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DIRECTIONAL FELLING SECOND CROP P. RADIATA ON STEEP COUNTRY

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F.R.I. PHOTO

Directional felling uphill with the assistance of felling jacks

The trend in New Zealand when felling radiata pine on steep country has been to fell in the direction of lean. Most felling has therefore been straight downhill, mainly because of the tree characteristics - a predominant downhill lean, and the heaviest portion of the tree crown being on the downhill side.

In Northwest America, and increasingly in New Zealand, trees are being directionally felled across slope or uphill in clear-felling operations. Some reasons are: to reduce damage to felled trees; to increase utilisation and value of the wood; to align the trees for easier extraction; to increase hauler productivity; and to reduce the amount of debris left behind on the cutover.

Studies carried out by the Forest Research Institute (FRI)* in 1978 in old crop untended stands of radiata indicated that when trees were directionally felled across slope instead of downhill, longer piece lengths, greater haul volumes, and greater daily hauler production (up to 50%) were obtained. Second crop radiata, however, has different characteristics to old crop, e.g. shorter, fatter trees with heavier crowns and less malformation, and were expected therefore to react differently to alternative felling patterns.

In early 1981 FRI initiated studies to examine products and value outputs, and costs of alternative felling patterns on second crop radiata pine on steep country. LIRA assisted with work related to the latter part of the study - to examine directional felling techniques.

THE TRIAL

A 41 year-old stand of radiata (4.0 m^3 ave.stem size) in Whakarewarewa State Forest was selected for the trial. The stand had been treated late with a high pruning at age 17 and a nominal thinning down to 200 stems per hectare at around age 24.

*Ref: *Murphy G., "Directional Felling of Old Crop Radiata Pine on Steep Country", N.Z. Journal of Forestry Science (In print).*

Five blocks of approximately 200 trees each were marked out. MARVL* assessment was done prior to commencement. To date only three blocks have been completely felled - across slope, 45° up slope, and downhill stems parallel.

Note: Only 78 of the 200 trees in the block to be felled 45° up slope were felled uphill. Felling stopped because there was no reduction in breakage, and the operation was considered too dangerous and time consuming. The remaining trees were felled downhill in the normal manner, which resulted in a high incidence of stems crossing over (downhill crossed block).

FELLING METHODS

Most felling was carried out by an experienced (8 years) faller, to give consistency. Techniques used were the conventional scarf and backcut and driving, in conjunction with a maul and wedges and hydraulic tree jacks. The technique was left to the discretion of the faller. An 80 cc chainsaw with a 50 cm (20") bar was found to be adequate. The downhill crossed block was felled by a Whaka Forest bushman using the conventional scarf and backcut method.

The downhill parallel block presented no felling problems - 96% of the trees were felled using only the conventional scarf and backcut. Trimming was difficult, especially where the slope exceeded 30°.

A secondary lean across slope enabled 71% of the trees in the across slope block to be felled using only a scarf and backcut. There was a marked increase in the use of wedging and driving. It was difficult to scarf trees low enough due to interference of the slope with the chainsaw motor. Trimming was carried out by walking along the log. There were no problems with logs rolling downhill when trimming.

Felling uphill was very difficult and dangerous. Less than 20% of the trees could be felled using the conventional scarf and backcut, and 73% were felled using a maul and wedges and tree jacks. A further 10% were driven. In many cases the tree broke out sideways before the jacks could move the crown from the downhill lean to an uphill lean. Trimming was not as difficult as in the downhill block but more difficult than the across slope block.

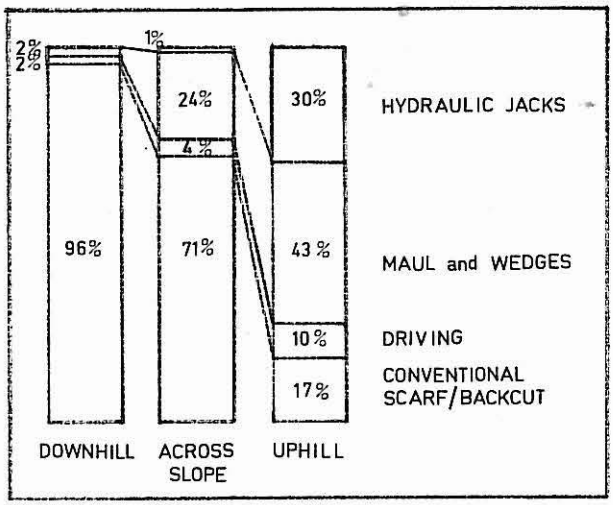

Figure 1 - Felling Methods

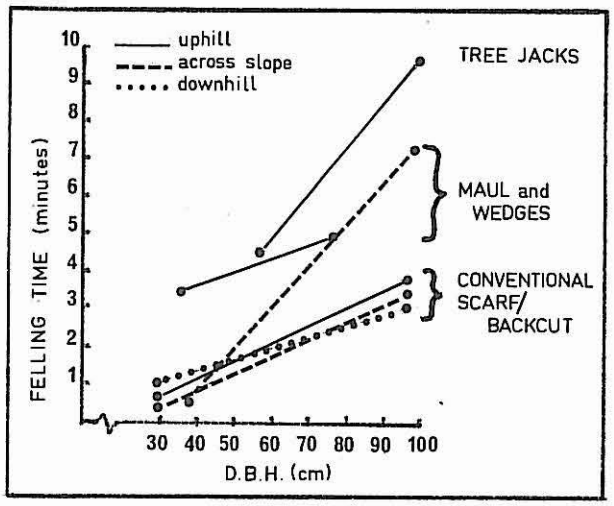

Figure 2 - Felling Times

FELLING TIMES

The relationship between tree size and felling times for the range of felling techniques used is shown in Figure 2. The felling time commenced with the first saw cut and finished when the tree hit the ground.

