SESSION 7
PAPER (a)

SMALLWOOD HARVESTING FROM STEEP COUNTRY

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Many factors influence the economics of handling smallwood on relatively easy terrain. With smallwood harvesting on steep terrain, the difficulties and costs can become even more critical, although there is a source of motivation that is free and very energy efficient - gravity. This paper looks at some of the techniques, influencing the criteria and requirements of steep country smallwood handling. The paper deals only with smallwood radiata pine from thinnings and clearfelling and not salvage from large tree breakage. Steep county is classified as slopes over 20°.

SYSTEM SELECTION CRITERIA

Often steep country has only the degree of slope as a common factor. The shape, length, roughness, aspect, access, soils, and undergrowth on individual slopes are all important factors which influence the logging systems selected, or which influence the efficiency of any particular system.

SLOPE

Shape - Slopes can be basically concave, convex, or straight. In most cases the concave slope is the most desirable for cable methods because more clearance can be gained between the cable and the ground. Convex slopes may require multi-span cable systems.

Length - This is important as it not only determines the selection of equipment but also affects the operational efficiency of the job. The longer the slope the more arduous is access for workers. It is more difficult to maintain lift if cable methods are used and it is slower for each cycle of the operation.

Roughness - Intervening cross-ridges, gullies and generally broken slopes are the most difficult to plan for and work. Progress for workers and logs, up or down the slope, are often impeded and special techniques need to be adopted.

Aspect and Undergrowth - These two factors are often related. In N.Z. the degree of undergrowth can depend on the aspect,with southerly facing slopes often being damper and more heavily clad. Undergrowth is a hindrance to fallers and affects all other parts of the operation regardless of what extraction system is adopted.

Soils - Soil type can be critical in determining the logging system. The stablility of the soil and whether it will support intensive

tracking patterns plus any other environmental precautions must be considered prior to logging.

Access - Although not a physical feature it must be considered when looking at an area to be logged. Planning of access to a logging area must consider the options of logging systems available and egress from the logging site. When considering gravitational methods for extraction, access must be below the country.

In many smallwood harvesting operations on steep country, the problem is often not how to extract the wood to roadside, but how to efficiently handle it from there, either into stockpiles or for load-out

FELLING AND LOG PRESENTATION

Both of these requirements are critical elements in harvesting smallwood from steep country. With young radiata pine virtually every branch needs to be cut off, and although it is most desirable to do this on the slope, this can be difficult and arduous as the slope steepens. Small trees with branches intact are often difficult to break out with low powered equipment, and they make handling at the landing a problem. Delimbing at the landing or at any other stage in the extraction phase, can interfere with the extraction cycle and be a major influencing factor for reducing daily productivity.

Felling should be organised to take best advantage of the extraction, in terms of both maintaining high production and preventing residual crop damage in thinnings. When cable logging downhill in tree lengths, the trees need to be felled downhill towards the extraction track in a herringbone pattern. Logs will be choked by the tops with extraction starting at the bottom of the slope. Felling square to the extraction line will lead to breakage of the trees and damage to the crop when breaking out. Felling parallel to the extraction line also leads to problems in getting logs clear and it may mean the breaker-out having to pull rope uphill into the thinned bays for some distance. Uphill cable extraction, where the tree butts are choked, must also be felled in a herringbone pattern. The butts of trees felled can be further away from the extraction line, and this results in longer lateral slack-pulling distances.

Felling aids, such as felling levers or small wedges, are available to make directional felling easier. These devices, when used correctly, can also reduce hang-ups, thereby increasing the productivity and safety of fallers. A fallers performance should not be assessed in isolation, but based on how effective he is in setting up optimum sized drags for extraction.

There is no easy way of delimbing young radiata on steep country. Operators need to be careful and safety conscious, wear good footwear, and should use other leg protection. Many fallers fell two trees and trim the two together , rather than scramble up and down the slopes for individual trees. Fallers have little need to use large powerful chainsaws in small-tree steep-country logging. A 60 cc saw with a 38 cm long bar is usually sufficient. A lightweight saw with short bar allows better and safer control over the saw and it will be less fatiguing.

Three options are available for log presentation, depending on the end requirements and logging system used. These are shortwood - either pulp or posts (up to 2 m lengths); long length logs i.e. a tree cut to several logs; or whole-tree lengths.

SHORTWOOD VERSES LONG LOG OR TREE LENGTH

Any shortwood system on steep slopes is very labour intensive. Pieces must be carried across the slope to the extraction line or stacked into bundles. This is extremely hard physical work and is particularly impeded by the degree of slope and undergrowth or slash on the ground. Often stands are thinned below prescription when a shortwood system is adopted because men are reluctant to struggle with the larger butts or pieces across the slope, and therefore, the bigger,perhaps malformed, trees are left standing. Shortwood systems on steep country should not be considered where the undergrowth is heavy.

Long log, compared to tree length presentation, allows more direct handling of the pieces, once landed at the roadside. A disadvantage is that more pieces must be extracted and that more lateral rope pulling is required to reach the last log cut out of a tree.

