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Steep Slope Logging Slash Treatment

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ABSTRACT

Prescribed burning has been widely used to eliminate slash resulting from logging operations, particularly on steep slopes (50 to 100 percent). However, air pollution concerns are driving requirements to reduce smoke emissions. These requirements have resulted in limited prescribed burning or no prescribed burning. This can cause increased fire hazard if the slash is not handled and/or treated by other means. The objective of this project is to develop concepts and strategies for handling and treating steep slope logging slash that will reduce the fire hazard and smoke emissions to acceptable levels.

Traditionally, management of National Forest lands has been broken into individual components, i.e., timber harvest, fuels management, etc., that are discharged separately or stand alone. In this project we are attempting to integrate the various management practices into a systems approach. Thus, we advocate maximizing the efficiency of the whole system, rather than individual components. For example, removing the slash during logging makes the harvesting operation less efficient but may provide real savings overall when site preparation, fuels reduction, and fire suppression costs are greatly reduced.

The goal of this project is to find ways to reduce the fire hazard caused by logging slash on steep slopes, with the major constraint being that the traditional method, broadcast burning, is not available. Changes in policy, procedures, and equipment are required. A pilot project to test the effects of these changes is needed. To summarize, the following hypotheses must be examined and tested:

1. Lower, and continue to lower, the utilization standards (to smaller piece sizes) so that most of the usable fiber (slash) will be removed.
2. Locate/develop equipment to efficiently handle smaller pieces and allow utilization of all fiber. Look for solutions internationally; forest managers in northern Europe have made utilization a priority for many years.
3. Whole-tree (or full-tree) yarding and transporting, in-woods and on-landing chipping and chip transporting, and using slash for energy needs should be encouraged.
4. Recognize that we will still need to deal with what is left after logging. The current trend is to leave more material on the ground after logging for soil protection, wildlife habitat, and seedling protection. A cost/benefit analysis is needed.
5. Locate/develop equipment to treat slash on steep slopes. Missoula Technology & Development Center (MTDC) has identified self-leveling excavators and slash-mulching heads that can operate on slopes up to 50 percent in some cases and, in one case, up to 70 percent. Therefore, these efforts should concentrate on steeper slopes.
6. Find ways to safely and economically utilize the available human resources in the forest industry to perform slash reduction and site preparation on steep slopes.
7. Study new innovative methods of treating slash in the woods so that it will decay rapidly, thereby reducing the fire hazard and returning nutrients to the soil. This may include the use of water and/or chemical or biological agents to speed decay.

INTRODUCTION

The practice of fuels treatment following logging operations is in a transitional period. The requirement of reducing the fire hazard has not changed, but new requirements to reduce smoke emissions are constraining land managers by limiting prescribed burning. Mechanized equipment to pile, crush, or mulch slash in place is an available alternative to burning, but currently can only be accomplished on gentle to moderate slopes (less than 50 percent).

Therefore, this project focuses on identifying policies, techniques, and equipment for reducing the fire hazard, without open burning, that is created by logging slash on slopes greater than 50 percent.

Traditionally, management of National Forest land has been broken into individual components, i.e., timber harvest, fuels management, etc., that are discharged separately or stand alone. In this project we are attempting to integrate the various management practices into a systems approach.

Thus, we advocate maximizing the efficiency of the whole system, rather than individual components. For example, removing the slash during logging may make the harvesting operation less efficient but may provide real savings overall when site preparation, fuels reduction, and fire suppression costs are greatly reduced.

CURRENT SLASH TREATMENT PRACTICES

Following most timber harvests today, slash is treated in some fashion. Slash is either yarded to the landing for chipping or burning, broadcast burned, hand piled, or, on moderate slopes, machine piled, left in place or burned in place.

With the decline in broadcast burning, hand piling, particularly on steep slopes, may be the only available option. However, it is very expensive, time consuming, and inherently dangerous. Costs vary, depending on site conditions, but can be estimated from $300 to $600 or more per acre.

EFFECTS OF UTILIZATION STANDARDS

The current trend in utilization standards is toward smaller piece sizes. Some advocate using "all" fiber from the forest. This would certainly eliminate the slash left on site after logging.

However, in the past decade, the trend has been away from the total cleanup concept. The current trend on timber sales has been to leave more material on the ground after logging for soil, watershed, wildlife habitat, and seedling protection. Land managers must use cost/benefit analysis to determine what amount of logging debris should be left.

