SESSION 4
Paper (e)

PLANNING FOR MECHANISED OPERATIONS

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1. Introduction

A successful mechanised harvesting operation requires efficient planning, effective management and operational competence at all levels. The management of mechanised operations is extremely complex. The factors which cause this complexity include :

1. The work environment of the harvesting operation which is inevitably variable in comparison with the factory environment in which many machines operate.

2. The many choices available for machines, but once a system has been chosen there is a relatively low level of flexibility in terms of methods, suitable tree dimensions and product specifications.

3. The high capital cost of the equipment which is subject to frequent mechanical breakdown. The more complex the equipment, the greater is the chance of individual component failure.

4. The operating and maintenance personnel who need to adapt to new methods, new equipment and a new environment, and therefore require adequate training.

Some of these factors are common to all logging operations. This paper deals with the planning required to overcome those factors which are unique or especially important to mechanised operations.

2. What is Planning?

Intensive planning is essential if management is to be successful. Planning means fitting together the variable factors such as machinery, operators, and supervisors with the fixed factors such as the trees, the stand and the terrain so that management objectives can be achieved. The Logging Manager is presented with an area of forest which he is required to harvest according to his organisation's objectives. The forest and the terrain on which it stands are fixed and he cannot alter them. The equipment, the men and the methods with which he harvests the area of forest are to a varying degree within his control. Planning for a good match between the forest which he has been given to harvest and a mechanised system which he chooses to introduce, is particularly important because of :

1. The high capital cost of the equipment, meaning tht productive machine time must be maximised to reduce the fixed costs per unit of wood produced.

2. The lack of flexibility once the equipment has been chosen, meaning that the correct choice is vital.

Unless these factors are carefully considered during the planning stage, management objectives are unlikely to be met.

3. What is Mechanised Logging?

The most labour intensive (or least mechanised) logging method employed in New Zealand is the motor manual shortwood system. In this sytem the following breakdown of time is commonly found for the processing components of harvesting :

(a) Felling : 15%
(b) Delimbing : 55%
(c) Cutting to length : 15%
(d) Stacking : 15%.

Extraction is considered mechanised in all but a very few operations. Cable skidder systems require men in the bush who are not needed in grapple skidder or forwarder systems, and therefore represent a lower level of mechanisation. However, only the processing components are considered here.

If this shortwood system is taken as a non-mechanised system as a yardstick to assess other options, there is a range of systems with varying degrees of mechanisation, up to fully mechanised. The extent to which they are mechanised depends on the proportion of the time involved in the shortwood method which has been replaced by mechanised methods. The following table gives some examples. Note that in many systems such as producing long pulp, cutting to length may be mechanised at the mill site, and stacking may not be required.

System	Mechanised Phase				% mechanised
	fell	delimb	cut to length	stack	
Shortwood	0	0	0	0	0
Tree length	0	0	15	15	30
feller buncher, tree length	15	0	15	15	45
delimber feller buncher, shortwood	15	55	0	0	70
feller buncher, processor, shortwood	15	55	15	15	100

In some highly mechanised systems extra delimbing is required for example at the landing. In this case there will be less than 100% mechanisation.

For the purposes of planning, mechanised harvesting has here been taken as any system where the felling or the whole or part of delimbing is carried out by a machine.

4. Planning Requirements

The following notes cover in some detail specific planning requirements for mechanised operations.

4.1 Management Objectives

Management objectives will usually be stated in terms of the quantity and quality of wood required at a certain point over a period of time, with the operation to be conducted at minimum cost. Various constraints may be given, for example acceptable limits of stand damage, maximum production capacity required and minimum piece size to be harvested.

Mechanised systems frequently have production rates five times greater than motor-manual systems. Care must be taken to choose systems which can achieve the required rate at optimum daily utilisation. There will obviously be less flexibility with fewer production units. It is unwise to rely on just one, or even two units for the entire input to a mill. Often a mixture of mechanised and motor-manual systems will be the best choice.

Delimbing quality and accuracy of log making vary in different mechanised systems, and end user requirements must be clearly understood. Delimbing quality can be improved by additional manual work, but this must be planned in advance.

