Session 3
Paper (e)

ECONOMIC ANALYSIS OF LOG MANUFACTURING LOCATIONS IN STEEP TERRAIN PLANTATIONS (1)

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The locations examined in this paper were: at the stump, at a landing, and at a central processing yard. Comparisons were made on the basis of value recovery, harvesting productivity and costs, and land taken out of production by landings.

In an overall economic analysis it was concluded that log manufacturing at the stump with the aid of hand-held computers shows the greatest potential profit. Until such time as computer aided manufacturing becomes operational, log manufacturing at the landing is preferred.

INTRODUCTION

Due to an increase in the relative proportion of steep country harvested, combined with an overall absolute increase in total volume harvested, there will be about an eight-fold increase in the amount of wood coming from steep country plantations in New Zealand by the year 2010. (Levack, 1978) (Figure 1).

Carson (1983) has suggested that New Zealand's "steep country logging problems" would rise dramatically unless the cable logging skills of both planners and practitioners were vastly improved. He pointed out similarities between New Zealand in the 1980's and the United States in the 1960's. In the U.S. the high cost of harvesting steep country plus the rising tide of environmental concerns (often stimulated by the poor logging practices brought on by the difficult conditions) caused by U.S. Forest Service to consider blocking large segments of land out of its productive land base. The timber was there but the value was not. He suggested that unless all options are carefully examined, New Zealand may find that much of its steep country plantations may not be economically or environmentally feasible to harvest.

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1. This paper is a slightly edited version of a paper submitted by G.E. Murphy and E.D. Olsen to (US) Journal of Forestry. It is the last of a series of three papers (see also references for Murphy and Olsen, 1987 and Murphy, Olsen and Sessions, 1987) based on research carried out in partial fulfilment of the requirements for Ph.D. degree at Oregon State University.

