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Improved harvesting systems for wet sites

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Abstract

Environmentally acceptable and economical forest operations are needed for sustainable management of forest resources. Improved methods for harvesting and transporting timber are especially needed for wet sites. As the demand for hardwood lumber continues to increase, improved and alternative methods are needed to ensure acceptance of timber harvesting for the wet site conditions that are typical of bottomiand hardwoods. Some alternative technological developments include grapple saw feller-bunchcrs, wide tires, larger forwarders. clambunk skidders, two-stage hauling, mats, cable systems. helicopters and towed vehicles and air-cushioned vehicles. These developments have the potential to improve the performance of the harvesting system and to reduce the negative effects of conventional operations on conventional sites and on difficult sites such as wet areas. Although many of these new alternatives are now operational, others are just concepts or evolving prototypes. More research is still needed to optimize these alternative technologies and to reduce costs associated with their implementation.

Keywords: Bottomland hardwood; Timber harvesting; Wet site

1. Introduction

Bottomland hardwoods cover 24% of the timberlands in the southeastern United States and 21 % in the south-central United States (Saucier and Cost, 1988; McWilliams and Faulkner, 1991). Because of frequently wet soils, these sites are difficult to harvest using conventional harvesting systems.

The demand for hardwood pulpwood and lumber products has increased significantly since the late 1980's due to growing domestic markets for higher quality paper products, lower furnish costs and more stable export markets. Exporting hardwood chips from gulf and Atlantic ports has resulted in the construction of chip-handling facilities along major waterways and the expansion of hardwood harvesting in the bottomlands.

New cost-effective and environmentally acceptable methods, including grapple saw feller-bunchers, wide tires, larger forwarders, clambunk skidders, two-stage hauling, mats, cable systems, helicopters, and towed vehicles and air-cushioned vehicles are being developed to harvest these sites. Some of these systems are currently operational while others are still evolving and need additional evaluation. These new alternative methods of harvesting bottomland hardwoods are examined in this article.

2. Harvesting systems

Feller-bunchers (Fig. 1), grapple skidders (Fig. 2) and tractor-trailers now typify the prevalent harvest-

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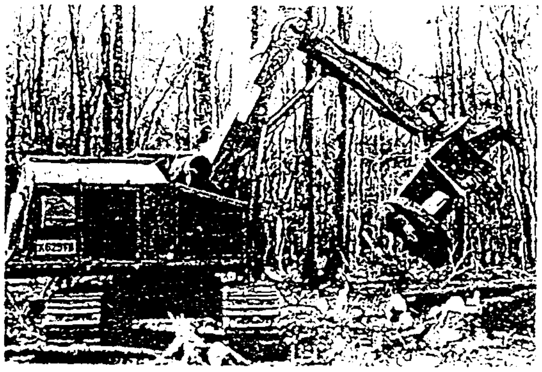

Fig. 1. Tracked, swing feller-buncher with felling saw.

ing system. In 1986, lull-tree and tree-length harvesting accounted for 94% of logging harvests in the United States (McCary, 1991). Stokes (1988) reported that the American Pulpwood Association's survey of wetland loggers in 1986 revealed that over 50% of the felling was mechanized and 96% of the timber was extracted by ground skidding (50% used rubber-tired skidders only). Jackson (1990) surveyed loggers operating in the Mississippi River Delta and found them to be less mechanized than loggers elsewhere in the United States. Almost 90% used chainsaw felling only; however, 98% used rubber-tired skidders. Some of the Mississippi River Delta loggers also used crawler tractors and forwarders in addition to the rubber-tired skidders.

Mechanization has replaced many typically labor-intensive harvesting Iunctions because of the increased insurance cost and decreased availability of workers. Chainsaw felling, a method of high-risk for the worker, has been replaced by mechanized felling saws wherever possible.

Wet soils reduce operational efficiency, increase costs and reduce profits. Unacceptable residual effects on the site are degradation of site productivity, water quality and aesthetics. The forest industry and loggers realize the value of minimizing site damage and are looking for low-impact harvesting systems (Jackson and Stokes, 1991).

3. Felling

Many operations have added swing, tracked feller-bunchers. Such machines. although costly, reduce disturbance by limiting the amount of travel on the site and by using wide tracks. On extremely wet sites. portable mats can be used to increase mobility on the site and yet reduce the amount of cite disturbance.

