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Mor-Bell Logger: Skidding Case Study

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SUMMARY

A production equation was developed for the Mor-Bell logger for skidding while thinning a loblolly pine plantation. Production and costs for skidding and iron gate delimbing were determined for a range of operating conditions.

Additional keywords: Plantation, thinning, production rates, costs.

INTRODUCTION

The Mor-Bell logger[1] is a recently introduced machine with a trianglar (3 wheel) configuration. It has several possible applications in timber harvesting. Although originally designed for loading sugarcane in South Africa, the converted machine can be used in forestry operations to skid, load, unload, prebunch, or feed a chipper. The logger is being marketed to interface with existing harvesting equipment such as between a feller buncher and skidder or skidder and processor.

Taylor (1978) evaluated the logger as a pulpwood forwarder in coniferous thinning systems in South Africa. He found that overall simplicity, low operating costs, maneuverability, and high production capacity for its size made it a very useful machine.

The objective of this study was to determine the skidding production rates for the Mor-Bell logger during a thinning application. Although the logger is not designed specifically for skidding, it is important to-determine its skidding production and costs since it does have potential to perform this function.

The logger does not have a steering wheel, clutch, or brakes; instead there are two large independent hydrostatically powered and controlled drive wheels in front and one small castor wheel in the rear. The direction and speed of the drive wheels are controlled through bidirectional foot controls. The machine has excellent maneuverability since it is possible to have one drive wheel rotating forward while the other is in reverse.

A boom and grapple assembly is hinged above the cab on a cross member. When traveling forward the operator has excellent visibility. However, when traveling backward as in skidding, the operator visibility is reduced due to the location of the fuel tank

Figure 1.—*Mor-Bell Logger.*

[1]The use or mention of trade or corporate names is for reader convenience and is not necessarily an endorsement by the U.S. Forest Service.

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and supporting framework. Selected equipment specifications are given in table 1 and the logger is shown in figure 1.

SYSTEM DISCUSSION

Other equipment in the operation consisted of one skid-steer feller buncher and a knuckleboom loader. The system was operating in a loblolly pine (*Pinus taeda)* plantation on the southern coastal plain of South Carolina. The method of harvesting included clearcutting access corridors at 100 ft intervals and selectively thinning within the strips. Felled trees were placed in bundles containing from one to four stems with the tree butts generally oriented toward the landing or nearest access corridor.

The logger consolidated the bundles in the stand when necessary and then skidded by way of the corridors. Skidding proceeded from the landing toward the opposite side of the plantation. A delimbing iron gate was used near the landing to remove limbs. At the landing, final delimbing and topping were completed with a chainsaw. The trees were loaded with a knuckleboom loader onto trailers.

DATA COLLECTION

Sample plots were used to determine the stand density before and after thinning. The stand contained 464 trees per acre before harvesting and 391 trees per acres after harvesting. Stand characteristics are. shown in table 2 and tree characteristics are shown in table 3.

Skidding data were collected for two days. Skidding distance, number of stems, bundles per cycle, and volume were measured on 26 cycle observations. Elemental times were recorded for consolidating bundles, travel loaded, travel empty, gate delimbing, and decking. A skidding cycle included all these elements except that in some cases bundles were not consolidated and only a single bundle was skidded. The time study data were summarized in table 4.

RESULTS

The data were analyzed using a computerized statistical package (SAS 1979). Linear regression analysis was used to develop equations to predict time for traveling empty to the bundles, consolidating and grappling bundles for skidding, and traveling to the delimbing gate. The following prediction equation was developed by combining the prediction equations with mean times for the other elements of the total cycle.

$$\text{Minutes per cycle} = 0.12 + 0.56 \times \text{bundles per cycle} + 0.27 \times \text{no. stems per cycle} + 0.20 \times \text{skid volume (ft}^3) + 0.004 \times \text{one-way skid distance (ft).}$$

Equation $R^2 = 0.54$

The constant, 0.12, was obtained by consolidating the regression intercept and the means for other cycle activities as explained:

Table 1 *.-Mor-Bell logger specifications*

Item description	Specification
Engine	Deutz 3-cylinder diesel (42 hp)
Dimensions	
width	105 in
wheelbase	106 in
ground clearance	16 in
Boom lift capacities	
full extension	1,500 lbs
half extension	2,000 lbs
full retraction	2,500 lbs
Grapple	
maximum opening	60 in
minimum opening	4 in
Machine weight	6,000 lbs
Ground pressure	10 psi (unloaded)

Note: Specifications are based on manufacturer's literature.

Table *P.-Stand summary*

Species	Trees per acre		
	Initial	Removed	Residual
Pine	276	73	205
Hardwood	166	....	166
Total	464	73	391

Table *3.-Harvested tree characteristics*

Variable	Statistics		
	Mean	Standard deviation	Range
Dbh (in)	5.6	1.6	2.0-10.9
Total height (ft)	45.3	10.0	26.0-65.0
Volume per tree[1] (ft^3)	5.4	4.2	0.21–21.8

[1]Volume to 3-in top (i.b.).

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0.12 = −1.31 (regression intercept for bunching)
+0.34 (gate delimbing mean)
t-O.70 (mean travel time from gate to deck, round trip distance was 350 ft)
+0.393 (deck time mean)

Only with the larger skid loads over approximately 40 ft^3 did the logger have any problems with gate delimbing. Travel time to the deck from the gate was dependent on the same fixed distance during the study. Adjustments to the total cycle time should be made for different distances between gate and deck. Deck time included dropping the load and turning around.

