ECONOMIC CONSIDERATIONS IN DOUGLAS-FIR STAND ESTABLISHMENT

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by

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INTRODUCTION

One of the most important problems facing a forest manager is how to successfully bridge the gap between the cutting of the old stand and establishment of the new one. Perhaps its importance is due to the fact that it requires prompt action based upon definite planning. At most other points in a forest stand's history, failure to take action is not quite so obvious. That is, failure to prune, thin, salvage mortality, etc., may result in a less-than-maximum output; but the area continues to produce. On the other hand, failure to get a new stand established following cutting means no production on the area at all—and quite obviously so. With evidence of success or failure following so closely whatever action is taken to establish a new stand, there is ample justification for studying every angle of all possible regeneration alternatives. This paper is concerned with a consideration of the economic aspects.

The primary objective of forest regeneration in the Douglas-fir type is to establish a satisfactorily stocked stand of desired tree seedlings. Since the costs of regeneration are to a large degree dictated by silvicultural requirements and conditions, recognition of these physical factors on any particular area must precede a choice between economic alternatives. Each course of action has its probability of success and the forester on the ground must use his experience and informed judgment in predicting the probabilities. Economics alone cannot tell, for instance, if an area might be reforested by natural means, if rodent or brush control is advisable or will be successful, if artificial reforestation is an absolute necessity, or what the resulting stocking percent might be. These problems must be approached through study of regeneration fundamentals and of as many case history analyses as possible; actual experience under the particular conditions of the individual landowners is, of course, invaluable. A forester may find that he has a choice of several reforestation alternatives, any one of which he predicts will result in a satisfactorily stocked stand of established seedlings within a reasonable time. It is at this point that economic analysis can help by providing cost estimates for the separate jobs involved and, by the use of valuation techniques, indicate the relative value of the several alternatives.

Job costs vary greatly according to method and equipment used, weather and ground conditions, and efficiency of labor and supervision. It has always been difficult to correlate costs with these variables since they are not easily measured. The human factor, which is often the most important variable, can be measured only in a general way, if at all. As a result, most administrators have to rely on average estimates based on past experiences of their own or others.

PLANTING COSTS

An analysis of over 150 Douglas-fir planting jobs on seven national forests during 1953 and 1954 resulted in the planting cost relationships shown in fig. 1. Although the curves are based on averages, and the cost of any single planting job could be more or less than indicated, the gross relationships shown are of value. The nature of the available data did not permit a more detailed cost analysis.

The inexperienced and experienced curves represent planting by Forest Service crews under direct supervision; total cost includes labor, supervision, overhead, and cost of seedlings delivered to the planting area. The contract curve represents planting done by a contractor using his crews; total cost includes the bid price (which covers the contractor's labor, supervision, overhead, and a profit allowance), seedling cost, plus a cost incurred by the Forest Service for administration and checking of performance. Although contract planting appears to be, on the average, more costly than noncontract planting, local circumstances of operational efficiency might alter the gross relationship shown here.

The differentiation of planting conditions as favorable or unfavorable was not a distinct one because of the nature of the available data. Any planting done in rocky ground, on rough, steep topography, during bad weather, or where brush cover or ground debris was heavy, was classified under unfavorable conditions; all other plantings were classified under favorable. When using experienced crews the effect of unfavorable conditions appears to diminish as the number of trees planted per acre decreases. This is probably due to an ability to pick the easier planting spots within an area classified over all as unfavorable.

DIRECT SEEDING COSTS

There have been no cost studies correlating cost per acre with the pertinent variables involved in direct seeding or rodent control. A number of case histories have been reported in which average cost for the job was quoted. On ten jobs of spot seeding by hand, total

