THE FOREST RESEARCH INSTITUTE'S WORK ON CABLE LOGGING: A REVIEW OF ITS MAIN FINDINGS

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ABSTRACT

Cable logging will become more important as harvesting moves into steeper terrain where logging is about twice as expensive as on flat country. The hauling phase is the high cost centre for cable logging, with extraction distance and volume extracted per haul being two of the main factors affecting production and costs. Production can be improved by using methods which take into account these and other factors. Much of the Forest Research Institute's work has been in untended stands, and more work needs to be done in the tended stands of future crops.

INTRODUCTION

Surveys have shown (Chavasse, 1969) that new forest establishment will increasingly be carried out on topography classed as steep. To utilise forest from such areas cable-logging systems will have to be used, implying an increased reliance on this method of extraction in the future. It has been estimated (Levack, 1978) that shortly after the turn of the century about half of New Zealand's cut of exotic tree species will be logged by over 300 cable-logging gangs.

For the past decade, and particularly in the last 4 years, the Forest Research Institute has been studying cable-logging operations extensively, using standard techniques (Murphy, 1977a, b).

A survey of the logging industry has been made in order to put cable logging in perspective and to see where we currently stand (Murphy, 1976a). As well, eight intensive production and method studies have been carried out to date on a range of thinning and clearfelling, highlead and skyline operations. This paper reviews the general findings of all these studies and indicates probable trends, as sufficient data are not yet available to enable specific relationships to be drawn. The figures and tables in this paper should be treated accordingly.

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THE 1974 LOGGING INDUSTRY SURVEY

The 1974 survey provides the most up-to-date figures on the New Zealand logging industry. For the year ended March 1974 the total exotic cut was approximately 7.5 million m^3, of which 14% was logged by cable systems. Of the 25 gangs involved, 14 gangs using highlead (or two-rope) systems produced 60% of the cable-logged wood (Fig. 1).

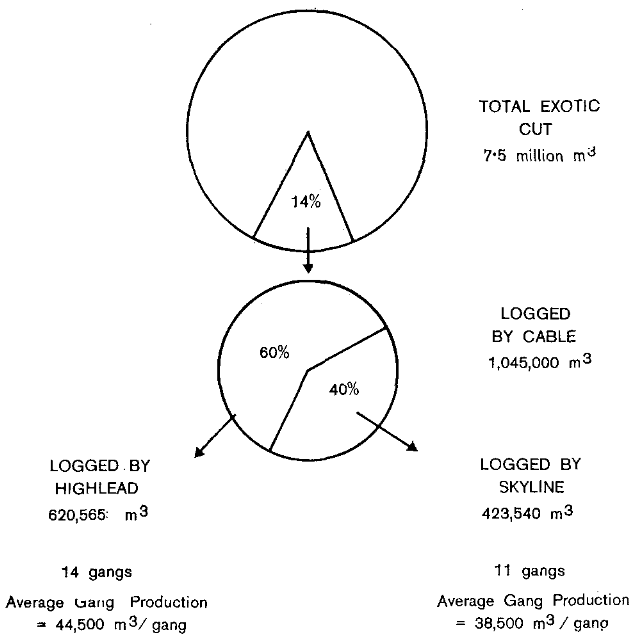

FIG. 1: *The importance of cable logging in New Zealand as at March 1974*

HAULING PHASE MOST EXPENSIVE

Table 1 gives an example of the cost distribution for a mobile highlead operation. Fifty-five percent of the cost was in the hauling phase and comprised the hauler's fixed and operating costs and payment of the hauler operator. Although the actual percentages for the different phases of individual cable-logging operations may vary, the relative importance of the hauling phase will be unlikely to change.

The importance of this finding is that small increases in gang production would compensate for large percentage increases in the cost of phases other than the hauling phase. For example, if it was possible to increase hauling production by only 4% (through larger piece sizes resulting from more care in directional felling of trees on steep country) for the particular operation shown in Table 1, felling costs could be doubled without any increase in unit costs. Increasing production by more than 4% could result in decreased unit costs.

TABLE 1: AN EXAMPLE OF THE DISTRIBUTION OF COSTS FOR A CABLE-LOGGING OPERATION

Phase	*Percentage of costs*
Administration	8
Felling	4
Breaking out	6
Hauling	55
Skidwork	9
Loading	18
	100

AVAILABILITY AND UTILISATION

As found also in overseas research, cable-logging operations tend to have high mechanical availability but low utilisation levels (see Table 2 and Murphy, 1976b, 1977c; O'Reilly, 1974; Twaddle, 1977, 1978); that is, compared with conventional skidders, cable haulers suffer less from mechanical breakdowns, but other factors reduce the percentage of time they can be used. These characteristics are related to the type of work the haulers perform. Because a hauler mainly sits stationary on a landing it is not knocked around as much as a skidder or tractor traversing stumps and branches. It can also be more solidly (and heavily) constructed because it does not have to be moved around often. For these two reasons, higher mechanical availability than for skidders or tractors can be expected. Low utilisation levels are related to the large amount of time spent on such things as shifting ropes and guylines, moving the hauler, and interference from the skidwork and loading phases.