An equipment cost analysis using the standard method of computing straight line depreciation and average annual investment (Miyata 1981) is given in table 5. The cost per machine hour (pmh) is estimated to be $23.15 which includes fixed, operating, and labor costs.

SUMMARY AND CONCLUSION

Production rates and costs were determined for a Mor-Bell logger operating in a commercial thinning of a loblolly pine stand. For an average skidding distance of 600 ft, the hourly production was

Table 4.-*Observed skidding cycle time summary*

Element description	Statistics		
	Mean	Standard deviation	Range
Bunching time (min)			
(consolidating bunches)	1.11	1.15	0.17-4.58
Travel loaded			
travel distance (ft)	797	329	329-l 345
travel time (min)	1.94	1.04	0.70–5.34
volume per cycle (ft^3)	27.89	11.65	13.42–57.20
number of stems	5.9	2.2	3-10
Travel empty			
travel distance (ft)	849	327	353-l 345
travel time (min)	1.77	0.71	0.67-2.79
Gate delimbing time (min)	0.39	0.08	0.20-0.50
Decking time (min)	0.34	0.32	0.10-0.85

Table 5.—*Cost analysis for the Mor-Bell logger*

Item description	Cost[3] per year	Cost[3] per pmh
Fixed Cost:		
Depreciation ($35,500—$3,550)/4	$ 7,987.50	$ 5.32
Taxes, interest & ins. (20% × $23518.75[1])	4,703.75	3.14
	$12,691.25	$ 8.46
Operating Cost:		
Maintenance & repair (60% × $7,987.50[2])	$ 4,792.50	$ 3.20
Fuel ($1.25/gal × 1.1gal/hr) × (1,500 hrs)	2,062.50	1.38
Oil & lube (33% × $2,062.50)	680.62	0.45
Tire replacement ($147.50/year)	147.50	0.10
Tire repair (15% × $147.50)	22.13	0.02
	$ 7,705.25	$ 5.15
Labor Costs:		
Wages ($5.50/hr × 2080 hrs/year)	$11,440.00	$ 7.63
Fringes (25% × $11,440)	2,860.00	1.91
	$14,300.00	$ 9.54
Total Costs:	$34,696.50	$23.15

[1]Average annual investment.
[2]Annual depreciation.
[3]Assumptions: Life = 4 years; Salvage value = 10 percent. Machine hours per year = 1500. Labor hours per year = 2080.

estimated to be 378 ft³. Assuming a machine cost of $23.15 per productive hour, the skidding cost would be $6.12 per 100 ft³ of wood (table 6).

On level terrain, a volume of approximately 40 ft³ caused the lifting of the rear castor wheel and an increase in cycle time. The tricycle configuration and independent hydrostatic drive of the large wheels gave the machine excellent maneuverability within the stand. Bundles were easily consolidated with little observed residual stand damage. The ability of the logger in forming large bundles from small feller buncher bundles gave much flexibility to the feller buncher operation.

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Table B.-Estimated *production and cost rates-skidding and gate delimbing*

Skidding distance	Stems per cycle	Bundles per cycle	Volume per cycle	Total time per cycle	Volume per pmh	Cost per 100 ft³
ft	------------no.------------		*ft³*	*min*	*ft³*	*dollars*
200	4	1	30	3.16	570	4.07
200	4	1	40	3.36	714	3.24
200	4	2	30	3.72	484	4.79
200	4	2	40	3.92	612	3.76
200	6	1	30	3.70	486	4.76
200	6	1	40	3.90	615	3.76
200	6	2	30	4.26	422	5.46
200	6	2	40	4.48	538	4.30
400	4	1	30	3.96	454	5.10
400	4	1	40	4.18	577	4.01
400	4	2	30	4.52	398	5.62
400	4	2	40	4.72	508	4.55
400	6	1	30	4.50	400	5.79
400	6	1	40	4.70	511	4.54
400	6	2	30	5.06	356	8.51
400	6	2	40	5.26	458	5.08
600	4	1	30	4.76	378	6.12
600	4	1	40	4.96	464	4.79
600	4	2	30	5.32	338	6.85
600	4	2	40	5.52	435	5.33
600	6	1	30	5.30	340	8.82
600	6	1	40	5.50	436	5.31
600	6	2	30	5.66	307	7.54
600	6	2	40	6.06	396	5.85
600	4	1	30	5.56	324	7.15
800	4	1	40	5.76	417	5.56
800	4	2	30	6.12	294	7.87
800	4	2	40	6.32	380	6.10
600	6	1	30	6.10	295	7.65
800	6	1	40	6.30	381	6.08
600	6	2	30	6.66	270	6.57
800	6	2	40	6.66	350	6.62
1000	4	1	30	6.36	283	8.18
1000	4	1	40	6.56	366	6.33
1000	4	2	30	6.92	260	8.90
1000	4	2	40	7.12	337	8.87
1000	6	1	30	6.90	261	8.66
1000	6	1	40	7.10	338	6.65
1000	6	2	30	7.46	241	9.60
1000	6	2	40	7.66	313	7.39