Integrating limited processing and piling into the felling function can reduce the subsequent negative effects of removing the felled trees from the site. A grapple-saw on a swing feller-buncher is a development soon to be tested for felling on difficult terrain. It will reduce the weight on the end of the boom and allow the felling machine to perform limited bucking and topping. Such a machine can cut the trees, cut off the tops and some of the larger limbs, buck the logs and pile and shovel the stems. Integrating limited processing and piling into the felling function can reduce subsequent extraction impacts.

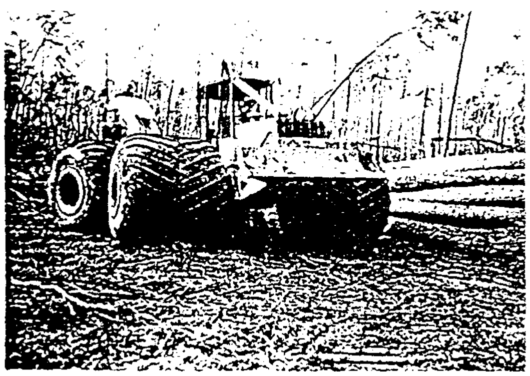

Fig. 2. Grapple skidder with 100-cm wide tires

4. Skidding

Historically, track skidding has been relatively expensive. Rigid, steel-track carriers, such as crawler tractors, use a towed arch or have an arch mounted on the machine to support the load. In the 1970's, flexible track machines, adapted from the military, were designed for wet site applications. Many rigid, steel-track carriers were pushed past their capabilities, and spiraling costs forced the use of other options, such as skidders with wide tires. However at the present time, track skidding still has potential uses in forestry.

Rubber-tired skidding has been the most widely used and cost-effective wood extraction method. Because the cable skidder is able to operate under extremely difficult conditions and the grapple skidder is highly productive and relatively safe using cable-grapple for rubber-tired skidders is an option for use on wet sites (Stokes and Rawlins, 1989). Cable-grapple skidders combine the advantages of both methods. This relatively old, cable-grapple technology has had limited acceptance in the southern United States.

Using dual tires will improve skidding flotation on wet sites. The dual tire option has proven to be a cost-effective alternative, giving the contractor some flexibility in adapting quickly to wet sites and wet seasons (Koger et al., 1984). Dual tires may enable the skidder to work in harsh conditions by improving traction, but still may leave the site with high levels of disturbance.

Several studies have shown that wide tires provide better flotation. Porter (1984) reported that on wet sites wide tires (1000 mm and greater) provide access to more timber, decrease soil damage, and reduce damage to the residual stand. He also listed disadvantages such as high costs, reduced reliability, loss of maneuverability, and increased maintenance. Over time, the common tire width has increased from about 700 mm to about 900 mm with many operations in the southern coastal area of the US using about 1000 mm or larger tires.

Wide tires are just now becoming acceptable in the southern United States. Such tires can exert less than 21 kilopascals (kPa) of pressure on the soil as compared to over 30 kPa of pressure for small tires and are still relatively maneuverable. In some cases, wide tires tend to minimize the effects of skidders on wet soils (Rollerson, 1990; Aust et al., 1991, 1993).

5. Forwarders / clambunks

Large forwarders (Fig. 3) have been used on wet areas and steep slopes with some success (Jackson et al., 1990; Stokes et al., 1992). In eastern Canada, wide-tired forwarders have shown: (1) increased access to timber without building roads, (2) improved stability, safety, and comfort, (3) adaptability to wet season logging, (4) less maintenance and more productivity because of their flotation ability, and (5) reduction, if not elimination, of residual damage to the site. Tree-length forwarders can move payloads of up to 22 metric tons and, with wide tires, have a loaded static pressure of about 47 kPa. This type of machine has the ability to move felled timber up to a distance of 8 km. Large payloads reduce the number of passes required on the same trail.

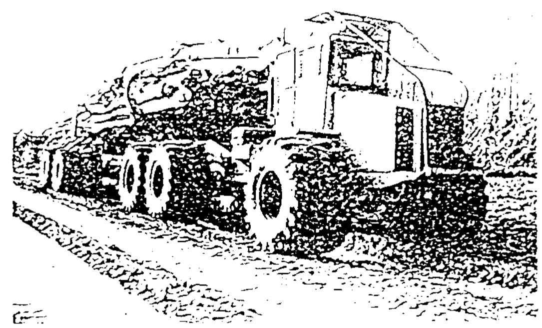

Fig. 3. High capacity, tree-length forwarder.

Clambunk skidders have been used successfully to skid large payloads over long distances. Various companies have produced six- and eight-wheel drive clambunks, but they have not been widely accepted due to their overall size and price. The large size makes them difficult to move over public roads from one location to another.

