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Thinning with the John Deere 743A
A Case Study

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Thinning with the John Deere 743A A Case Study

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A STUDY of the John Deere (JD) 743A[2] felling and bunching trees was conducted in eastern North Carolina during the summer of 1982. This was part of a larger study examining the operational characteristics and productivity of several feller-bunchers used in thinning applications. Two methods were examined: clearcutting every fifth row and selectively cutting (low thinning) from two rows on either side of the clearcut rows.

STUDY CONDITIONS

The stand was a 21-year-old loblolly pine plantation with an initial density of 680 trees per acre. It had been bedded prior to planting and, therefore, had good row alignment. Dense brush in the stand restricted visibility to less than 30 feet. In both thinning methods, hardwoods were removed only for access.

The JD 743A, cover photo, is a 152-horsepower, rubber-tired, swing-to-tree feller-buncher. A 5-foot boom extension increased the machine's reach to a maximum 22.5 feet. The felling head was a John Deere 'scoop' shear with an 18-inch capacity, see figure. Vehicle width was 10.6 feet with 30.5 × 32-inch tires.

METHODS

Plots were set up to test differences between the two thinning methods. For the corridor cut, a section of row approximately 860 feet in length was designated. All trees in this row were numbered, measured for diameter at breast height (dbh), and identified by species. Since rows were located on 12-foot centers, cutting a row resulted in corridors approximately 24 feet wide. For the selective cut, a 1/5-acre plot was flagged

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[2]Use of trade names and brands is for reader convenience and is not an endorsement by Auburn University or the U.S. Forest Service.

John Deere 743A scoop shear head.

with all trees on the plot numbered and dbh and species recorded. The trees from the corridor were cut and removed before selective thinning began.

After the plots were established, the machine was videotaped while operating. The numbers of each cut tree were audibly recorded on the videotape while the machine progressed through the plots. After cutting, stump diameters and total heights of felled trees were measured from a sample of trees so that local volume tables could be constructed by dbh and stump diameter.

Time study data were obtained by viewing the videotape and measuring time with a stopwatch. A cycle consisted of moving and/or swinging to the first tree, shearing, moving and/or swinging to and shearing of additional trees in accumulation, moving and/or swinging to bunch location, dumping, and occasional bunch maintenance. Cycle time was divided into elements as follows: move to tree, swing to tree, shear, move to dump, swing to dump, and dump. If both boom and machine movement occurred simultaneously, it was recorded as machine movement. The move-to-tree and swing-to-tree elements were combined into a single element. The move-to-dump and swing-to-dump elements were also combined. Time study data were placed into computer files along with tree data for analysis.

Summary statistics were computed for the element and cycle times on a per tree basis for both thinning methods. A local volume equation was constructed using the sampled diameters and heights estimating cubic feet inside bark (i.b.) to a 3-inch top. From these data, average productivity rates were developed, which when combined with a machine rate, provide estimates of cost per unit of production.

RESULTS

The average move-to-tree time was 0.05 minute per tree for both cutting corridors and select cutting, tables 1 and 2. Average swing-to-tree times were also nearly identical. Shear time for selective cutting was 0.02 minute per tree faster than that for corridor cutting. This statistically significant difference indicated greater difficulty in cutting the trees in the clearcut fifth rows, most probably a result of a larger average diameter in rows than in the selectively cut trees.

There was a significant difference in move-to-dump time

TABLE 1. CORRIDOR CUTTING WITH THE JD 743A

Element	Time per tree			
	Observations	Mean	Standard deviation	Range
	No.	*Min.*	*Min.*	*Min.*
Move to tree	31	0.05	0.03	0.02 - .16
Swing to tree	31	.15	.04	.08 - .27
Shear	31	.06	.02	.04 - .11
Move to dump	31	.002	.005	.0 - .021
Swing to dump	31	.02	.02	.004- .10
Dump	31	.05	.02	.02 - .10
Move-swing to tree	31	.20	.07	.10 - .43
Move-swing to dump	31	.02	.02	.004- .10
Total	31	.33	.09	.23 - .68

TABLE 2. SELECTIVE CUTTING WITH THE JD 743A

Element	Time per tree			
	Observations	Mean	Standard deviation	Range
	No.	*Min.*	*Min.*	*Min.*
Move to tree	8	0.05	0.02	0.02- .09
Swing to tree	8	.15	.04	.09- .20
Shear	8	.04	.01	.03- .06
Move to dump	8	.02	.01	.01- .05
Swing to dump	8	.01	.01	.0 - .03
Dump	8	.03	.01	.02- .04
Move-swing to tree	8	.19	.05	.12- .28
Move-swing to dump	8	.04	.02	.02- .07
Total	8	.30	.06	.20- .38

between the two thinning methods. When cutting the corridor, the operator would dump the load after accumulating the last tree with little movement of the machine. The operator carefully laid and spaced bunches in the select cutting to have adequate room for all the trees in the corridor without overlapping the bunches. However, during cutting of the corridor going forward, the bunches had to be laid to the side of the corridor. This resulted in longer swing-to-dump times per corridor cutting. For the study, swing-to-dump was not significantly different between the two methods, even though it took less time during the select cut while traveling backwards and dumping to the front.