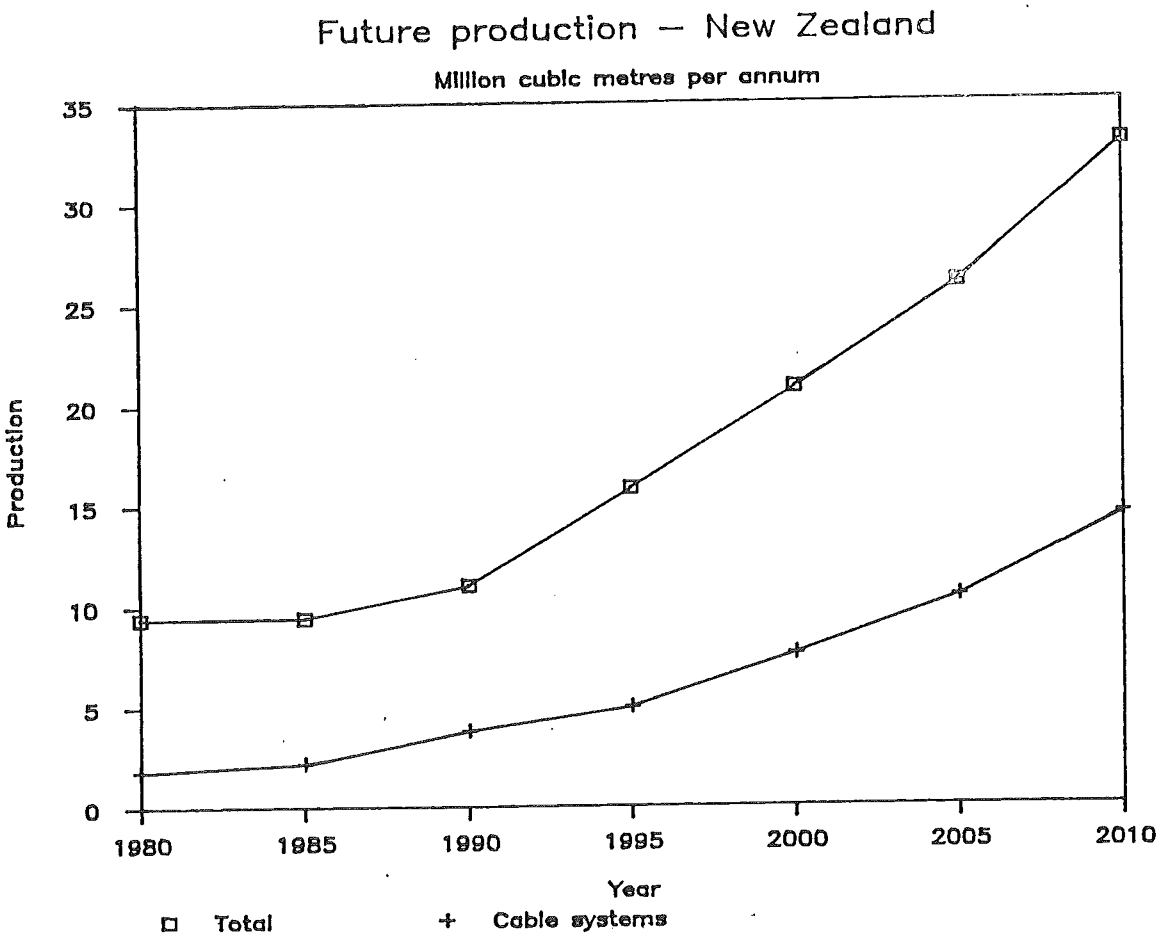

Figure 1-1 Future production from New Zealand's plantation forests

It is currently common practice on both flat and steep terrain to extract wood in a tree-length or full-tree form to large landings (0.1-0.3 hectares) where logs are then cut-to-length (manufactured) and segregated. From five to as many as twenty log-types may be sorted on the landing.

Until recently the prime concern of logging managers has been to maintain a high level of productivity at the least possible cost (Ellis, 1985). Many logging operations work under incentive schemes which are primarily based on production targets. The importance of value recovery and land taken out of production to economic viability has only recently been recognised as also being significant considerations.

ALTERNATIVE HARVESTING METHODS

Myers (1986) has quoted Tony Grayburn, the forest resources division manager of N.Z. Forest Products (one of the largest forest companies in New Zealand) as saying that "large landings will not be tolerated for much longer, either by environmentalists or forest owners". Extracting logs, which had been manufactured at the stump into their final form, to small landings will become much more common. Grayburn has said that the need for more research into the log landing phase of the harvesting system is one of the most important issues facing the logging industry today.

Somers (1986) has reported that Bryce Heard, the logging and transport manager of Tasman Forestry (the largest forest company in New Zealand), believes that central log processing yards might also become commonplace in some areas. Semi-processed trees could be taken to small roadside landings and then trucked to processing yards where the high-value pruned buttlogs and sawlogs could be cut for maximum grade/value recovery.

New Zealand has limited experience with these alternative options for steep terrain harvesting other than tree-length logging to large landings. In view of the importance that steep country harvesting may play in the overall economics of New Zealand's export oriented forest industry, the Forestry Council, at the 1981 NZ Forest Development Conference, recommended that high priority be given to a greater research effort in the fields of harvesting and log segregation. This paper concentrates on the three alternatives mentioned above :

- final log manufacturing at the stump and log-length extraction to small landings,
- tree-length extraction to, and final log manufacturing on, large landings,
- partial processing at the stump, extraction of long-log lengths to small landings, and trucking to central processing yards for final log manufacture.

Issues relating to ergonomics, safety environmental considerations, and the effect on the soil nutrient status are recognised by the authors as factors that logging managers should consider when selecting from alternative harvesting systems. When steep country harvesting operations are being planned the aim should be to define the best environmentally acceptable plan with the best safety and best logging economics. This paper only addresses considerations which can be relatively easily quantified in economic terms.

PROCEDURE

To compare alternative log manufacturing locations a systems level approach, which incorporated stump-to-milldoor harvesting costs, value recovery, and the cost of land taken out of production by landings, was adopted.

A stand, representative of stands to be harvested from steep terrain over the next decade, was selected as a basis for the comparisons. The stand had been intensively managed, albeit belatedly by currently accepted "optimal" regimes in New Zealand (Table 1).

yarded to a small landing. A value audit system, such as AVIS, on a hand-held computer was used to assist in optimal log-bucking decisionmaking. Threadgill and Twaddle (1987) have reported that experimental trials with the AVIS system on the Husky Hunter hand-held computer look very promising. It was assumed that if computer aided tools were available the log manufacturers would be able to achieve 99 percent value recovery. A one percent value loss was assumed because of likely inaccuracies in length measurement at the stump.