Too much slash left will lead to fire hazards. Too little will not meet soil and watershed protection, and wildlife and silvicultural objectives.

EFFECTS OF LOGGING TECHNIQUES ON SLASH

We will attempt to take a systems approach to the steep slope slash problem. To examine this problem, a flow chart was developed to trace the many possible paths in the logging cycle that slash can take—from its creation to utilization or treatment.

Figure 5 illustrates the many paths slash can take during logging operations on steep slopes. While this diagram may not be comprehensive (prebunching is not shown, for instance), it does show that slash can be handled via several routes in the logging process.

What follows is an attempt to define how different logging techniques can effect slash production, handling, and treatment.

Falling

Falling can be accomplished by conventional falling, directional falling, or by a mechanical feller buncher. Conventional falling is the falling method most commonly used.

Directional falling can be used to reduce the amount of breakage and slash created during cutting. Wedges, hydraulic jacks, and/or cable winches are used to push (or pull) the tree in the direction that causes the least damage to the saw logs but also keeps more limbs and tops intact.

By falling uphill, particularly on steep slopes, the tree can be dropped with a gentle "thud" rather than crashing to the earth after falling much farther downhill.

An additional benefit is that the trees tend to be better oriented towards the cable landing. Research has shown that directional falling is no more costly than conventional falling because there is less breakage resulting in greater utilization.

Feller bunchers can also be used to lay down a tree more gently, but are limited to slopes of 70 percent or less. Cut-to-length harvesting systems process logs at the stump and mash the slash in the skid trails, thereby reducing the slash problem. They are limited to gentle ground slopes, generally less than 50 percent.

Only one feller buncher machine, Allied ATH-28 Feller Buncher, is known to be presently manufactured that will operate up to 70 percent slopes. See figure 1 on the next page.

Figure 1.—Feller buncher capable of operating up to 70 percent slopes manufactured by the Allied Systems Company of Sherwood, Oregon. This Model ATH-28 (ATH for Allied Tree Harvester) is equipped with a four track (each is a D6D size track) system. Each track is independently hydraulically driven and can pivot up or down 30° (60° total movement) about the track mounting. The track suspension is also such that all four tracks will remain in contact with the ground.

Delimbing and Topping

Conventional in-woods delimbing and topping with a chain saw results in slash scattered throughout the cutting unit. In-woods delimbing is hazardous for the sawyers and has a significant effect on production. To maximize the number of trees felled per hour, delimbing and topping can be accomplished at the landing, where mechanized processors can do the job more precisely and efficiently.

Also, when trees are processed at the landing, the slash can be more easily handled (in bulk and by mechanical equipment) and treated.

Following in-woods delimbing and topping, the resulting slash can be dealt with in a number of ways. Traditional broadcast burning eliminates the slash and leaves a clean appearance but results in undesirable smoke emissions. It also sometimes causes scorched topsoil, damaged adjacent trees, or wildfires.

Many view this burning as a waste of energy resources. If it is to be burned, why not use the resulting energy?

Piling before burning reduces fire containment problems but may exacerbate the scorched topsoil problem, albeit over a smaller area; and smoke emissions may not be reduced below acceptable limits. Machine or hand piling on steep slopes can be difficult and expensive.

In-place mulching or off-road chipping may be feasible, though expensive. Another method that may work in some areas, where water is available, is to wet down the slash one or more times to promote decay and/or use chemical solutions or biological organisms to encourage natural decay.

Machines to mechanically treat the slash, when delimbing and topping are done on the slopes, are very few. The Missoula Technology & Development Center (MTDC) prepared a report titled "Site Preparation Equipment for Steep Slopes" and the only machine listed that will operate on over 50 percent slopes is the climbing backhoe.

Other machines that may operate on slopes above 50 percent are the Allied ATH-28 Feller Buncher, which is claimed to be able to operate up to 70 percent slopes, and the New Zealand Hydraulic Excavator Roller Crusher. A limitation of the Excavator Roller Crusher is that the unit must work from the top of the slope and also be able to move along the slope in order to cover the area in need of treatment.

Figure 2.—Hydraulic excavator from New Zealand, equipped with roller crusher for operating on steep slopes. Swagged wire rope from two winches controls path of roller.

