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Research Note

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Dense Undergrowth Reduces Feller-Buncher Productivity In Shortleaf Plne Plantations

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SUMMARY

Production rates of a feller-buncher are shown for row thinning pine plantations with light and dense undergrowth conditions. Dense undergrowth reduced macliine output by about 20 percent.

Additional keywords: Row thinning, timber harvesting, tree harvester.

INTRODUCTION

Plantations of loblolly and shortleaf pine frequently have understories of hardwood brush. On some sites, in the absence of control measures, small hardwoods and other vegetation can become quite dense. As part of a study of mechanized row thinning of pine plantations, we investigated whether understory hardwoods might have an impact on harvesting operations.

This note reports the effect of hardwood undergrowth on the productivity of a feller-buncher for row thinning shortleaf pine plantations. Feller-bunchers are the most common type of mechanical harvester used in row thinning. In row thinning, undergrowth will most likely affect productivity in the felling phase of the operation, since the harvesting of entire rows provides convenient roads for skidding machines. Other factors being equal, shortleaf plantations may have a large number of hardwoods in the understory because of the slow early growth of the pine.

The machine studied was a Melroe Bobcat 1075 Feller Buncher (fig. 1). This machine was equipped with a 16-inch capacity shear and an accumulator arm. In operation, two arms hold the tree while it is severed at ground level. The accumulator arm allows several small trees to be gathered before the stems are deposited on the ground.[2] Severed trees are carried and piled until the desired bunch size is created.

PROCEDURES

Data were gathered in time studies to develop regression equations for predicting processing times under different undergrowth conditions.

Data collection took place in two pine plantations in central Tennessee. A shortleaf plantation located adjacent to a minor stream bottom had a dense hardwood understory, while an adjoining loblolly plantation contained only light undergrowth. Other environmental conditions were the same; terrain was generally flat and soil conditions were dry.

A thinning operation was removing every third row in the plantations. Time and output measurements were obtained on line-segment plots installed in

[1]Mention of the trade names is solely to identify equipment used and does not imply endorsement by the U.S. Department of Agriculture.

[2]The accumulator on the observed machine was used sparingly; hence, study data essentially represent the operation of a single-tree feller-buncher.

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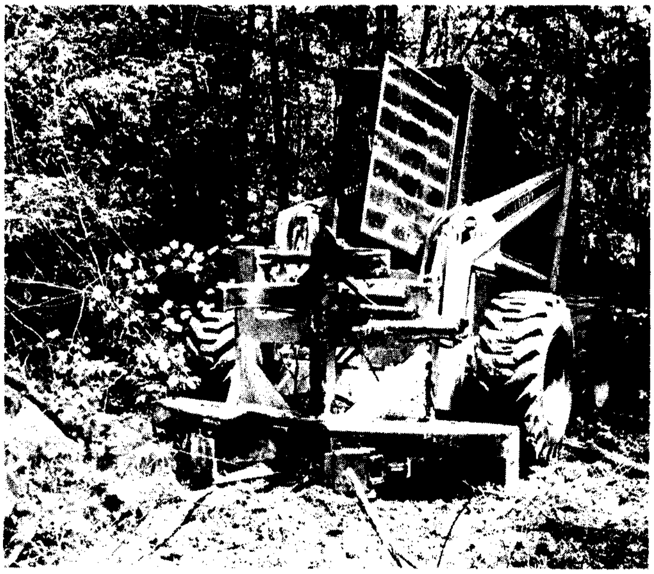

Figure 1 .—*Melroe Bobcat* 1075 *feller-buncher.*

rows prior to felling. All data collected were with the same machine and operator.

Thirty sample plots were harvested in each plantation. Before cutting, length of segment, dbh of each tree, and total tree height were measured. Total time required for the machine to fell and pile the trees on a plot was recorded. In addition, log lengths and top diameters were measured after chain saw operators had limbed and topped the trees.

Numerous vines and thick hardwood brush reduced visibility for the machine operator while he harvested rows of shortleaf pine (fig. 2). Saplings also restricted maneuverability, and a few stems 3-4 inches dbh required shearing and removal. Hardwood brush encountered in the loblolly plantation, however, was small and scattered.

Two undergrowth conditions-dense and light—were recognized. Data collected in the shortleaf plantation reflected machine performance with dense undergrowth, while data from the loblolly plantation represented performance with light undergrowth.

Estimating equations were developed from the measurements taken in each undergrowth category. The dependent variable was time, expressed in minutes per hundred feet of plantation row. Other data were also converted to a hundred-foot basis. Independent variables tested for significance were:

1. Number of trees.
2. Average dbh.
3. Average of the dbh squared.
4. Sum of the log lengths.
5. Sum of the log lengths/average of the dbh squared.
6. Average of the dbh squared/average of dbh.