GRAVITATIONAL EXTRACTION

Extracting logs from hillsides by gravity is probably one of oldest methods of logging ever used. In this paper three different free descent techniques are discussed.

WIRE SKIDDING

This is a simple system for extracting low value wood down concave slopes with gradients from 20-35°. Distances to 300 m could be skidded provided the slope and clearance was sufficient, although half that distance would be more common. Extraction tracks must be cleared down the slope at right angles to contour so bundles of shortwood have unimpeded travel. The system is based on the simple rigging of a live skyline, which is fixed at one end and tensioned at the other. The bundles, which should not exceed about 200 kg, are attached to the slackened line, which is then tightened causing the bundles to slide freely downhill. Disposable skidding blocks can be used and these are broken by a wedge fixed on the line at the lower end, thus dropping the load. Up to 200-300 pieces per hour can be extracted by this method. Further information is available in LIRA Report Vol.3 No.12, 1978, or N.Z.Forest Service publication 'Gravity Extraction of Thinnings from Hill Country Woodlots, 1969'.

Variations and modifications of this basic system have been tried overseas and are reported on in LIRA's library. One is using a small pulley with a chain attached to freewheel logs down the line. Up to 20 pulleys are on the line with two used to support each load. The last pulley has a return line attached, which is used to pull all 20 pulleys back up the slope for re-use. A further extension of this is using a small portable winch to pull logs across the slope to the extraction track. A small swivel block is attached to the suspended skyline to give lift to the portable winch line. The logs are then lowered by the free descending pulleys. Also being developed is this free decent gravity extraction over intermediate supports.

CHUTES

Gravity extraction using chutes made from various materials have been used within N.Z. and overseas for a number of years. Recently, heavy industrial 6 metre long alkathene pipe, cut lengthwise into half or third rounds, has been used. This is a very effective means

of extracting short-pulp or short roundwood. The sections of chute can be bolted together and supported on the slope by ropes tied to trees. Cull trees 4-6 rows adjacent to the chutes are felled, trimmed, cut to shortwood lengths, carried across the slope and tossed into the chute. A minimum slope of 15° is required for logs to travel down the chute. Downhill travel is extremely quick, depending on the degree of the slope, but the wood is left in an untidy heap at the end of the chute, and this needs to be man-handled into stacks if a loading system is to uplift them efficiently. On chute logging, a two-man gang have averaged 14.7 tonnes per day with a maximum of 17 tonnes per day. Approximately 2 man hours are required to stack one day's chuting.

HAULER EXTRACTION OF SMALLWOOD

Lightweight haulers have been used in N.Z. for a number of years for thinnings and small tree clearfelling. Details on work done by the N.Z.Forest Service experimental logging unit at Golden Downs in the mid-1960's, was reported on in a paper by R.H. Robinson at the LIRA 1978 Cable Logging Seminar, and will not be dealt with here.

In the last 4 years, newly designed skyline machines have become available and have been operating mainly in 11-17 year old radiata thinnings. These are the Timbermaster, Wilhaul, and more recently, the experimental Lotus. A range of thinnings systems have been adopted including tree length uphill and downhill extraction with single span or multi-span, using intermediate supports. Uphill and downhill trials extracting shortwood in bundles have also been undertaken, as have trials extracting longer length logs. The results from this work have been written up in the following publications:

Uphill tree length extraction

LIRA Machinery Evaluation Vol.2 No. 3 1977
"Timbermaster Skyline Hauler"

F.R.I. Economics of Silviculture Report No. 107, By A.A.Twaddle, 1977 (Unpublished)
"Strip Extraction Thinning by a Timbermaster Skyline Uphill Setting"

Downhill tree length extraction

F.R.I. Economics of Silviculture Report No. 113, By A.A. Twaddle, 1978 (Unpublished)
"Strip Extraction Thinning by a Timbermaster Skyline Downhill Setting"

Shortwood extraction by hauler

LIRA Report Vol.3 No.8, 1978
"Shortpulp Extraction With Timbermaster Skyline"

LIRA Technical Release Vol.1 No.3, 1979, By D.Lamberton, N.Z.Forest Products Limited
"Shortpulp Extraction With a Small Hauler (A Further Trial)"

Lotus development trial (Various systems)

LIRA Report Vol.4 No.7, 1979
"Lotus Experimental Skyline Hauler (A Progress Report)"

LIRA Report Vol.4 No.12, 1979, By M.McConchie, F.R.I.
"Lotus Experimental Skyline Hauler (Production Trial Summary)"

LONG-LENGTH SMALLWOOD EXTRACTION WITH HAULERS

Some of the lessons learnt to date from small hauler extraction are:

- Most elements uphill and downhill are similar, the main exception being choking logs and breaking out. More lateral slack-pulling is required for uphill extraction to reach the butts of the trees in the thinned bays. Also, it is more difficult to choke butts than tops. In downhill extraction most of the trees are felled with their tops in or close to the extraction line and less slack-pulling is required.