Yarding

Whole-tree (or full-tree) yarding can increase productivity by reducing the chokers required per produced log. This increases turn sizes, eliminating limbing and bucking by sawyers on steep slopes, allowing more efficient processing at the landing where slash can be more readily handled, treated, and utilized. In addition, worker safety may be enhanced since whole trees do not roll downhill as easily as delimbed logs. Drawbacks include: expensive processors are required, landings must be larger and can become clogged, and residual stand damage may be greater.

Pre-bunching slash by hand, using a low-cost yarding system, is an alternative to whole-tree yarding and/or yarding material that is not merchantable with high-cost yarding equipment. Systems, such as the Zigzag, yard the slash material to the landing. This makes sense economically because high-value equipment can move on to more productive work. However, this also means working the same ground twice.

Landing

Large processing machines that delimb, debark, or chip (or combinations of these functions) at the landing or other central location are becoming widely used. Other machines shred, grind, and/or bale wood fiber. Most can handle more fiber than one logging side can deliver to them. Wood chips can be machine separated for use as pulp, particle board, and hogged fuel. If haul distances are long, and therefore prohibitively expensive, the chips can be blown onto the ground to recycle the nutrients. The chipped material can be mechanically spread along roads.

A machine which can spread chips along a road is the Aero-Spread, manufactured by Highway Equipment Company of Cedar Rapids, Iowa. This machine can disperse material up or down slopes to distances up to 200 feet, and has done so in Alaska (figure 3).

Figure 3.—Aero-Spread, manufactured by Highway Equipment Company of Cedar Rapids, Iowa, can spread chips as far as 200 feet up or down slopes along a road.

Integrated harvesting and processing can maximize the usage of wood resources and utilize these resources in their highest-value product forms. It makes sense from the standpoint of ecosystem management, fire protection, reforestation, and energy savings.

Another treatment alternative to dispose of slash, which has been brought to the landing or other central location, is the use of an air curtain destructor. The air curtain destructor system uses large blowers to deliver a stream of air into a burning pit to provide high-temperature burning yielding small amounts of ash and greatly reducing smoke emissions. If operated properly, no smoke is visible (figure 4).