There was a significant reduction in the dump time element between the methods. It took more time to dump in the corridor cutting because the bunches were laid into the stand. There was resistance from the crowns in laying the bunches on the ground.

For the combined elements, there was little difference between the cutting methods for the move-swing-to-tree time element, reflecting the slight difference found between the individual elements. There was a significant difference between corridor and select cutting for the combined move-swing-to-dump element. It took twice as much time in the select cutting, due to the difference in the move-to-dump element.

Even though select cutting took a little less time than corridor cutting, an analysis of the total time per tree showed no significant difference between the two cutting methods. The trade offs and variability among the individual elements tended to balance the total cycle time between the two cutting methods.

As expected, average diameter was higher in the corridor cut than in the selective cut, table 4. This supports the con-

TABLE 3. COMPARISON OF CUTTING METHODS WITH THE JD743A

Element	Means per tree		Percent difference
	Corridor	Select	
	Min.	*Min.*	%
Move to tree	0.05	0.05	0
Swing to tree	.15	.15	0
Shear	.06	.04	− 33.3[1]
Move to dump	.002	.02	+ 9.0[1]
Swing to dump	.02	.01	− 50.0
Dump	.05	.03	− 40.0[1]
Move-swing to tree	.20	.19	− 5.0
Move-swing to dump	.02	.04	+100.0[1]
Total	.33	.30	− 9.1

[1]Significant difference at 1 percent level.

clusion drawn earlier concerning the differences in shear time. Also, it is apparent that a relatively greater amount of hardwoods had to be cut in the corridor removal than in the selective cut. Hardwoods were not considered merchantable and were avoided where possible. Selective cutting allowed greater freedom to avoid the hardwoods than did cutting corridors. Cut hardwoods were removed along with the pine.

Table 5 gives a comparison of thinning methods based on cycle variables. Corridor cutting had greater productivity in terms of cubic feet per hour than did selective cutting. However, the situation was reversed when productivity was measured in terms of trees per hour. Selective cutting resulted in more production on a tree basis, probably because of the greater average number of trees per cycle than corridor cutting. However, the greater average tree size cut in the corridors resulted in greater cubic feet production.

Combining cost assumption in table 6 with the estimates of productivity in table 5 gives cost per cunit (i.e., cost per 100 cubic feet of solid wood). The estimated cost for the JD 743A cutting corridors was $8.88 per cunit, and cutting selectively was $11.35 per cunit. Under the study conditions, during which the feller-buncher cut corridors approximately one-third of the time, the total felling cost was $9.47 per cunit.

TABLE 4. PLOT REMOVALS BY THINNING METHOD

Variable	Corridor cut	Selective cut
Number of trees		
All	113	45
Pines	86	40
Average dbh per tree, in.		
All	5.7	5.4
Pines	6.4	5.7
Average pine height, ft.	43.1	41.7
Average pine volume per tree, cu. ft. inside bark to a 3-in. top	4.5	3.2

TABLE 5. ESTIMATED PRODUCTIVITY BY THINNING METHOD

Variable	Corridor cut	Selective cut
Time, productive minutes per tree	0.33	0.30
Volume, cu. ft. per tree	4.5	3.2
Basal area, sq. ft. per tree	.22	.17
Number of trees per cycle	3.4	4.5
Cubic feet per PMH[1]	818.1	640.0
Trees per PMH	181.8	200.0
Pines per PMH	138.4	177.8

[1]PMH=productive machine hours.

TABLE 6. MACHINE RATE ASSUMPTIONS AND CALCULATIONS

Item	Amount
Delivered price[1]	$ 178,331.00
Residual value at end of depreciation period	$ 35,666.20
Depreciation period, years	5
Scheduled machine hours, SMH, per year	2,000
Productive machine hours per year, PMH	1,400
Utilization	70%
Owning Cost	
Annual straight-line depreciation cost	$ 28,532.96
Interest, insurance, and taxes	$ 23,646.69
Total ownership cost per PMH	$ 37.27
Operating Cost	
Fuel, $/PMH	4.40
Oil, lube, and filters, $/PMH	1.32
Maintenance and repair, $/PMH	20.38
Operator, $/PMH	9.29
Total operating cost, $/PMH	35.39
Total Owning and Operating Cost	
$/PMH	72.66
$/SMH	50.86

[1]1984 price.

CONCLUSIONS

Analysis of the JD 743A used in a thinning application resulted in the following conclusions:

1. Corridor cutting took more time per tree than did selective thinning.
2. There were significant differences for shear, move to dump, and dump time elements between the thinning methods.
3. Corridor cutting removed trees of greater average size than selective thinning.
4. More hardwoods had to be cut during corridor cutting than in selective thinning.
5. Selective thinning cut more trees per cycle than corridor cutting and was more productive in terms of trees per hour.
6. Corridor cutting was more productive in cubic feet per hour than was selective thinning because of cutting larger trees.
7. Estimated cost for selective thinning was $2.47 per cunit greater than that for corridor cutting.
8. Estimated cost for a fifth-row application of the JD 743A was $9.47.