4.2 Terrain

Slope and surface obstacles are important limitations to mechanised logging systems. As a generalisation, machines mounted on rubber-tyred carriers have more or less constant production on slopes up to 10° in wet weather and up to 15° in dry weather. This is if the machine can work as closely as possible at right angles to the contour. Side slopes over 5-7° cause operators to lose confidence and in thinnings operations stand damage will become unacceptably high. Machines mounted on tracks may be able to move more readily on steeper slopes. However, positioning a felling head or controlling the movement of trees on steep slopes is difficult and these machines are limited to the same extent as those mounted on rubber-tyred carriers.

Prototype feller bunchers which will work on steep slopes are under test in the U.S.A. In Europe, whole trees may be extracted from steep slopes with a cable hauler, and processed on the landing by a machine.

Surface obstacles include gullying on relatively flat terrain, old logging rubbish, boulders, etc. In New Zealand gullying or surface uneveness is likely to be the most important factor. Mechanised system production is considerably reduced where operators have to cope with surface obstacles.

In some instances it may prove worthwhile having a backup logging system such as a rubber-tyred skidder to cope with areas such as gullys or short steep slopes where the productivity of a mechanised system would be significantly reduced.

4.3 The Forest or Stand

The first requirement is sufficient quantity of wood on suitable terrain to keep the system operating for the life of the mechanised equipment. Mechanised systems require a large volume of wood and area of forest per year compared with a motor-manual system. Unlike a motor-manual system, they cannot be shifted to less favourable terrain when the forest is finished.

An important consideration is the size of the area of forest which is to be harvested before the logging equipment must be moved to a different site. The greater the capital cost of the equipment the more expensive it is to move. This is partly related to transport costs and partly to the lost production while moving. The cost of moving from one site to another must be spread over the volume to be logged from the new area of forest. If this volume is large then the extra cost per cubic metre will be small. Ideally, a highly mechanised logging system should operate for the life of the machinery in the one stand.

Stand stocking has a very limited affect on productivity of mechanised systems within the normal ranges found in New Zealand plantations. A more important factor is the residual stocking in a thinnings operation. Where many trees are to be left, highly mechanised systems will be limited in their productivity because of the need to search out the next tree and to avoid damaging remaining trees during the moving phase.

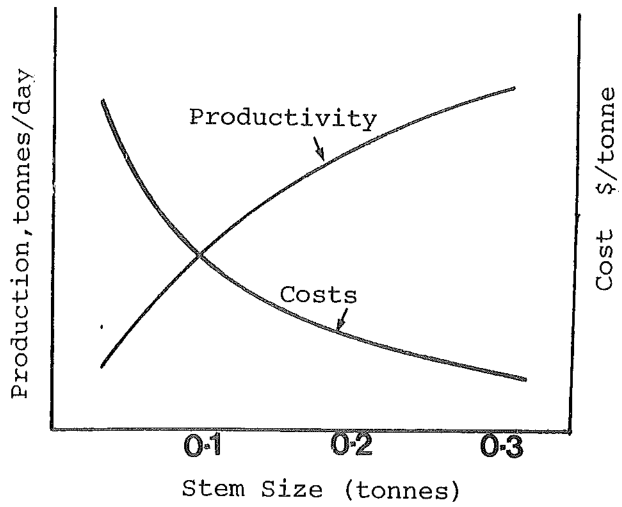

Figure 1

Productivity and Costs Related to Stem Size for a Highly Mechanised System.

4.4 The Trees

Knowledge of tree dimensions and wood characteristics is fundamental to matching equipment with the forest. Mechanised equipment for harvesting small trees costs less than that for handling large trees. However, the effect of tree size on productivity for any equipment has a much greater influence on final wood cost than does the cost of the capital equipment. For example, to harvest a tonne of 10 cm dbh trees in a fully mechanised single tree system will be approximately 5 times the cost of harvesting 20 cm trees. In a motor-manual system, the cost difference will be only a factor of two or three. The relatively higher cost of small trees can be overcome to some extent where the mechanised system can handle several trees at once, such as in flail delimbing or accumulating felling heads. These multiple stem handling systems are more suited to clear felling than to thinning operations.