TABLE 2: AVAILABILITY AND UTILISATION IN FIVE CABLE-LOGGING OPERATIONS

	Availability (%)	*Utilisation* (%)
Skyline thinning uphill	89	42
Skyline thinning downhill	99	36
Skyline clearfelling	87	49
Skyline clearfelling	90	41
Highlead clearfelling	94	57
Average	92	45

FACTORS AFFECTING PRODUCTIVITY AND PRODUCTION*

Two factors have repeatedly been found to affect the productivity of cable-logging operations; these are extraction distance and haul volume (Lisland, 1975; Murphy, 1977c; O'Reilly and Mackintosh, 1973; O'Reilly, 1974; Twaddle, 1977, 1978). Increasing the haul volume has little effect on cycle times and, as a result, improves productivity (Table 3). On the other hand, increasing the extraction distance increases cycle times, reduces the number of cycles per hour, and thus reduces productivity.

TABLE 3: EXAMPLES OF THE EFFECTS OF HAUL VOLUME AND EXTRACTION DISTANCE ON PRODUCTIVITY

	Haul. Vol. = 3 m³	*Haul Vol. = 6 m³*	
	Ext. Dist. = 200 m	*Ext. Dist. = 200 m*	*Ext. Dist. = 100 m*
Cycle time (min)	6.80	7.45	5.95
Cycles/hour	8.82	8.05	10.08
Productivity (m^3/PMH*)	26.52	48.30	60.50

*PMH = productive machine-hour

Production tends to be affected by more factors than does productivity. As well as haul volume and extraction distance, stocking and the number of productive machine-hours worked per day influence the levels of production achieved (Murphy, 1977c; O'Reilly and Mackintosh, 1973; O'Reilly, 1974; Twaddle, 1977, 1978). It is interesting to note that in one study no significant difference was found between the levels of production achieved in two similar settings, one logged uphill and one downhill.

EFFECT OF TREE SIZE ON PRODUCTIVITY AND PRODUCTION

Productivity tends to increase as tree size increases (Lisland, 1975). However, this trend is complicated by such things as the size and versatility of the hauler being used to extract the wood.

*Throughout this paper, "production" refers to daily production (*i.e.*, the amount of material produced per shift) and "productivity" is defined as the volume of wood delivered to the landing per *productive* machine hour.

As found overseas (Lisland, 1975), production is affected in essentially the same way as productivity, increasing with increased tree size (Fig. 2). The magnitude and predictability of this trend, however, are further complicated by such variables as mechanical availability and the number of productive machine-hours worked per day. The number of productive hours worked is virtually the residual of total time after allowance has been made for access, rope shifts, maintenance, preparation, interference delays, etc. These are themselves variables and are often unrelated to tree size.

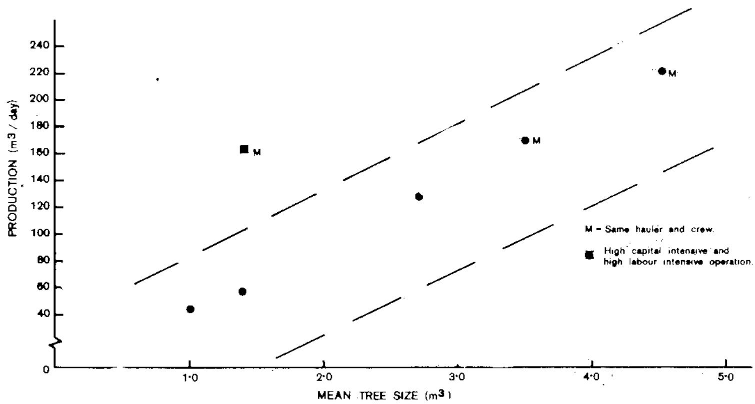

FIG 2: *Production (for a mean extraction distance of 200 m) vs. tree size (clearfelling operations).*

Greater daily gang production can be achieved by using very expensive equipment and large numbers of men, but higher unit costs are often associated with these higher levels of production.

IMPORTANCE OF BREAKAGE

Breakage is a factor which is often overlooked when cable-logging operations are being planned, and directional felling of trees to reduce breakage during felling and extraction is the exception rather than the norm. It is common practice to fell with the direction of lean (*i.e.*, downhill on steep country), and this often results in breakage, especially with the larger and more brittle radiata pine trees with "old crop" characteristics.

Figure 3 shows a summary of the breakage observed in a few limited studies. These studies were not designed specifically to investigate breakage, and so the results are only tentative at this stage. Further work will be carried out when opportunity permits. Line A indicates the theoretical "one piece, one tree" arriving at the landing. As tree size increases, the actual piece size* (line B) diverges further from the theoretical piece size. Line C expresses the actual piece size as a percentage of tree size. As mean tree size increases, mean piece size as a percentage decreases. For trees below 1 m^3 the percentage was between 80 and 90%; for trees above 4 m^3 it was between 50 and 60%.

Currently, the "one tree, one piece" ideal is rarely achieved in whole stands on steep country. In many cable-logging operations the problem is not in handling a full load but in obtaining a full load at each haul so that the machine is working to capacity. Reduction of breakage should be one of our prime aims.