- Small haulers generally have high availability but low utilisation. This is often as a result of a need for frequent line shifts.

- Crew experience is important for reducing delays.

- Poor log presentation can seriously influence breaking out and the hauler cycle, especially if the machine operator is required to do extra trimming on the landing.

- With cut log lengths, usually more can be extracted per haul but longer choking time is required.

- Heavy slash can affect the breaker-outs move-in and move-clear time.

- Lightweight chokers often cause delays when tangling around the carriage and skyline. Careful machine operation when taking the slack out of lines can reduce this occurring.

- On uphill extraction, incoming logs can tangle with the previous drag at the landing causing some delay. Interference often occurs between haulers and secondary machines clearing logs from in front of the hauler. A knuckle-boom crane fitted on the hauler can also cause some interference, although it can be used to good effect to hold logs while they are unchoked. Downhill extracted logs can usually be cleared by a secondary machine without interference, as the ropes are well clear of the stockpile. In downhill extraction however, the inhaul can be slower if it is necessary to carefully lower the trees into a stockpile. The unhook time is also affected if the skiddy or operator has to climb onto a high stockpile.

- Logs landed downhill into a stockpile can overrun and damage the machine. If it is a tight situation the stockpiles can be a nuisance if they block the road.

- Average tree size greatly influences daily production. For example; at 0.2 m^3 tree size it is difficult to exceed 30 m^3 per day (tree length logging); at 0.4 m^3 tree size production up to 50 m^3 can be achieved - all other things being equal.

- Intermediate supports with small haulers offer significant advantages. Slopes with intervening ridges or a profile where deflection is limited or non-existent, can be hauled when intermediate supports are used. Approximately 40-60 minutes is required to rig an intermediate support. A heavier carriage is required than the normal system. Further details on intermediate supports is available in LIRA Report Vol.4 No.4, 1979.

SHORT-LENGTH SMALLWOOD EXTRACTION WITH HAULERS

Trials have been conducted at N.Z.Forest Products Limited with the Timbermaster and Wilhaul skyline haulers to evaluate the production potential of these machines extracting short-pulp. The trials indicated that between 55 and 60 tonnes per day could be extracted with these machines and this could be increased if the roadside

handling of the produce was improved. Some of the lessons learnt from these trials were:

- Undergrowth and slope very seriously affect the cutting and stacking production of the shortpulp cutters. Production ranged from 5.5 tonnes to 8.4 tonnes per man day. The steep slopes(in excess of 30°) affect the ability of cutters to safely carry and easily stack the shortpulp.

- Extraction lines at 12 m centres proved satisfactory. 20 m centre lines were too far for the cutters to carry each piece.

- For effective breaking out, the bundles must be stacked directly under the skyline. Damage to crop trees occurred when bundles were stacked off to the side.

- The weight of the bundles of short-pulp must be within the designed capacity of the machine. With the Wilhaul this was 0.95 tonnes and with the Timbermaster 0.8 tonnes. An advantage of this method is that the optimum haul size can be achieved on each cycle.

- For good control of bundles during downhill extraction the hauler needs an effective haulback brake. The Wilhaul proved to be better than the Timbermaster in this regard. However, both machines allowed the best control of the incoming load during uphill extraction.

- A lock-in carriage (Christy) did not prove any more effective than the normal Timbermaster/Wilhaul carriage system.

GROUND SKIDDING SYSTEMS

Recent Canadian studies* have been comparing the use of small crawler tractors for extraction off steep country with skidders and with cable machines. Although logging costs for the skidders and the crawler tractors are very similar, the small tractor advantage was that much less soil disturbance occurred because a smaller width track could be formed than with skidders or large crawler tractors. Other advantages of small tractors, listed from the studies, were:

- They are more versatile than wheeled skidders or cable machines.
- They can log a total area without other machine assistance.
- They are cheaper to operate than cable systems.

(This comparison is only valid provided the site can withstand an intensive tracking pattern without environmental implications.)

The study results concluded that the small tractors were most suited on side slopes greater than 16°. Slopes less than that could be logged by skidders without tracks. Small tractors were considered a viable alternative for logging steep country as an alternative to other ground skidding machines or cable systems.

CONCLUSIONS

This paper has listed recent experiences for logging smallwood off steep country. The brief inclusion of details on the recent Canadian study using small tractors is because very little has been done on this in N.Z. in recent years. In many situations,such as farmers small woodlots, small tractor extraction operating off tracks may offer a more economical alternative to hauler or other methods.

*"*Skidding with Small Crawler Tractors" By B.McMorland. FERIC Technical Report No. TR-37, March 1980*

Regardless of the extraction system, gravity can be used to good advantage when handling smallwood. The alkathene chutes offer a low cost method and have great potential in N.Z. Free running wire or skyline gravity extraction systems also offer low capital cost methods which should be given more extensive trials.

Small haulers, such as the Timbermaster, Wilhaul, and Lotus, have proved viable for logging uphill and downhill. Average piece size extracted is the most critical factor influencing daily production. Intermediate supports are a valuable means of extending the capability of small haulers.