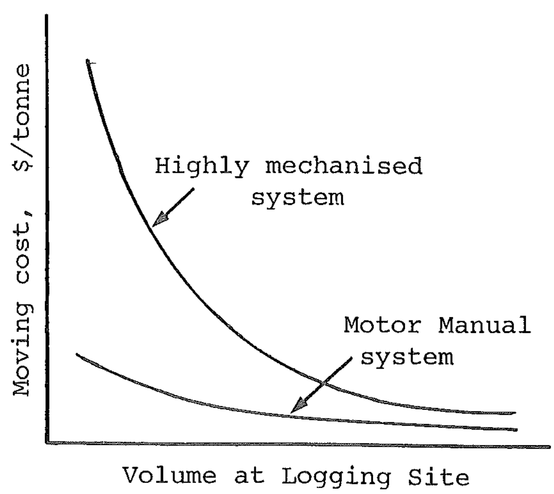

Figure 2.

Moving Cost - $/Tonne. Different Move Distances give Different Parallel Curves.

While the average tree size in a stand will have considerable influence on the productivity of a mechanised system, the maximum tree size is also important. The maximum capacity in terms of diameter for felling head and delimbing knives must be closely related to the maximum butt diameter of the stand trees. The more uniform the tree size the better, as one chosen mechanised system will not work efficiently over a wide range of tree sizes. In some cases it will be more efficient to manually fell and delimb a small percentage of large trees either before or after the mechanised operation rather than plan the mechanised equipment to handle the greatest stem dimension which exists. No more than five percent of trees should be bigger than the machine's capacity. A small number of machines, for example the New Zealand developed delimber-feller-buncher head are limited by the stem length over which they can effectively operate.

The fast growth of some plantation species may cause problems where planning takes place a year or more before harvesting. When harvesting does occur the trees may have grown beyond the capacity of the machines which were originally planned for that stand. Therefore, planners will have to bear in mind the growth rate of the stands for which they intend to use mechanised systems.

The need for an accurate inventory of tree dimensions and the proper timing of operations for mechanised systems follows from the lack of flexibility of these systems. Once the machines have been chosen there is a narrow range of tree sizes over which lowest costs can be expected. It is difficult to change their capacity. With motor-manual systems the chainsaw cutter bar size, or the chainsaw itself can be increased at little extra cost if trees are found to be larger than expected.

Branch and wood characteristics are likely to be fairly uniform in New Zealand as mechanised systems are likely to be restricted to only a few species. For these species, branches can only be completely removed by cutting. Flails will partially delimb, while gate systems have not been shown to be successful.

4.5 Operators

Good bushmen, i.e. skidder drivers or fallers, do not necessarily make good operators for highly mechanised machines. Experience has shown that many fallers find working on highly mechanised systems relatively less exciting and often move on after a short period. Most mechanised systems involve using feet and hands to control the felling and delimbing functions at a remote distance. Formal training facilities for this kind of work are non-existent in New Zealand. When planning a mechanised operation it is important to bear in mind the learning period of operators. Results indicate a six-week learning period is required in clearfelling operations, and longer then this in thinning operations.

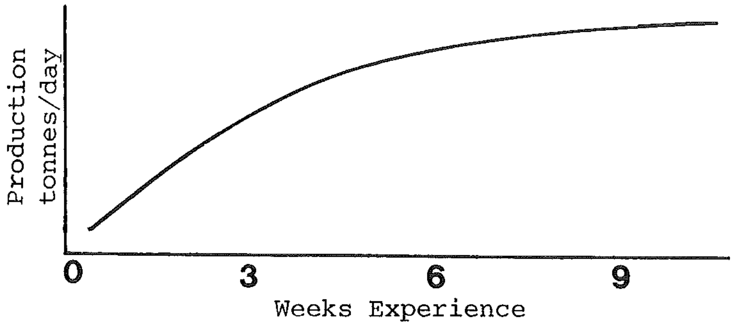

Figure 3.

Learning Curve for Sophisticated Logging Machines.