**Ref:Deadman M.W. & Goulding C.J., 1979, "A Method of Assessment of Recoverable Volume by Log Types", N.Z. Journal of Forestry Science 9 (2): 225-39.*

When tree jacks had to be used, felling times were up to four times longer than using the conventional scarf and backcut. Wedging took up to three times longer than conventional felling. Because very few times were gathered on driving, only averages could be included in this report:- downhill parallel 1.05 minutes per tree; across slope 3.82 minutes per tree; uphill 5.84 minutes per tree.

Felling times and proportions of techniques used were applied to a standard diameter distribution so that downhill, across slope, and uphill felling could be compared on an equal footing. The following times were found:

Downhill crossed	-	1.44 minutes per tree
Downhill parallel	-	1.59 minutes per tree
Across slope	-	1.75 minutes per tree
Uphill 45°	-	3.98 minutes per tree

The uphill felling times were more than twice that of the downhill or across slope times. Normally uphill felling would require two men because of the extra equipment to be carried, the higher danger risk, and the increased concentration required. It may therefore take over four times as many man minutes for uphill felling as compared with downhill or across slope. This relative difference remains constant when other times associated with felling, such as walking between trees, refueling and sharpening the saw, clearing undergrowth, etc. are taken into account.

STUMP HEIGHT AND BUTT DAMAGE

In tended radiata stands a great deal is invested in the bottom five to six metres of the tree. It is essential that stump heights be kept as low as possible and butt damage kept to a minimum. Stump heights were lowest on the downhill felled block and highest on the across slope block, due to slope interference with the chainsaw motor.

	Downhill crossed	Downhill parallel	Across slope	Uphill
Ave. stump height (cm)	15.7	10.2	18.4	16.3
Butt damage (% of trees felled)	63	34	11	55

Table 1 - Stump Heights and Butt Damage

The incidence of butt damage (greater than 20 cm in height) in the forms of drawwood, slabbing, and splitting, varied between the blocks. The heavy downhill lean in the downhill felled block resulted in less of the backcut being made before the tree started falling, causing frequent butt damage, particularly in the downhill crossed block. This could be markedly reduced by side cutting, as was done in the downhill parallel block, where directional control was best.

The incidence of butt damage was also high in the uphill felled block. This was caused by the increased amount of holding wood left on the uphill side which was required to swing the tree uphill.

The least amount of butt damage occurred in the across slope block, due to side cutting practices and more of the backcut being completed before the tree fell. The stump height was, however, 8 cm higher than in the downhill parallel block.

BREAKAGE AND ITS CAUSES

Very few trees of the size encountered in this study did not break during felling (refer Table 2). The average height of the first break relative to the total tree height, for the downhill, across slope, and uphill felled blocks, was very similar, about 70% of the tree height. The number of pieces and their average length above the first break varied considerably between the blocks. Tops of trees in the downhill felled blocks broke out into a greater number of shorter pieces than the across slope or uphill felled blocks.

	Downhill Crossed	Downhill Parallel	Across Slope	Uphill 45°
Probability of tree not breaking	1%	4%	8%	8%
Relative height of first break	68%	71%	69%	71%
Number of pieces above first break	2.7	2.6	2.5	1.9
Ave.length of pieces above first break to 10 cm	3.5 m	4.3 m	4.6 m	5.2 m

Table 2 - Breakage

Causes of almost half of the breaks could not be identified due to the trees rolling or sliding away from the impact zone. Where the cause could be positively identified by far the most common cause of breakage was crossing of felled trees (refer Table 3). Sharp changes in slope, (e.g. short deep gullies,ridges) and stem malformation were also important contributors to breakage.

	Downhill Crossed	Downhill Parallel	Across Slope	Uphill 45°
Trees crossing	72%	54%	61%	62%
Standing trees	1%	2%	7%	6%
Malformation	3%	2%	5%	13%
Stumps	5%	2%	9%	1%
Change in slope	19%	39%	18%	17%

Table 3 - Causes of Breakage

CONCLUSIONS

The fact that the break point was so similar in all trials indicates that it is not slope which is the greatest cause of breakage. The three factors which contribute most to breakage are crossing logs over, changes in slope, and malformed trees. When felling trees on steep slopes the area should be walked over prior to felling to determine areas of slope change. A short deep gully can result in severe breakage. Fallers should endeavour to fell trees parallel.

Uphill felling should generally be avoided in mature radiata. It is dangerous, substantially increases felling times, and little reduction in breakage results. Care should be taken in interpreting overseas experience with uphill felling. Tree form is distinctly different in most Northern Hemisphere areas where this is practiced, with trees generally more erect and with a lower ratio of height to basal area.

Across slope felling frequently requires the use of felling aids, and hence a longer felling time is necessary. High stump heights also result, but there is a greatly reduced incidence of butt damage. Trimming is much easier and breaking-out is considerably eased because of a reduced concentration of logs and heads at the bottom of the slope. Provided a hauler which can achieve good clearance for easy break-out is being used, across slope felling appears to be the best option.

Downhill felling has many advantages, especially when trees are felled parallel and do not cross. Felling times are faster and few trees require felling aids. Stump heights are left low, however, butt damage is generally high when there is a heavy downhill lean causing the trees to fall too soon.

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