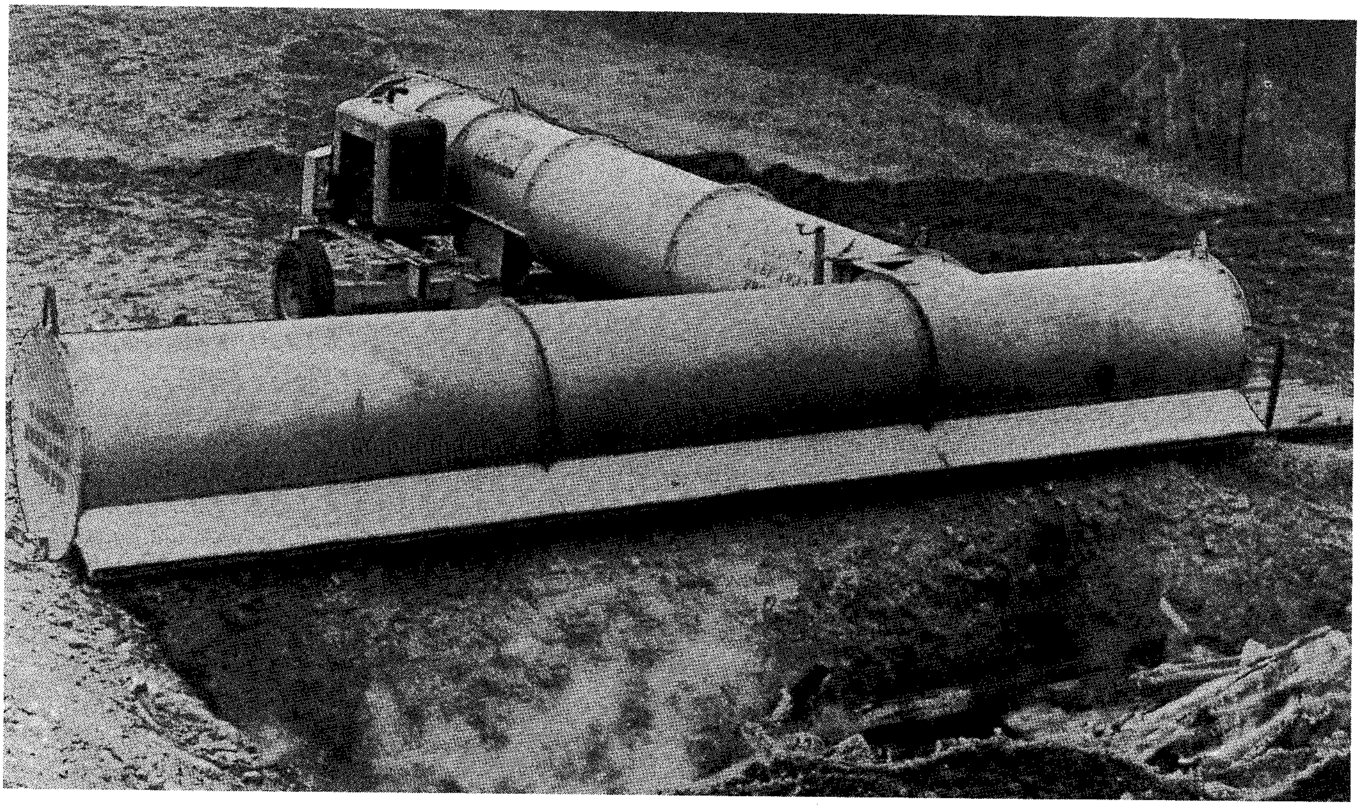

Figure 4.—Air curtain destructor in operation. Note, there is very little visible smoke.

Transportation

Wood chips for pulp (paper) and hogged fuel (energy) have traditionally been hauled in 45-foot "chip vans." However, "B-train" trailers should be more cost effective because they can haul a larger payload. Since clean chips for pulp are purchased for several times the cost of dirty chips for hogged fuel, it may be cost effective to use some mechanical method to sort chips at the landing—then transport only the high-value chips.

Because it may take more than one logging operation to keep a whole-tree processor supplied, it may be more feasible and practical to locate a whole-tree processor operation on a main haul road and transport whole trees from several logging operations to that location. However, new forwarders, trailers, or containers, and new loading methods may need to be developed to transport whole trees.

Rail and barge transportation methods are cost effective ways to move large quantities of biomass, but new routes and possibly new loading, handling and feeding equipment may be necessary to make use of biomass at cogeneration plants or mills.