4.6 Maintenance

Because of the high capital cost of mechanised systems, it is vital that machine downtime for maintenance and repairs be kept to a minimum. Mechanised logging systems usually involve fairly sophisticated hydraulic components and these are commonly the cause of downtime. If machine operators are to undertake basic maintenance and repairs they will need specific training for the kind of equipment which they are working. More complex repairs and servicing will mean calling in experts, usually from a considerable distance. It is essential to plan for a very efficient, rapid repair service if highly mechanised systems are to be kept operating in the forest. Regular planned maintenance is a must. Although it rarely happens in New Zealand, the ideal situation is where enough highly sophisticated machines are working close together so that a repair mechanic can be available full time.

4.7 Roading

Road location is a critical factor to consider in planning for logging operations on steep terrain. However, mechanised operations are generally restricted to easy country and roading is less of a problem. The main decisions concern the roading pattern and road spacing.

Parallel roads with occasional link roads, are preferred. Where thinning is to be undertaken, roads should be parallel to row direction. Road and landing spacing depend on a trade-off between road building cost, forest area lost to roads and extraction cost. To achieve a mean haul distance of 100 m, roads need to be 400 m apart.

Where the extraction machine has a large load capacity (e.g. a 15 tonne payload forwarder) road spacing can be wider than where a lower load capacity machine (e.g. a 2 tonne payload grapple skidder) is to be used. Thus planning for road spacing must consider the extraction machine to be used.

5. Planning the Operation

Once machines have been chosen, roading pattern established, and decisions made on operating amd maintenance personnel, attention can turn to the actual operation. The following points should be borne in mind.

5.1 Reduce Unproductive Time

Because of the high capital cost involved with complex logging machinery, the fixed cost per hour regardless of whether the machine is operating or not is high. The greater the hours in a day and days in a year when a machine is operating the lower this fixed cost will be per cubic metre of wood produced.

Avoid dead moving as a result of shifting between rows, between stands to be harvested and from operating to maintenance positions. If at all possible, work long days or double shift the prime machine in a mechanised system. In addition to reducing the fixed cost per volume of wood produced, this also ensures that the total life span of the machine will be as short as possible. This would enable new technology to be taken advantage of as soon as they are introduced.

If silviculturally compatible, thinning operations should be conducted on an outrow system as the amount of dead moving between trees will be less than with a selection thinning system.

If a situation arises where log supplies must be reduced, for example because of mill shutdown, that part of the supply from mechanised systems should be maintained as long as possible. Because of the high capital investment, the cost of not working is higher in these systems than in motor-manual systems.

5.2 Work Perpendicular to the Slope

The pattern of movement of the machine should be planned in advance and should always be perpendicular to the slope. This will enable greater slopes to be negotiated and reduce residual stand damage in thinnings operations to a minimum.

5.3 Match Equipment Capacities

Mechanised harvesting systems generally have a large hourly or daily volume output. This reduces the flexibility when matching one machine to another, compared with, for example, a motor manual system where the output of an individual man is relatively low. Once again, because of the high capital cost of the equipment involved, it is important that machines are not kept waiting for each other. It is sometimes difficult to get advance estimates of the productive capacity of the various pieces of equipment which might be employed. It is therefore a good idea to allow some flexibility in the working hours of the machines so that they are matched. It is general experience that sophisticated logging machines are only used on productive work for about 70% of the time during which they are scheduled for work. Where a processing machine and an extraction machine are working in the same forest, the processing machine should keep at least one day ahead of the extraction machine. This means that short periods of downtime experienced by the processing machine will not affect the extraction machine.

5.4 Consider the Next Operation

To gain greatest advantage from mechanised logging systems, it is important that each operation leaves the trees or logs handled in the best situation for the next machine. For example, a processor or harvester should leave trees in the best situation for the extraction machine and the extraction machine must leave logs suitably placed for loading. The pattern of operation of a felling and/or delimbing machine should be such that the extraction machine has the shortest possible route to the landing. Product length is important for trucking, especially where tree length logs are extracted. Planning should ensure that truck layouts are suited to log length.

6. Conclusions

The most important factors to bear in mind when planning for mechanised logging operations are :

6.1 The forest and the terrain on which it grows are fixed. Make sure the the machine introduced to harvest in this environment are suited to it.

6.2 Once a system has been introduced, choice of working methods is reduced and flexibility is relatively low. Plan patterns of operation to best suit the machines and plan machine capacities to suit each other.

6.3 Because of the high capital cost of equipment employed it is essential to keep it operating for as long as possible, each day and each year.