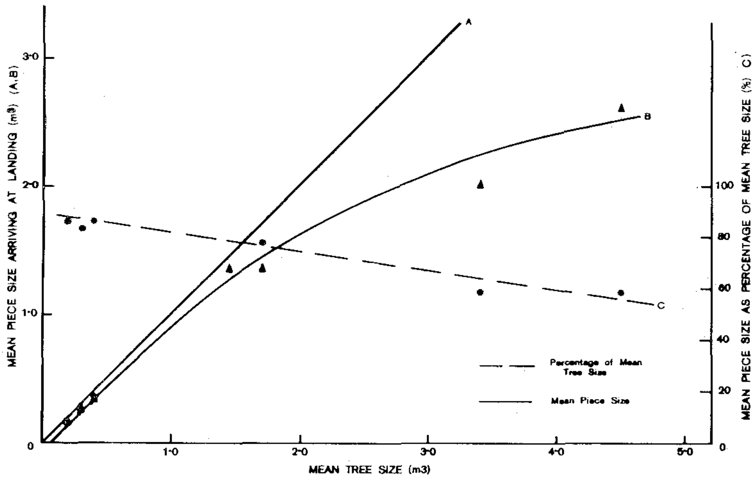

FIG 3: *Breakage during felling and extraction.*

"THERE IS ALWAYS A BETTER METHOD"

An important part of the Forest Research Institute's work has been looking at new methods currently in use and developing better methods. This phase of our work began with flat-country logging operations—*e.g.*, the introduction in New Zealand of the use of polypropylene strops with quick-release attachments for a thinning system (Terlesk, 1975), and the "tip first, two pass" method for chain-flail delimbing (Terlesk, 1976)—and has continued with steep-country cable-logging operations.

*"Piece size" in this paper is defined as the unprocessed volume of a tree stem or part of a tree stem arriving at the landing.

Method studies carried out by FRI cover such areas as rope-shifting for highlead operations (Murphy, 1978), the use of preset strops (Twaddle, 1977), and pinpointing the best place for carrying out log preparation (Murphy, 1977d). The findings of the last-mentioned study bear summarising in this paper.

TABLE 4: PRODUCTION LEVELS AND COSTS FOR THE THREE LOG-PREPARATION ALTERNATIVES AT THE STUMP

	Nil Processing	*Partial Processing*	*Complete Processing*
Daily production (m^3) for a mean extraction distance of 135 m	205	205	143
Unit cost on truck ($\$/m^3$)	5.77	5.92	8.44

The study indicated (Table 4) that it is most profitable not to do any log preparation at the stump, even when the costs of constructing larger landings and later restoring them are taken into account. As well, processing at the landing has the production advantages that:

(a) the landing is a safer place to carry out processing;

(b) the landing is a better place than the stump to optimise log cutting and sorting;

(c) potential pulp or energy material (in the form of branches, needles and tops) is brought to the landing with each haul.

EXPERIENCED MEN IMPORTANT

In FRI's studies the human element has been shown to have the most important influence on logging operations. It can outweigh all physical factors, and an inexperienced or non-motivated crew is almost without exception a low-producing crew.

Experienced men are needed for all phases of cable-logging operations. Poor felling leads to poor breaking out; poor breaking out leads to poor hauling; poor skidwork and loading leads to hauling interference; poor planning (at all levels from gang boss to logging manager) creates even more problems and lower production.

Particularly when mobile imported machinery is involved, cable logging is costly and sophisticated in comparison with techniques that can be used in logging flat country. So it is essential that experienced people are trained at all levels if cable logging is to continue to be a successful and acceptable method of harvesting.

THINNING COSTS AND PRODUCTION

Just as in operations on flat country, thinning with cable-logging systems on steep country is more costly than clear-felling. Table 5 gives a comparison of production and costs between cable-logging operations involving thinning and clear-felling. The difference in unit cost is related mainly to the much smaller trees harvested in thinning operations.

TABLE 5: A COMPARISON OF PRODUCTION AND COSTS FOR TWO CABLE-LOGGING OPERATIONS

	Thinning	*Clearfelling*
Mean tree size (m^3)	0.4	4.5
Mean extraction distance (m)	100	200
Daily production (m^3)	42	220
Daily cost ($)	450	1100
Unit cost ($\$/m^3$)	10.70	5.00
Unit cost for similar flat-country operations ($\$/m^3$)	5.50	2.60

FLAT-COUNTRY *VS.* STEEP-COUNTRY LOGGING COSTS

A rule-of-thumb approach to estimating logging costs on steep country is that the wood will cost about twice as much as that harvested on flat country from similar-sized trees using the appropriate machines. This applies to both thinning and clearfelling operations (Table 5).

CONCLUSIONS

The cost of cable logging on steep country is about double that of conventional flat-country logging. About half of these costs are contributed by the hauler, and therefore the production achieved by the hauler is of paramount importance. Hauler production is affected by the size of the load, and hence by tree size and method of felling as well as various other factors. Work is continuing on quantifying these effects (particularly in short-rotation tended stands) and on developing ways of achieving greater hauler efficiency.

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