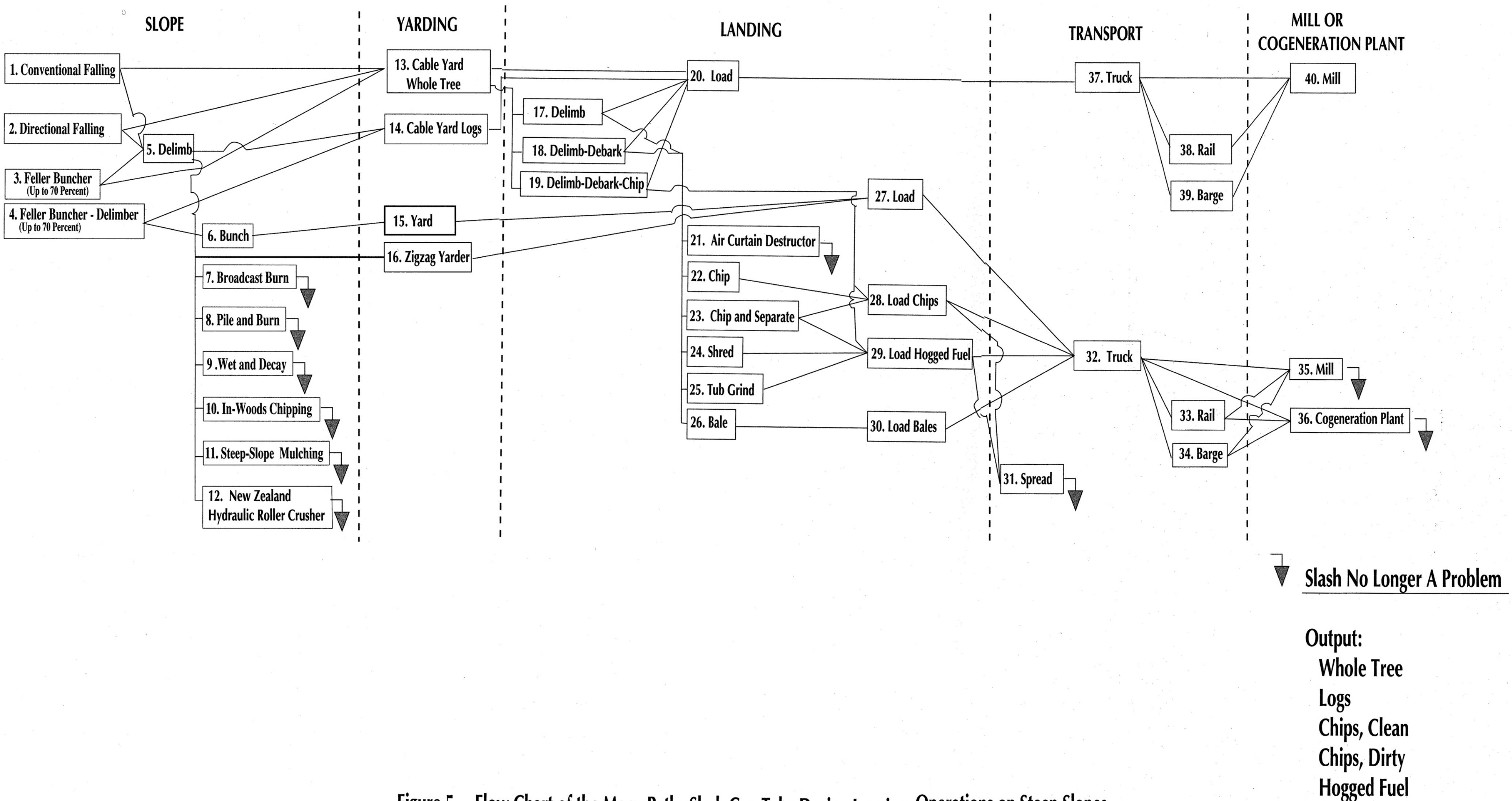

Figure 5.—Flow Chart of the Many Paths Slash Can Take During Logging, Operations on Steep Slopes.

IDENTIFICATION OF FIGURE 5.—BLOCKS

Blocks 1 & 2—Falling, conventional and directional falling costs are very close and for this systems approach can be considered a wash cost.

Block 3—Feller Buncher falling, the Allied ATH-28 Feller Buncher can work up to 65 to 70 percent slopes. The cost of this machine is $450,000 to $500,000 and would cost about $450 to $500 per hour to operate. Production rates of this machine have been measured at 195 and 225 stems per hour.

Block 4—The Allied ATH-28 Feller Buncher could be equipped with a feller-buncher-delimber and do the felling and delimbing all in one operation. The cost of the equipment would be $500,000 to $550,000 and costs about $500 to $550 per hour to operate.

Block 5—Delimbing and topping on the slopes with chain saws result in slash on the slopes. This slash then must be treated by a method in blocks 6, 7, 8, 9, 10, 11, or 12.

Block 6—Bunch slash so it can be yarded out. This is labor intensive, particularly on steep slopes, and very costly. Therefore, this operation should be avoided.

Block 7—Broadcast Burn is the method that has been used but is no longer available.

Block 8—Pile and Burn has also been used, but is both labor intensive, hazardous on steep slopes, and costly. Also, in many areas burning is no longer allowed; therefore, this method is not available in these areas and is therefore not considered in this analysis.

Block 9—Wet and Decay is an untried method where the slash would be sprinkled during warm weather to increase moisture and hasten decay. Wetting agents, other chemicals, or biological organisms could be used to enhance and hasten natural decay.

Block 10—In-Woods Chipping on steep slopes is slow and costly and should be avoided.

Block 11—Steep-Slope Mulching, using a climbing backhoe, is a method of treating the slash without burning. This is a slow and costly operation. The Olympic National Forest has experienced costs of about $1,000 per acre using this method.

Block 12—The New Zealand Hydraulic Excavator Roller Crusher can treat slash on steep slopes if the machine can get above the slope and move along the top of the slope, rolling the crusher up and down. Cost of this machine is estimated at $150 to $200 per hour.

Block 13—Cable Yard Whole Trees or yard with tops attached.

Block 14—Cable Yard Logs. For this system's approach, cost for cable yarding logs, cable yarding whole trees, or cable yarding trees with tops attached can be considered a wash cost. Costs are essentially the same and therefore have no effect on the total cost.

Block 15—Yard bunched slash. This is additional to yarding.

Block 16—Zigzag Yarder. The Zigzag yarder is labor intensive and would add considerably to the cost of treating the slash as compared to whole-tree yarding.

Block 17—Delimb at landing and haul out whole trees.

