SESSION IV
Paper (a)

ECONOMIES OF SCALE IN LOGGING

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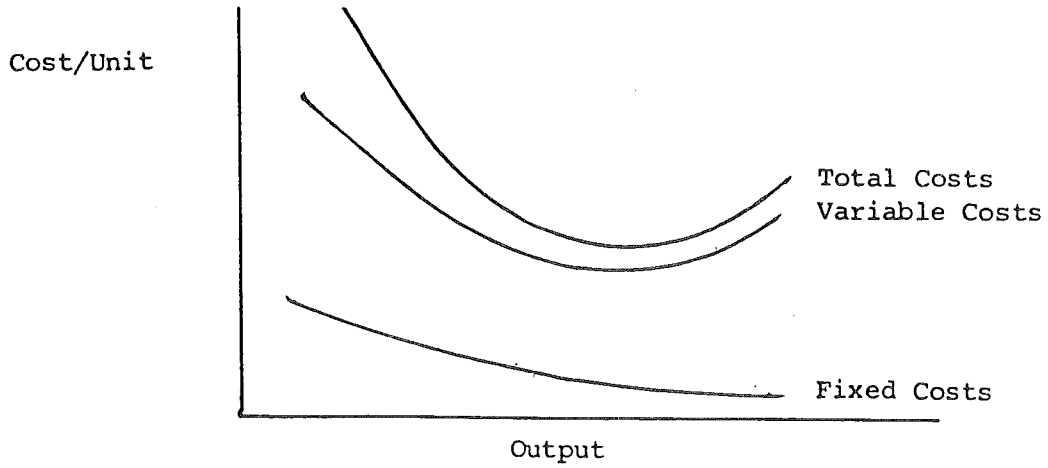
INTRODUCTION

Logging is a capital intensive industry, with a relatively high level of investment per worker. This is reflected in the high proportion of fixed costs in the cost structure of a typical logging operation. Not surprisingly, therefore, the viability of a logging contract is dependent on the scale of production. This paper briefly discusses costs of production and economies of scale and assesses their significance in logging.

ECONOMIES OF SCALE

Economies of scale arise when expansion of the level of production causes total costs to rise less than proportionately with the increase in output. Typically, fixed costs per unit fall as they are spread over a rising level of production. Variable costs per unit generally fall initially, level out, and may rise again if plant capacity is exceeded. As long as fixed and variable costs per unit decline so too will total costs per unit. Total costs reach a minimum at the optimal level of production. Beyond this point total costs will increase as variable unit costs rise sufficiently to offset the downward pull of fixed costs per unit. The general pattern of fixed, variable and total costs and economies of scale are illustrated in Figure 1.

FIGURE 1 : COSTS OF PRODUCTION AND ECONOMIES OF SCALE



The pattern of costs illustrated in Figure 1 is representative of many production processes. It clearly indicates that a business organisation does not have a single cost of production for its output, but that cost of production varies with the level of output. This has practical implications for the common practice of pricing on the basis of standard costs. Although standard cost estimates can play a useful role they can be misleading unless the user remembers that they are arbitrary except when related to a particular level of production.

Economies of scale may be achieved by a number of means, including :

- Specialisation and division of labour.

- The use of specialised technology.

- The balancing and meshing of the various stages of a productive process to take advantage of the optimum scale for each stage of the operation.

The specialisation and division of labour involves the employment of labour on individual components of a production process. Extensive specialisation is possible only in reasonably large firms. It will pay off most where the production process is complex and where many different skills and operations are involved. The development of mass production techniques by Henry Ford in car production is a well-known example.

Specialised large-scale technology is essential in many industries, such as pulp and paper mills, petrol refineries and steel mills. Small firms cannot afford such expensive equipment, for without a large volume of output the cost per unit would be prohibitively expensive.

In a large firm the various components in a productive process can be combined to take advantage of the optimum scale of each component in the process. For example, imagine a firm using two types of machine, X and Y, with machine X feeding machine Y. Machine X can produce 10 units of product per hour while Y produces 15. A system consisting of a single unit X and a single unit Y would clearly not be well balanced. The firm could achieve maximum efficiency if it installed three machines X and two machines Y. A small firm unable to expand in this way will either under-utilise machine Y or it will have to put X on an extra shift.

The above considerations might suggest that large concerns are most efficient. In point of fact, economies of scale do not continue indefinitely. Once division and specialisation of labour have reached a certain point further expansion merely leads to duplication of workers. The same is true of the use of expensive technology and combination of factors of production. Once an organisation is large enough to take advantage of the factors of production it can gain no further cost reduction by further growth.

Specialisation and division - the landing for a high throughput chipping operation in Olympic Peninsula, Washington,U.S.A.