2. STUMP - stems were manufactured into the final log lengths at the stump without computer-aided assistance. The logs were then yarded to a small landing. Field measurements of three log manufacturers, assumed to be representative of a cross-section of New Zealand log manufacturers, were used in the analysis.

3. LANDING-3% LOSS - stems were yarded tree-length to a large landing where they were then manufactured into their final log types without computer-aided assistance. Twaddle (1984) has estimated landing size on difficult terrain to be about 0.25 hectares. If each landing services about 8 hectares, and is not rehabilitated and replanted after harvesting, about 3% of the steep country land base would be taken out of production. This system assumed a 3% loss in volume and value from each hectare of land harvested. (Note: 0% loss in volume and value was assumed for the stump and CPY options since most of the volume would be extracted to roadside. Additionally it was assumed that the amount of area taken up by roads would be the same for each of the alternatives examined.)

4. LANDING-5% LOSS - this is the same system as above but a 5% loss in the productive land base is assumed. This is equivalent to assuming that each landing (0.24 ha) only services about 5 hectares of forest.

5. CPY - stems are cut into fixed 12.6 metre lengths, yarded to small landings, where they are loaded onto trucks and hauled to a central processing yard. The maximum log length that can be legally carried on a conventional truck in New Zealand is about 14 m; much shorter than the average stem lengths of 25 to 45 metres. Final log manufacture is carried out at the CPY before hauling to the final mill destinations.

STAND LEVEL ANALYSIS

A gross profit equation could be written as :

Profit (per ha) = (Value-Costs)(Volume)(100-% area loss) 100

From the gross profit would have to be substracted establishment, tending, roading, administrative costs and other overheads. These are not included in this analysis.

The gross profit per hectare can be discounted back to year zero to obtain a net present value. In this analysis a discount interest rate of 12 percent was used (see footnote). The stand described in Table 1 was 40 years old at the time of harvest. If silvicultural tending is carried out on time, instead of belatedly as occurred for this stand, it is believed that the same type of stand could be grown in about 30 years. Net present values for both 30 and 40 year rotations are reported below.

Table 2 contains the values, costs, yields and gross profit for the five harvesting systems analysed.

TABLE 2 : GROSS PROFIT CALCULATIONS

Harvest System	Value $/cu.m.	Costs $/cu.m.	Area loss %	Volume cu.m./ha	Profit $/ha
C.A.B.	52.28	39.52	0	620	7911
STUMP	39.37	36.21	0	620	1959
LANDING-3%	41.90	31.28	3	601	6387
LANDING-5%	41.90	31.28	5	589	6255
CPY	49.51	43.02	0	620	4024

The value recovery for the STUMP system was that found from the field trial. The difficulties associated with making, and carrying out, optimal bucking decisions at the stump have been described elsewhere (Stenzel and others, 1985). The value recovery for the two LANDING systems was also obtained from the field trial. Small, but significant, improvements in value recovery were found when logs were manufactured on the landing. Much of the improvement was due to a redistribution of volume cut from the lower value to higher value grades, and a reduction in inaccurate cutting of log lengths. The value recovery for the CPY system is based on an analysis of potential value recovery if logs were cut to fixed lengths at the stump and no further value loss was incurred at the CPY itself. No field data was available for use in this analysis. The CPY value may, therefore, be on the high side.

As mentioned earlier, all of the costs used in Table 2 were derived from a stump-to-milldoor harvesting simulation model. For the C.A.B., STUMP and LANDING systems differences in costs were primarily due to differences in average piece size extracted by the yarder; 0.75, 0.93 and 3.10 cubic metres respectively. The average piece size extracted for the CPY system was 1.24 cubic metres. The high cost of constructing and operating a CPY outweighed the reduction in yarding costs resulting from the larger piece size, however. The CPY option was the most expensive.

Banks in New Zealand are currently charging interest rates for loans of about 22 to 25% while the inflation rate is currently about 10 to 13%. This implies a real rate of about 12% should be used for discounting.