Block 18—Delimb-Debark at landing and haul out whole trees.

Block 19—Delimb-Debark-Chip at landing and haul out logs and chips. There are machines, commercially available, to do these operations.

Block 20—Load logs. The cost of loading logs for this study can be considered a wash cost for whole trees, delimbed trees, and delimbed and debarked trees.

Block 21—Air Curtain Destructor. By use of an air curtain destructor, all the slash yarded to the landing can be burned cleanly.

Blocks 22, 24, & 25—Chip, Shred, or Tub Grind limbs and tops. There are a number of heavy-duty machines commercially available for chipping, shredding, or grinding. The operating costs of these machines are very close to each other.

Block 23—Chip and Separate. There is, commercially available, chipping equipment that will chip material and separate the high value clean chips from the other material.

Block 26—Bale limbs and tops. The University of California at Davis has fabricated working prototype hardware for baling and handling slash.

Blocks 27, 28, & 29—Load chipped, shredded, or ground material. Cost of loading chipped, shredded, or ground material can be considered a wash cost.

Block 30—Load Baled material. Baled material can be loaded with a log loader at little additional cost to the operation.

Block 31—Spread chipped, shredded, or ground material along logging roads. The Highway Equipment Company of Cedar Rapids, Iowa, manufactures a truck mounted spreader that is able to spread wood chips and other material along a road up or down slopes to about 200 ft. Cost to operate this spreader is estimated at $100 per hour.

Blocks 32 & 37—Truck transportation. Large trucks can be operated for $2 to $3 per loaded mile.

Blocks 33 & 38—Rail transportation. Rail transportation, when available, is generally more economical than hauling by truck.

Blocks 34 & 39—Barge transportation. Barge transportation, when available, is generally the lowest cost transportation for large quantities of bulk materials.

Blocks 35, 36, & 40—Mill and Cogeneration Plants. Transportation of logs and processing at the mill will be a wash cost in this analysis. Transportation of the chipped, shredded, or ground material to a mill or cogeneration plant will be an added cost that, hopefully, will be more than offset by the value of the chipped material or other material as hogged fuel.