(LIRA Photo CN267/8)

In any business enterprise there are a number of possible obstacles to the achievement of economies of scale. A common constraint is the size of the market. An example is the cinemas in Auckland City, which serve a limited audience. More often than not, most would be considerably less than full. Unit costs must, therefore, be greater than they might otherwise be, given the capacity of the cinemas.

ECONOMIES OF SCALE IN LOGGING

In logging, economies of scale may be achieved through the application of appropriate technology and combination of factors of production rather than through specialisation and division of labour. Improved utilisation of particular equipment may provide some economies of scale, but it is less important than the scale of output and the spreading of fixed costs (Cubbage, 1982). Thus, economies of scale can be obtained on a particular contract by the use of machines suited to the topography, piece size of logs and other factors affecting job performance. This can be illustrated with reference to an example comparing two logging systems, A and B, being considered for use on a contract. System A involves lighter and less costly machines than B. The piece size of the logs and terrain are such that system A would be working close to the limits of its capacity. System B, by contrast, would be capable of coping efficiently with the piece

size and terrain. The production levels and costs of production of the two systems are summarised in Table 1 and detailed in Appendix 1. For simplicity, the cost structure of the two systems is assumed to be identical except for the difference in capital costs.

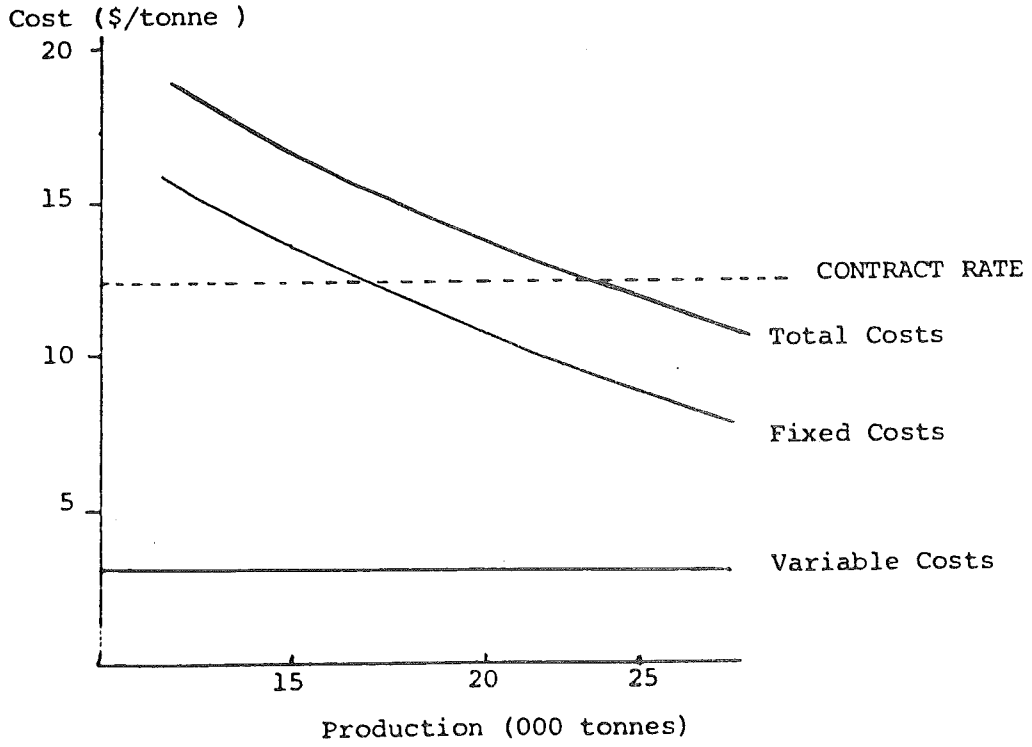
TABLE 1 : ECONOMIES OF SCALE FROM INCREASED INVESTMENT

	(A)	(B)
Annual production (tonnes)	18,000	23,000
Fixed costs ($)	190,550	215,750
Variable costs ($)	54,000	69,000
Total costs ($)	244,550	284,750
Total costs/tonne ($)	13.59	12.38

System A is capable of producing 18,000 tonnes per annum at $13.59 per tonne, while B can deliver 23,000 tonnes at $12.38 per tonne. The higher total costs in system B are more than offset by the large increase in annual production and resulting reduction in fixed costs per unit. The over-riding factor is clearly the ability of system B to increase the annual volume produced giving rise to a reduced unit price.

The importance of economies of scale in a particular logging system are readily illustrated with reference to a simplified hypothetical example of a tractor logging operation. In the example, the contractor has a production target of 23,000 tonnes per annum and a revenue target of $284,750 ($12.38 per tonne). This would allow him to meet all of his commitments and leave him with a profit of 15% on capital invested. The pattern of costs over a range of outputs is illustrated in Figure 2.

