INNOVATIVE HARVESTING SYSTEMS IN BOTTOMLAND HARDWOODS

Bryce J. Stokes
Bob Rummcr
USDA Forest Service
Southern Research Station
Devall Drive
Auburn, AL 36849

ABSTRACT

Current and innovative machines and systems for harvesting bottomland hardwoods are described. Four systems are evaluated for production and costs: (1) grapple skidder, (2) clambunk skidder, (3) tree-length forwarder, and (4) shovel logging.

INTRODUCTION

Bottomland hardwood forests are unique in that they provide a diverse range of functions and benefits, including high quality timber and fiber. However, they are also difficult to access and harvest. Logging systems have to be able to operate both efficiently and without excessive site disturbance. Some answers to all these concerns are found in new, innovative technologies and techniques (Jackson and Stokes 1990, Reisinger and Aust 1990).

As the demand for hardwood fiber and logs increases in the South, conventional harvesting methods may not provide acceptable operations on the adverse bottomland hardwood sites (Stokes and Schilling 1997). This paper reviews some current and newly-implemented harvesting machines and systems for bottomlands. Four systems are described and evaluated: (1) conventional grapple skidding, (2) clambunk skidding, (3) tree-length forwarding, and (4) shovel logging.

MACHINES AND SYSTEMS

Historically, chainsaws have been the predominant method of felling in bottomland hardwood stands. When workers' compensation insurance went through the roof in the late 1980's, mechanical feller-bunchers were introduced and have gone through an evolution. originally. rubber-tired machines were used, primarily because of lower costs, but increasing environmental concerns have caused many contractors to utilize tracked, swing feller-bunchers. Swing feller-bunchers may reduce site disturbance by limiting travel and by the use of wide flotation tracks. In any case, the use of feller-bunchers greatly increases the efficiency of the extraction function by bunching the felled trees. Combining the rubber-tired skidder with the feller-buncher continues to be the most common and effective harvesting system. Grapple skidders have become more popular than cable skidders when used with bunching machines. Wide tires and dual tires have continued to make the skidder a feasible wood extraction option (Table 1), but have not completely eliminated lost productivity and higher costs or soil site disturbance on extremely wet sites.

Some alternatives to skidders for ground-based extractions include tree-length forwarders, clambunk skidders, and shovel logging. These machines can either replace or work in combination with skidders and feller-bunchers. Tree-length forwarders can move payloads of up to 23 tons which reduces the number of trips across the site. Since these forwarders can work with limited trail construction, roads are not necessary. Forwarders can load or be loaded in staging areas in the stand. Skidders can be used to move stems from the stump to the staging area. Tree-length forwarders can work at longer distances than skidders and improve efficiency, reduce environmental impacts, and increase the number of operable sites and days of the year.

Stokes, Bryce J.; Rummer, Bob. 1997. Innovative harvesting systems in bottomland hardwoods. In: Meyer, Dan A., ed. Proceedings of the twenty-fifth annual hardwood symposium; 25 years of hardwood silviculture: a look back and a look a head; 1997 May 7-10; Cashiers, NC. Memphis, TN: National Hardwood Lumber Association: 99-102.

Table 1. Skidder tire ground pressures and costs.

Tire size Singles	Ground pressure (psi)	Total cost	Tire size Duals	Ground pressure (psi)	Total cost
23.1x26	7.1	$8,600	23.1 (2)	4.0	$17,200
28Lx26	5.9	9,800	28L (2)	3.4	19,600
30.5x32	5.3	12,400	34.00 (2)	3.2	28,000
66/43.00-26	4.1	14,800	24.5+30.5	3.4	23,000
72x68-28	2.6	39,400	28L + 43.00	2.8	24,600

Note: Based on a John Deere 548G[1] skidder weight.

Clambunk skidders, like tree-length forwarders, can extend extraction distance and reduce site impacts by reducing road construction and number of passes over the site. Six and eight-wheel drive clambunk skidders have been manufactured by various companies, but have not been widely used because of their large size and high price. A smaller, less expensive four-wheel drive clambunk capable of skidding 15-ton loads was introduced in 1993 (Schilling 1993). Clambunk skidders generally are self-loading, but with limited maneuverability are more productive loading pre-bunched material along a main trail. The effective extraction distance of clambunk skidders lies between conventional skidders and tree-length forwarders.

Shovel loggers are hydraulic knuckleboom loaders which are adapted to heavy swing applications. Shovel loggers have been used for extraction in the Pacific Northwest (Andersson and Jukes 1995, McNeel and Andersson 1993) to extract wood short distances to roadside. Typically, tree-length stems or logs are picked up, swung 180° toward the deck or roadside, perpendicular to the direction of travel of the shovel. In effect, the wood is moved two lengths of the boom: this distance is increased by grappling longer stems near the end.

In bottomland operations, shovel loaders pile felled trees in a long corridor of stems. The trees are laid down end-to-end which provides a continuous mat to support skidders. The shovel machine builds the mat from bunches made by the feller-buncher, and then loads the skidder as it picks up trees from the working end of the wood corridor. With long reach and wide tracks, shovel loaders minimize site disturbance. Corridor spacing can be two to three times the boom reach of the machine.