A recently introduced four-wheel drive clambunk capable of skidding loads of approximately 14 metric tons has been successfully used to skid felled trees distances of about 1.5 km. This machine has a list price of about one-third that of six- or eight-wheel drive clambunks, therefore, the use of clambunk skidders is becoming more feasible.

Two-stage hauling uses conventional rubber-tired skidders or clambunk skidders to skid to a remote landing. This system keeps skid distances at a productive level. At the remote landing, the logs are loaded onto a tree-length forwarder and carried long distances to an all-weather road where the load is put onto a haul truck. This method reduces road construction dramatically.

Alternatives to building roads are specialty equipment that can haul on lower quality roads or that can transport the logs farther without the use of roads.

Table 1
Harvesting systems for wet sites

Machine	Tires/tracks (width)	Loaded ground pressure (kPa)	Approx. purchase price ($US)
Cable Skidder	Single tires (1100 mm)	41.4	120000
Cable Skidder	Dual tires (590 mm)	37.9	110000
Grapple Skidder	Single tires (1100 mm)	48.3	130000
Cable Skidder	Flex tracks (560 mm)	58.6	175000
Cable Skidder	Rigid tracks (800 mm)	48.3	200000
Large Forwarder	Single tires (1100 mm)	48.3	160000
Large Forwarder	Single tires (1100 mm)	44.8	120000
Clambunk	Single tires (1100 mm)	51.7	300000
Clambunk	Single tires (1700 mm)	34.5	350000

Matting and central tire inflation systems are ways of using low-quality roads for transport. Tree-length forwarders, as discussed above, can move wood farther without roads. More research is required to completely understand these options and to properly select and apply the technology as it is developed. A comparison of loaded ground pressures, tire sizes and approximate costs of the optional ground-based extraction machines is shown in Table 1.

6. Aerial systems

Cable systems and helicopters (Fig. 4) have been used on a very limited basis. The primary advantage of these systems is a reduction in site disturbance; however, disadvantages are higher costs and sensitivity to tree size. Helicopters are being used more frequently on wet sites (Willingham, 1989). They cause the least site disturbance except for the building of decks and roads. Although they may be cost-effective in certain situations, but are not the answer to all the problems of harvesting wet sites because of usually higher costs, material and weather sensitivity and implementation problems.

Fig. 4. Helicopter logging system

7. Other harvesting methods

Other new methods for harvesting timber on wet sites are towed vehicles, specialty matting and lift devices. If traction is provided by a cable and winch at the roadside, then specially designed, lightweight vehicles can carry more wood and cause less rutting. Since slip is zero, soil movement is reduced. Specialty matting and matting-handling equipment may provide access to the more difficult sites. Currently, matting is a cumbersome, unsophisticated method of log removal, but it may become the major method in the future.

Air-cushioned vehicles have gained much acceptance in military applications and are almost environmentally benign. If combined with a cable and drum set, a lull barge of trees can be floated across wet sites, streams, swamps, etc., reducing the need for constructing roads for access to the site and reducing site damage from ground sled operations. If used with tow machines, such as skidders, air-cushioned vehicles can transport logs over unimproved skid trails instead of needing haul roads.

More research is required to completely understand these methods and to properly select and apply the technology as it is developed.

8. Conclusion

New developments for extracting' logs from wet sites include new and/or improved operating methods and techniques. These alternative methods cause less damage to the environment and are more cost-effective for working on wet sites than conventional methods. Some alternative technological developments include specialized felling machines, wide tires, large-capacity forwarder-s and clambunk skidders, mats, cable systems, helicopters, towed vehicles, and air-cushioned vehicles. Acceptable methods and equipment for timber harvesting on wet sites must continue to be developed.

9. Selected definitions Stokes et al., 1989

Cut-to-length	Bolewood components of a tree. cut to desired lengths.
Feller-buncher	Self-propelled machine designed to fell standing trees and arrange them in bunches.
Forwarder	Self-propelled machine, usually self-loading, designed to transport trees or parts of trees by carrying them completely off the ground.
Full tree	All components of a tree, except the stump.
Grapple saw	Attachment to fell standing trencher; grapples tree before cutting.
Skidder	Self-propelled machine designed to transport trees or parts of trees by tracking or dragging.
Cable	Uses a main winch cable and cable chokers to assemble and hold it.
Grapple	Uses a grapple or bottom-opening jaws to assemble and hold a load.
Tree-length	Entire tree, excluding the unmerchantable tops and limbs.

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