FIGURE 2 : ECONOMIES OF SCALE FROM INCREASED PRODUCTION



The inverse relationship between total and fixed costs per tonne and the level of output is clear from Figure 2. For production levels above 23,000 tonnes the contract rate exceeds total costs and at lower levels the opposite is true. Below a production level of about 17,000 tonnes the contract rate does not cover fixed costs per tonne.

The key variables are the level of production and fixed costs. Over the production range covered, fixed costs account for between 76% and 84% of total costs (Appendix 2). As contract revenue is directly related to the level of production, it follows that a fall in production gives rise to a pro rata reduction in total revenue but a less than pro rata fall in total costs. For example, a 10% cut in annual production from 23,000 tonnes to 20,700 tonnes reduced total revenue by 10% but total costs by only 2%.

The achievement of economies of scale has obvious financial implications in logging. In practice, however, the achievement of economies of scale may be an impossible goal. Apart from the vagaries of nature and site-related problems, the possible obstacles include lack of finance to purchase suitable equipment and limitations to the size of the market. In logging, market limitations may arise in a number of ways, including :

- Imposition of supply quotas either because of limited demand on the part of the customer or because of supply restrictions in the forest.

- Small size of contract areas (e.g. farm woodlots), with frequent shifts of location of operation.

- Delays in starting a new contract, following completion of the previous contract.

- Industrial stoppages, which halt the production of logs.

As noted above, one of the limitations on the volume of production may be the size of the contract area and the time lost in moving the location of operations. Costs of moving include the fixed costs of idle equipment, wages paid to non-productive employees, and the costs of transporting equipment from one site to another. Because of lost time there is a lower volume over which to spread fixed costs. Obviously, smaller systems will cost less to move, because of their lower fixed costs, and highly mechanised systems will be most costly (Cubbage, 1982).

DISCUSSION

The implications of a high level of production and the benefits of economies of scale are clear. But for the contractor in limited scale logging and, indeed, in logging in general, the reality of the situation may be quite different from the theoretical ideal. Even if the contractor has the right machinery and even if he has done his financial homework, market constraints or other factors beyond his control may force him to operate at a less than desirable target level of output. In this situation economies of scale are unattainable and costs per unit are higher than they might otherwise have been. However, the typical logger has no security of contract and no power to influence the market. As a result, in the competitive world of logging, the practical problem of survival is sometimes more important than the theoretical consideration of cost curves and economies of scale.

REFERENCE

CUBBAGE, F., 1982. "Economies of Forest Tract Size in Southern Pine Harvesting." U.S.D.A. Forest Service, Southern Forests Experiment Station. Research Paper S 0-184.

APPENDIX 1

ECONOMIES OF SCALE FROM INCREASED INVESTMENT

	(A)	(B)
Annual production (tonnes)	18,000	23,000
Capital Investment ($)	220,000	290,000
A.C.I. ($)	140,714	180,714
Wages ($)	92,000	92,000
Return on Investment ($)	21,107	27,107
Interest ($)	29,550	37,950
Insurance	2,814	3,614
Depreciation ($)	26,429	36,429
Gang Truck Hire ($)	8,050	8,050
Chainsaw Owning Costs ($)	4,600	4,600
Accounting, Admin etc ($)	6,000	6,000
Total Fixed Costs ($)	190,550	215,750
Total Variable Costs ($)	54,000	69,000
Total Costs ($)	244,550	284,750

APPENDIX 2

EFFECT OF PRODUCTION LEVEL ON COSTS

Annual Production (tonnes)	15000	16100	18400	20700	23000
Capital Investment ($)	290000	290000	290000	290000	290000
A.C.I. ($)	180714	180714	180714	180714	180714
Wages ($)	92000	92000	92000	92000	92000
Return on Investment ($)	27107	27107	27107	27107	27107
Interest ($)	37950	37950	37950	37950	37950
Insurance ($)	3614	3614	3614	3614	3614
Depreciation ($)	36429	36429	36429	36429	36429
Gang Truck Hire ($)	8050	8050	8050	8050	8050
Chainsaw Owing Costs ($)	4600	4600	4600	4600	4600
Accounting, Admin etc ($)	6000	6000	6000	6000	6000
Total Fixed Costs ($)	215750	215750	215750	215750	215750
Total Variable Costs ($)	45000	48300	55200	62100	69000
Total Costs ($)	260750	264050	270950	277850	284750
Total Costs ($/tonne)	17.38	16.40	14.73	13.42	12.38
Total Revenue ($)	185707	199325	227800	256275	284750
Annual Surplus/ Deficit ($)	-75043	-64725	-43150	-21575	0
Annual Surplus/ Deficit ($/tonne)	-5.00	-4.02	-2.35	-1.04	.00