Table 3 shows net present value figures and percentage differences in profitability. It can be seen from Table 3 that the gross profit for the C.A.B. system is close to $1600 per hectare (c. 24%) higher than for the system that would normally be used on steep country in New Zealand, LANDING-3%. If the log manufacturers did not have the assistance of a hand-held computer the gross profit would be considerably lower for the STUMP system than for the LANDING-3% system, $1959 and $6387 per hectare, respectively. The higher costs of extracting small pieces must be covered by higher value recovery if processing at the stump is to be a viable alternative.

The last column in Table 3 shows the change that would be required in value recovery for there to be no difference between alternatives. No values are given for the STUMP and CPY systems since they do not appear to be major contenders. If value recovery on a landing could be increased by about 5 to 6 percent above that assumed (i.e. to about 83%), there would be no difference between the C.A.B. and LANDING systems - profit would be about $7900 per hectare. Twaddle (1986) has found that tractor logging crews, processing tree-length logs on large landings, currently average about 85% value recovery and with training and incentives should average 90 to 95%. It could be expected that the greater "work pressure" on log manufacturers working on cable-logging landings (due to shorter cycle times) would result in lower value recovery than found for tractor crews. Nevertheless it should not be difficult to raise value recovery on cable logging landings to about 85%. At that stage other considerations come into play in determining which system - processing at the stump or on the landing - is best.

Alternatively, if value recovery obtained, when stems were processed at the stump with the aid of a hand-held computer, was about 5.3% lower than assumed (i.e. about 94.7%) there would be no difference in gross profit per hectare between the C.A.B. system and the LANDING-3% system - profit would be about $6400 per hectare. It is unlikely that computer-aided value recovery at the stump would be quite that low.

TABLE 3 : ECONOMIC ANALYSIS OF FIVE HARVESTING SYSTEMS

Harvesting system	Profit $/ha	N.P.V. $/ha 30 yr	N.P.V. $/ha 40 yr	Difference % (*)	Breakeven Recovery % (**)
C.A.B.	7911	264	85	+23.9	0
STUMP	1959	65	21	-69.3	NA
LANDING-3%	6387	213	69	0	+5.5
LANDING-5%	6255	209	67	-2.1	+6.1
CPY	4024	134	43	-37.0	NA

* Change in profit with LANDING-3% as the reference.

** Required change in value recovery for there to be no profit difference between the C.A.B. and LANDING systems.

For the CPY alternative to be selected other considerations would need to be taken into account. Central processing yards permit the accumulation and segregation of specialist products that would not be practically feasible to segregate and store in the forest for individual harvest operations. High premiums for such specialist products might reduce the difference in gross profit between this and other alternatives. Further research is needed in this area before this option should be dismissed.

CONCLUSIONS

For conditions similar to those described here the overall conclusions that can be drawn from these analyses are as follows :

1. Final log manufacturing at the stump, with hand-held computers to aid in optimal log-bucking decisionmaking, shows the greatest potential profit. Use of the value audit system, AVIS, for final log manufacturing at the stump should receive serious consideration and research effort. Research effort is needed to determine the best way to implement AVIS in terms of cost, timing and training strategies. This alternative is also more likely to satisfy environmental and physical concerns with building large landings.

2. Computer aided bucking at the stump has yet to be demonstrated operationally. If hand-held computers are not operationally feasible final log manufacturing at the stump can be expected to result in higher costs and lower value recovery than the traditional method of tree-length extraction to, and final log manufacturing on, large landings.

3. Until the feasibility of CAB can be demonstrated New Zealand should continue to build large landings and use large yarders to extract tree-lengths to those landings.

4. Computer aided landing operations may have operational delays which limit its complete implementation. However, even small increases (5%) in value recovery achieved through conventional methods (e.g. training, incentives) will make the landing economically competitive with computer aided stump operations.

5. The central processing yard alternative could not be classed as a preferred option on the basis of these analyses.

6. The importance of value recovery in overall economics has been strongly highlighted in this paper. The differences between people in their ability to obtain high value recovery from a stem should be recognised by management and incorporated into manpower selection, training, and management schemes. The gains that can be obtained, as shown in the extensive work carried out by Twaddle of the New Zealand Forest Research Institute, have been confirmed by results of this paper.

7. Selection from alternative harvesting systems must be done on an overall economics basis. Basing decisions on productivity, or cost, or value recovery alone may lead to sub-optimal decisions.

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