (man minutes)																	
productive	6.61	-	7	1.5	-	1	4.64	13.1	15	2.34	-	7	3.0	-	8		9.5%
rest	10.63	-	7	5.7	-	1	9.34	47.7	15	6.16	-	7	12.4	2.3	8		23.9%
Total man minutes per (1,000 lbs.)	46.34			34.14			40.76			32.07 25.74[4]			45.36			41.7	
Total equipment cost per (1,000 lbs.)	\$.2664			\$.649			\$.3161			\$.3424 .5956[4]			\$.1374			\$.255	
Percent of population in category	13.9			2.5			37.3			12.9			33.4				

1/ $\bar{x} = \frac{\Sigma x}{n}$ 2/ $s^2 = \Sigma x^2 - \frac{(\Sigma x)^2}{n}$ 3/ n = number of loads observed.

4/ operators using a mechanical loader

5/ weighted by percent of population in operator category

Key to operator categories

A = 1 skidder, 1 load per day
B = 2 skidders, 1 load per day
C = 1 skidder, 2 loads per day
D = 2 skidders, 2 loads per day
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