THE USE OF MULTIPLE PRODUCTION UNITS IN TIMBER HARVESTING

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SYNOPSIS

Each forest area has its own particular problems concerning the extraction and harvesting of logs. Machinery and equipment suitable for one area will not necessarily suit another, but the basic problems are the same. What equipment to use? When should it be used? What expenditure is available? And, probably the most pertinent, how can existing costs be maintained or reduced?

This paper attempts to show methods, broadly applicable to all age classes of trees, of calculating varying costs by different combinations of machines and men, particularly with regard to thinnings of the younger age classes.

INTRODUCTION

With the continuing expansion and utilization of exotic forests it is becoming increasingly necessary to obtain greater efficiency with extraction, loading and hauling units.

Each year an increasing amount of the production from forests is being harvested from the younger age classes. Because of the smaller volumes per acre and the smaller piece size, harvesting this volume by either thinning or clearfelling is more costly than in the existing older age classes.

A wide variety of extraction equipment is available for the harvesting of this timber and there is no doubt that, of all logging equipment, tractors used on tractor country give the cheapest unit cost. However, there is no one tractor that will successfully and efficiently do all the logging operations that are necessary for full utilization throughout a rotation.

Consider a forest of mixed age classes managed on a rotation of 50 years, with a thinning cycle that commences at age 12 and is repeated every six to eight years. Such a forest will need at least three basic sizes of tractor. When topography, ground conditions and forest stand differences are taken into consideration, these three basic sizes of tractor can increase to an alarming multiplicity of tractor types.

As the economic life of a logging tractor in continuous operation is usually from three to five years, the basic cost that must be recovered in any one year is correspondingly high. The make, size and h.p. rating will dictate the actual operating costs, and the operating costs of the tractor unit(s) and labour costs determine the landed cost of logs. The forest manager can lower the cost of extracting logs, or maintain present rates in the face of rising costs from outside, only by increasing the efficiency of the operation.

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It is generally considered that the higher the production achieved, the greater the efficiency. This is true only if a lower unit cost is achieved at the same time.

Increased efficiency of tractor operation can be arrived at in a number of ways, some of which are already common practice — e.g., by adding to the basic unit extra equipment such as timber sulkies, A-frames, bulldozer blades, and log loaders; or by varying the gang size. A further method of attaining greater efficiency and lower unit costs is to work two or more tractors of different sizes together as one production unit in the same area.

The five basic factors that determine tractor efficiency and output are topography, soil conditions, volume per acre, piece size and distance of haul. These factors also determine the type and size of tractor and its h.p. rating.

**PRODUCTION UNITS**

A production unit comprises a number of men, their equipment, and the machines required to produce logs from any one area in the forest and deliver those logs to any specified point.

The point of delivery specified determines the structure and operational scope of a production unit, e.g., roadside delivery will require a production unit of men and one or more tractors, whereas, for delivery to mill skids, a loader and one or more trucks must be added to the production unit.

As a general rule, the separate parts of a production unit must work towards maximum supply for that part of the unit that has the highest productivity rating. If the tractor or tractors have the highest rating, sufficient men and equipment should be available to keep the tractor(s) working at maximum production, whereas, if the loader has the highest productivity rating, sufficient tractors, men and equipment should be available to keep the loader working at maximum capacity.

Theoretical models of these production units can be constructed using basic standards to arrive at values of performance and cost.

This does not mean that each part of the production unit will be working to standard or even has to be working to standard. Performance is rarely, if ever, balanced evenly between men and machines. There are, in any stand of trees, inherent physical limitations that restrict the grouping of men and machines, and these limitations will determine the size and complexity of a production unit.

**UNIT COST**

The unit cost is the cost per unit of measure of logs extracted from the forest and delivered to any given point, i.e., roadside, on truck or to mill skids. One method of finding the unit cost is to divide the total operating costs of the production unit per year by the total production per year. It is necessary to know the number of days that are to be worked in the year, particularly Saturdays and holidays, so that allowances can be made for penal rates in the operating costs.
TABLE 1: COMPARISON OF RELATIVE DAILY PERFORMANCE OF FOUR PRODUCTION UNITS