Variables 5 and 6 were significant at the 1 percent level. Variable 5 has characteristics that account for tree volume and weight. Variable 6 is a measure of dispersion of tree size around the mean. Resulting equations for the two undergrowth conditions are shown in Table 1, along with measures of goodness of fit.

A covariance analysis of the regressions showed no difference in slopes, but a significant difference in intercept values at the 0.01 level. That is, the effect of the undergrowth is reflected largely by the difference in the constant terms.

The equations apply to productive time only. Therefore, allowance must be made for downtime, idle time, and turn-around time, depending on the method of operation.

Table 1 .-*Equations for estimating feller-buncher performance*

Undergrowth class	Estimating equation	R^2	SE
Dense	$Y=-7.377+.589(\Sigma L\div\frac{\Sigma D^2}{N})+1.140(\frac{\Sigma D^2}{\Sigma D})$	.72	1.28
Light	$Y=-3.097+.415(\Sigma L\div\frac{\Sigma D^2}{N})+.503(\frac{\Sigma D^2}{\Sigma D})$	.84	.78

Y =**Time** per **100** feet of row, in minutes.
D=Dbh, in inches.
L =**Log** length, in feet.
N=Number of trees.

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Figure *2.-Dense undergrowth obscured the row being removed. A felled tree lies adjacent to the leave row on the right,*

PRODUCTIVITY

To illustrate the effect of undergrowth on machine productivity, the equations were used with stand and yield data for shortleaf pine to calculate hourly production rates for plantations with each undergrowth condition.

Detailed stand structures for unthinned shortleaf pine are available from Smalley and Bailey (1974). The tables used were for plantations age 20 with a site index of 50 (25-year basis) and densities ranging from 750 to 1,250 trees per acre. Merchantable trees were limited to those in the 4-inch diameter class and larger, and tree lengths and volumes were computed to a 3-inch top diameter. Stand characteristics for each density were entered into the estimating equations to derive processing times per hundred feet of row.

Processing times were used to calculate potential hourly output for each stand situation. It was assumed that the feller-buncher would be working in a 40-acre tract with rows 1,320 feet long, and with a grapple skidder as supporting equipment. To limit skidding distance, the feller-buncher would cut half of the row with butts facing one way and half facing the other. It would do this by entering a row from one end, cutting 660 feet, returning to the end of the row, and then entering the next row to be removed. An allowance for return time was made, but not for downtime or idle time. Thus, hourly production figures represent potential output; that is, at 100 percent machine utilization. To obtain realistic

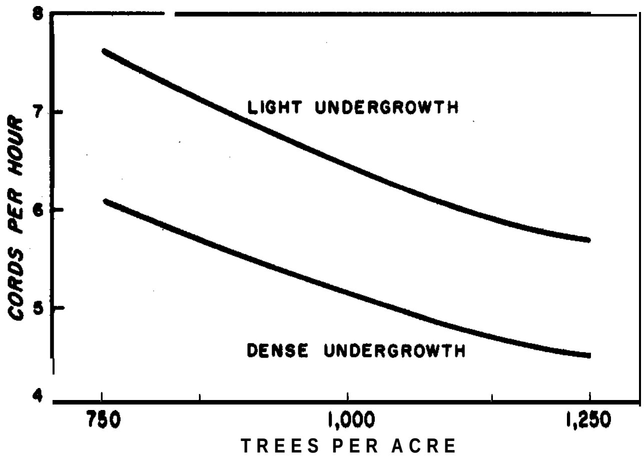

Figure 3.—*Effect of undergrowth conditions on hour/y output of feller-buncher row thinning shortleaf pine plantations (age 20, site index 50, rows d-feet apart).*

production levels for longer time periods or an average hourly rate, such figures must be adjusted for the probable utilization rate.

Machine productivity, in cords per hour, is shown in Figure 3 by stand density for dense and light undergrowth conditions. Output is in the form of bunched trees. Results indicate production rates for the feller-buncher are about 20 percent less when row thinning pine plantations with dense hardwood undergrowth as opposed to light undergrowth.

DISCUSSION

Overall, mechanization has probably reduced the sensitivity of timber harvesting operations to most environmental conditions. Some machines, nevertheless, are adversely affected by particular factors. The identification of such factors and their influence on productivity is important in machine selection and for estimating harvesting costs.

This study revealed dense hardwood undergrowth conditions significantly reduced the production rate of a feller-buncher used in row thinning southern pine plantations. The effect of undergrowth may be different for other machines or thinning methods. Monitoring harvesting operations is necessary to identify the relative importance of undergrowth and other environmental factors on system productivity and cost.

LITERATURE CITED

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