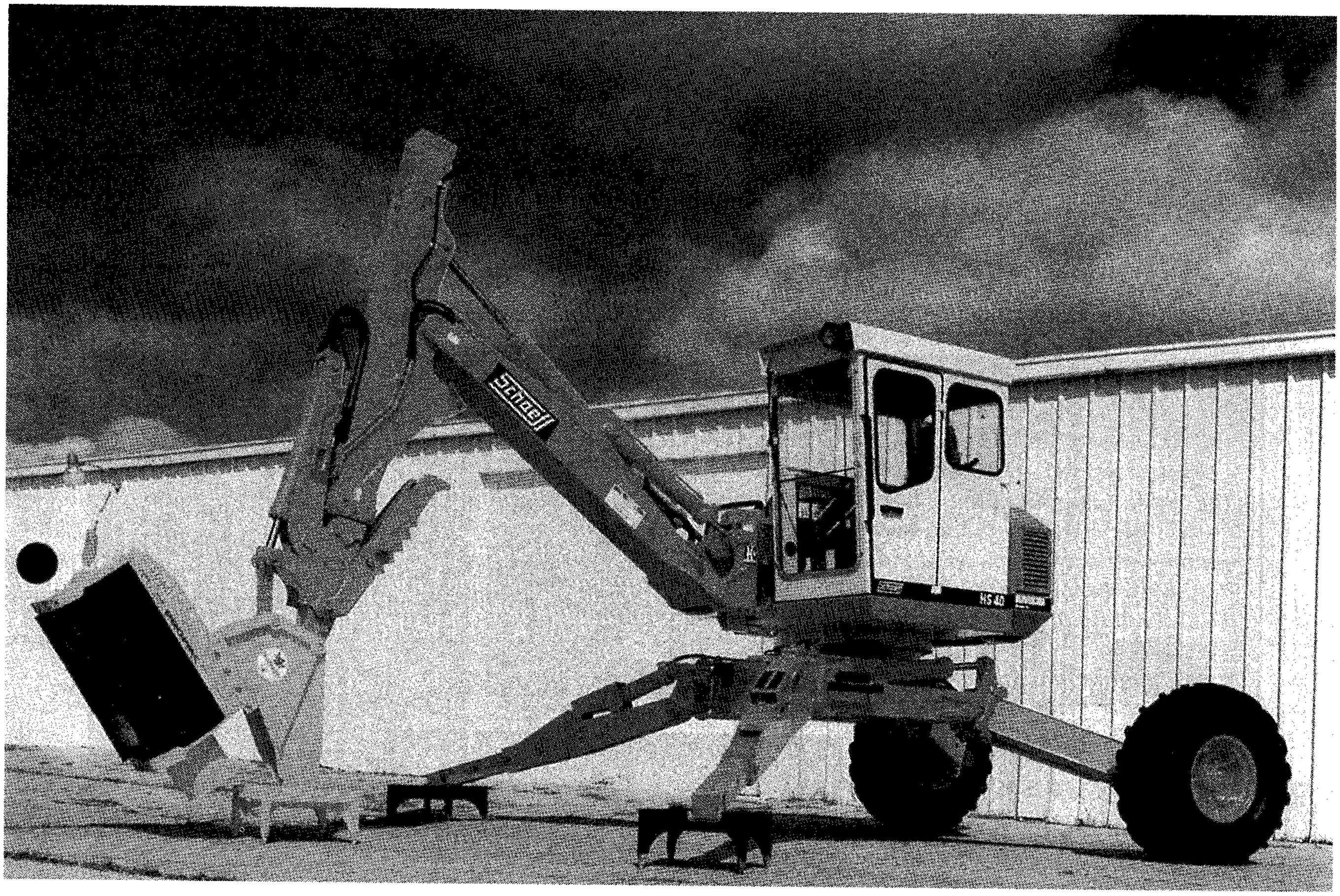

Figure 6.—Mountain-climbing backhoe which can treat logging slash on steep slopes.

DISCUSSION

The objective of this investigation is to identify policies, techniques, and equipment for reducing the fire hazard of slash without smoke emissions from burning. Figure 5 shows the path slash can take with a "to ground" symbol when the slash is no longer a fire hazard. Open burning and labor intensive operations on steep slopes can be eliminated from consideration because of the smoke emissions from open burning and the high cost and hazard of working large crews on steep slopes. This will eliminate bunching, broadcast burning, piling and burning, in woods chipping, and Zigzag yarder.

What is left (when delimbing in place on the slope) is steep slope mulching with a climbing backhoe, New Zealand Hydraulic Excavator Roller Crusher, and wet and decay.

Steep slope mulching with a climbing backhoe is very expensive. The New Zealand machine area of operation may be very limited, and wet and decay is an untried method.

The best way of handling the slash is to yard it attached and delimb at the landing. Once trees have been processed at the landing (delimbed) the slash then can be processed further by utilizing clean burning techniques, making clean chips, or making hogged fuel. These operations at the landing can be carried out using available commercial equipment.

When the slash has been processed, a determination can be made to transport the material to the mill or spread along the logging road.

This determination will depend on the value of the material at the mill, the cost of transportation to the mill, and the cost of spreading the material along a logging road. If the value of the material at the mill is greater than the cost of transportation minus the cost of spreading along a road, then the material should be transported to the mill and used. If the value of the material at the mill is less than the cost of transportation to the mill minus the cost of spreading, the least costly alternative for disposing of the material would be to spread the material along the logging road.

CONCLUSIONS AND RECOMMENDATIONS

The goal of this project is to find ways to reduce the fire hazard caused by logging slash on steep slopes, with the major constraint being that the traditional method, broadcast burning, is not available. Changes in policy, procedures, and equipment are required.

A pilot project to test the effects of these changes is needed. To summarize, the following hypotheses must be examined and tested:

1. Lower, and continue to lower, the utilization standards (to smaller piece sizes) so most of the usable fiber (slash) will be removed.

2. Locate/develop equipment to efficiently handle smaller pieces and allow utilization of all fiber. Look for solutions internationally; forest managers in northern Europe have made utilization a priority for many years.

3. Whole-tree (or full-tree) yarding and transporting, in-woods and on-landing chipping and chip transporting, and using slash for energy needs should be encouraged.

4. Recognize that we will still need to identify and provide for leaving some woody material on the ground after logging for soil protection, wildlife habitat, and seedling protection. A cost/benefit analysis is needed.

5. Locate/develop equipment to treat slash on steep slopes. MTDC has identified self-leveling excavators and slash-mulching heads that can operate on slopes up to 50 percent in some cases, and, in one case up to 70 percent. Therefore, these efforts should concentrate on steeper slopes.

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