Cable systems and helicopters have also been used in wetlands on a limited basis. The primary advantage of such systems is the ability to extract wood in areas which will not support ground systems. Such systems offer greater access, reduce site impacts, and offer operability during the winter. Murray (1996) describes a cable system operating in Georgia which uses mobile intermediate supports for a multi-span standing skyline. A tracked feller-buncher cuts the timber which is shoveled about 300 ft laterally to the skyline. This yarder has an extraction capacity of about 2,500 ft. Helicopters are being used more frequently on wet sites but require larger tree sizes and short distances to be cost-effective. This system causes the least disturbance except for the building of decks and roads. Both of these systems require large capital investments, high operating costs, and well-trained, skilled crews.

MACHINE COSTS

Table 2 summarizes some current, representative price information for the mentioned machines (Brinker 1997). The larger and more specialized machines cost more, also usually indicating higher operating costs:

[1]The use of trade names and brands is for readers' convenience and does not constitute or imply an endorsement by the authors or the USDA Forest Service.

Table 2. Costs of representative wetland logging quipment.

Machine	Make/Model	Tiitracks	Purchase Price
Cable skidder	Franklin 405	23.1x26 duals	$95,000
Grapple skidder	Timberjack 450C	28Lx26 duals	139,000
Grapple skidder	Timberjack 480C	28Lx26 duals	181,000
Clambunk skidder	Franklin 170	24.5x32 duals	163,000
Clambunk skidder	Timberjack 933C	20.5x25	418.000
Clambunk skidder	Ardco "N" 6x6	66/43.00-25	460,000
Swing feller-buncher	Timbco T425-B	tracks	239,000
Swing feller-bunch&r	Timberjack 608	tracks	249,000
Swing feller-buncher	'Iigercat 860	tracks	319,000
Drive-to-tree feller-buncher	John Deere 643D	28Lx26	174,000
Drive-to-tree feller-b&her	Franklin C5000	28Lx26	174,000
Tree-length forwarder	Ardco "K" 6x6	66/43.00-25	234.000
Shovel loader	Timberjack 735	tracks	255,000

SYSTEM EVALUATIONS

In order to compare among alternatives, the selected systems' production rates were estimated using spreadsheets to combine stand information, production equations, and cost information. Four systems were modeled: (1) swing feller-buncher with grapple skidder, (2) swing feller-buncher, grapple skidder, clambunk; (3) swing feller-buncher, grapple skidder, tree-length forwarder; and (4) swing feller-buncher, shovel loader, grapple skidder. All systems included manual topping with chainsaws. A representative bottomland hardwood stand from an actual cruise was used. The stand had 139 trees per acre, merchantable volume of 13 tons per acre, and a quadratic mean DBH of 11 .O inches.

Production functions were developed for a clambunk skidder, shovel loader, and swing-to-tree feller-buncher using standard production and time study methods. Productivity functions of tree-length forwarders, grapple skidders, and loaders were selected from previous studies. Machine costs were estimated using the machine rate approach and current price data.

Production and cost estimates are shown in Table 3. Each system was modeled at the actual observed extraction distances and varied by system. The lateral distance is the average distance from the stump to the main trail (prebunch distance). The extraction distance is the one-way distance of primary transport. These distances are representative for each specific system, but the different distances make it difficult to make direct comparisons between systems.

SUMMARY

Harvesting systems for bottomland hardwoods need to be able to operate in extremely difficult, but fragile conditions. They need to be both economical and friendly to the environment. Conventional systems are being modified to help meet these constraints, but innovative technologies are still needed.

This paper described the major ground-based options and estimated system costs. However, these systems have inherently different extraction distances that make these estimations uniquely non-comparable. In selecting systems, other factors such as road construction and reduced site impacts must also be considered.

Table 3. Estimated production and cost for selected logging systems.

System	Lateral distance (ft)	Extraction distance (ft)	System (Tons/SMH[1])	System ($/SMH)	$/ton
Feller-buncher, grapple skidder	-	700	32.6	172	5.26
Feller-buncher, grapple skidder, clambunk	350	1200	35.3	220	6.24
Feller-buncher, grapple skidder, forwarder	350	5500	32.3	214	8.21
Feller-buncher, shovel, grapple skidder	-	900	44.8	238	5.29

[1]SMH is scheduled machine hours.

REFERENCES

Andersson, B. and W. Jukes. 1995. Harvesting coastal second-growth forests: two case studies. Technical Note TN-232. Pointe Claire, Quebec: Forest Engineering Res. Institute of Canada. 13 p.

Brinker, R. 1997. Personal communication.

Jackson, B.D. and B.J. Stokes. 1991. Low-impact harvesting systems for wet sites. In: Coleman, S.; Neary, D.G., comp., eds. Proceedings of the 6th Biennial Southern Silvicultural Research Conference; 1990 October 30-November 1; Memphis, TN. Gen. Tech. Rep. 70. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 701-709. Vol. 2.

McNeel, J. and B. Andersson. 1993. Shovel logging with different retrieval patterns. In: Proceedings of the 16th annual COFE meeting; 1993 August 8-l 1; Savannah, GA. Corvallis, OR: Council on Forest Engineering. 14 p.

Murray, H. 1996. Western cable yarding and Georgia swamp harvesting. Technical Release 96-R-13. Washington, DC: American Pulpwood Association. 2 p.

Reisinger, T.W. and W.M. Aust. 1990. Specialized equipment and techniques for logging wetlands. Paper 90-7570. St. Joseph, MI: American Society of Agricultural Engineers. 11 p.

Schilling, A. 1993. Franklin's clambunk skidder. Technical Release 93-R-67. Washington, DC: American Pulpwood Association. 2 p.

Stokes, B.J. and A. Schilling. 1997. Improved harvesting systems for wet sites. Forest Ecology and Management 90(1997) 155-160.