<table>
<thead>
<tr>
<th>Tractor Times</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Production per tractor per hour (cu. ft)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drott</td>
<td>320</td>
<td>320</td>
<td>320</td>
<td>320</td>
</tr>
<tr>
<td>Timberjack</td>
<td>5.5</td>
<td>7</td>
<td>11</td>
<td>16.5</td>
</tr>
<tr>
<td>Total tractor extraction time (hr)</td>
<td>1.5</td>
<td>—</td>
<td>3</td>
<td>4.5</td>
</tr>
<tr>
<td>Total tractor loading time (hr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Logging truck loads | | | | |
| Number (per day) | 3 | 4 | 6 | 9 |
| Volume (cu.ft) | 586 | 612 | 622 | 633 |

| Bush Time | | | | |
| Production per day (cu.ft) | 1760 | 2450 | 3730 | 5700 |
| Production per man day (cu.ft) (980) | 880 | 816 | 932 | 950 |
| Production per man hour (cu.ft) (140) | 126 | 116 | 133 | 135 |
| Trees per man hour (7) | 6.3 | 5.8 | 6.6 | 6.75 |
| Operating cost per year | £7,288 | £8,508 | £12,689 | £19,932 |
| Production per year (cu.ft) (229 days) | 403,040 | 561,050 | 854,170 | 1,305,000 |
| Unit cost loaded on truck | 4.3 | 4.4* | 3.8 | 3.6 |

* Includes loading cost of 0.8 pence per cu. ft by R.B. crane loader.

Figures in parentheses indicate standards derived from work study.
PRODUCTION UNIT VALUES

Four alternative production units for thinning an eighteen year old *Pinus radiata* stand to extract and load logs on truck will be considered. The stand is on easy, undulating topography, soil conditions are firm and dry, and the number of trees to be removed averages 80 stems per acre, giving a yield of 1,600 cu.ft per acre.

The standards from work study are:

- Days worked per year: 229
- Actual hours worked per day: 7
- Tractor hour production: T.D.6, Drott 320 cu.ft, Timberjack 350 cu.ft
- Trees per man hour (bushmen): 7
- Maximum distance of haul: 12 chains
- Loading time (Drott, 635 cu.ft): 30 min

In the examples that follow, one of the tractors, the International T.D.6 Drott, is used part-time as a loader. It is particularly suited for first and second thinnings and eliminates the use of a more costly crane type loader.

For simplicity and ease of comparison the quoted annual operating costs include fuel, repairs and maintenance, and depreciation on tractors, gang transport and power saws. They also include wages and sundries, such as replacement of wire ropes, strops, axes, first aid and fire equipment. No overheads or royalties are included.

The four production units to be compared for this operation are:

1. A single tractor gang comprising a T.D.6 crawler tractor with Drott log-grapple-loader and three men (one driver, two bushmen).
2. A single tractor gang comprising a Timberjack wheeled tractor and four men (one driver, three bushmen). Loading is by crane-loader.
3. A two-tractor gang with a T.D.6 Drott and Timberjack and six men (two drivers, four bushmen).
4. A three-tractor gang comprising one T.D.6 Drott, two Timberjacks and nine men (three drivers, six bushmen).

The relative daily performance of these four production units may be compared as shown in Table 1.

DISCUSSION

The four models show that the different grouping of men and machines will give varying unit costs all determined to one common point, in this case the unit cost of logs loaded on truck. It is evident that working to the standard rates set by work study is not as important for the bushmen as it is for the tractors. What is important is knowing the standards and operating costs...
for each individual part of the production unit in relation to each other. In none of the production units quoted are the men and machines working equally to standards; in all four models only the tractors work to standard rates of production. This bears out an earlier statement that, as a general rule, the separate parts of a production unit must work towards maximum supply for that part of the unit that has the highest productivity rating. A proof of this is to construct models in which parts of the production unit, other than the tractors, are working to standard.

If gang 4 is used as an example and the bushmen allowed to work to standard, it will be seen that six men producing 980 cu. ft per man day will produce more than three tractors can cope with. The use of a fourth tractor would drastically reduce individual daily tractor output, operating costs would rise and so would the unit cost. On the other hand, if the number of bushmen should be reduced to five, the operating costs would be reduced only by one man's wages, and all other costs would remain the same.

The values for gang 4, with three tractors and five bushmen, would then become:

Operating costs/year .................................................. £18,567
Production/year (five men @ 980 cu. ft × 229 days) .................................................. 1,122,100 cu. ft
Unit cost ............................................................... 3.97 pence per cu. ft

Obviously the ideal cost from the four models is that achieved by gang 4 which resulted in a unit cost of 3.6 pence per cu. ft loaded on truck. However, this cost can be maintained only while all the men and equipment and tractors continue to work as one production unit.

The purpose of these theoretical models is to illustrate what the unit cost will be when any one of the various production units is in operation. They are intended to show that the cost of logs need not be tied to the production of a conventional one-tractor-gang when it is possible to use two- and three-tractor gangs. Cheaper and more efficient methods can be achieved thereby, without necessarily incurring higher capital costs.