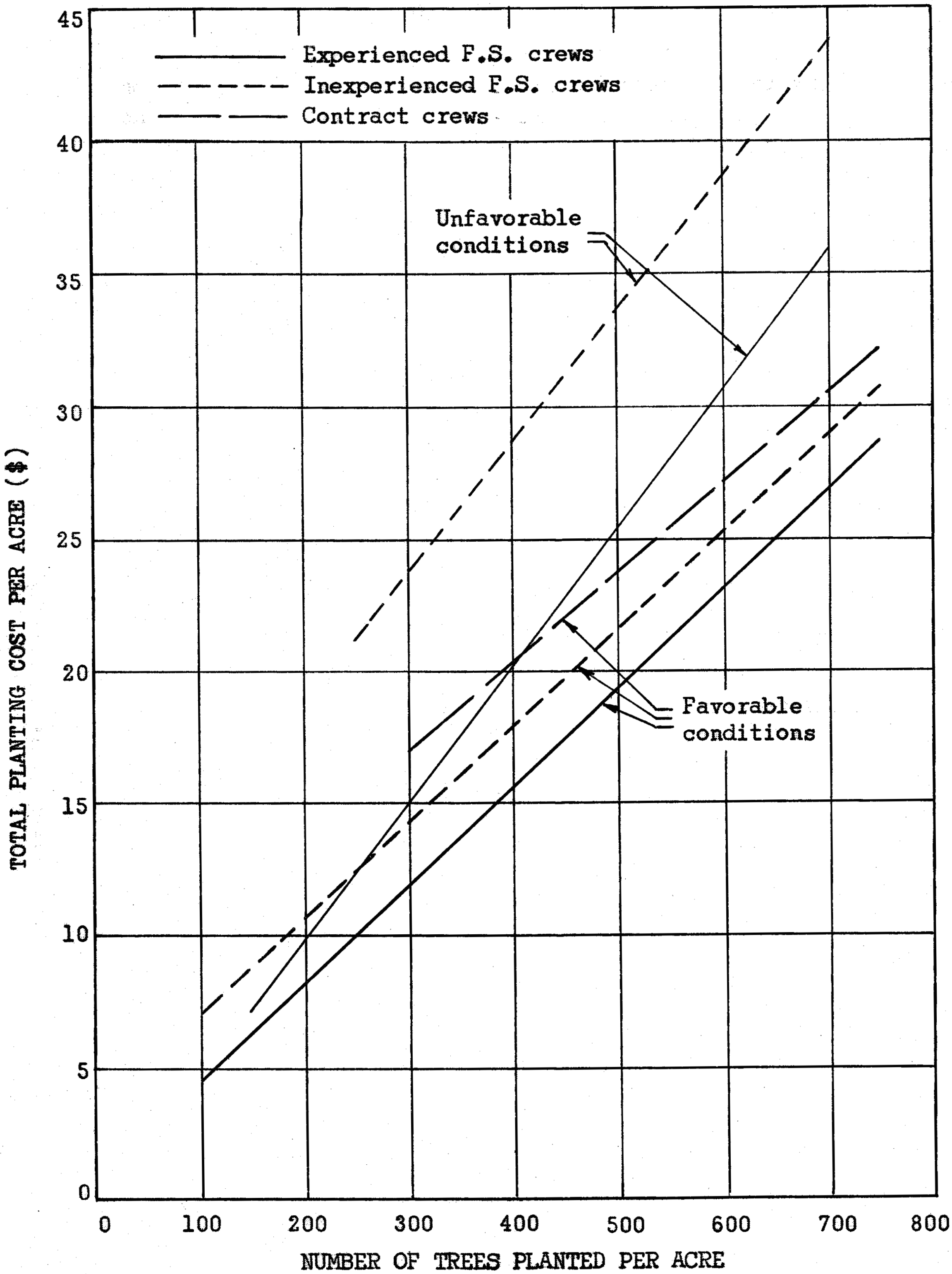

Figure 1.--Gross relationship of Douglas-fir total planting costs to type of labor, planting conditions, and number of trees planted per acre. Based on national forest data for 1953 and 1954.

cost has been from $4-$9 per acre on areas 10 to 80 acres in size. Rodent control by hand spreading of poisoned wheat on some 15 separate jobs had total costs ranging from $1.50 to $3.50 per acre. One project of poisoning and seeding by helicopter reported total costs of about $7.00 per acre, while another somewhat similar aerial project showed total costs of about $12.50 per acre. A private company recently advertised helicopter seeding with tetramine-treated seed for $8.00-$10.50 per acre with a 500-acre minimum. The State of Oregon reported average costs (1949-51) of $4-$6 per acre for poisoning and seeding large acreages by air in the Tillamook Burn.

STAND RELEASE COSTS

Another stand establishment cost which might be incurred is seedling release from overtopping competition. Reported costs of hand-girdling overtopping alder ranged from $5-$15 per acre, the size and number of stems per acre being the most important variables. Airplane spraying or dusting of alder on areas 20-50 acres in size showed costs of $5-$7 per acre with no lasting damage to conifer seedlings beneath the alder canopy. A large private forest owner testing aerial brush spraying by helicopter reported total costs of $7-$10 per acre. An aerial brush control project in the Lake States reported costs of $2.50 per acre and one on pine lands of central Oregon showed costs of about $3.00 per acre. This technique is still in an exploratory stage and costs for successful control depend on coverage necessary, efficiency of operation, and amount and type of chemical and carrier used.

SLASH BURNING COSTS

Where an accumulation of logging slash creates a fire hazard which by law must be abated, the costs of burning cannot properly be charged against establishment of a new stand. Any seedbed improvement resulting from slash burning is only incidental. In some instances it may actually make regeneration more difficult, such as by removing beneficial shade on south slopes. Any additional cost incurred for the specific purpose of facilitating regeneration could properly be charged against the new crop. If utilization of logging residues increases to the point where a serious fire hazard no longer exists, the land manager will have a choice of whether or not to burn. In this case burning the slash will become a regeneration cost since the cost is incurred for the purpose of improving the seedbed and fire hazard reduction is only incidental. This situation will most likely occur only in second-growth stands and the costs associated with this type of burning should be recognized.

The foregoing costs are presented merely as rough estimates of what it might take currently to do the various jobs associated with stand establishment. These costs will never remain constant because of changing economic conditions and the continuous development of better techniques and equipment. Comprehensive cost studies yielding information which anyone might fit to his particular conditions for accurate estimates are not available. Until such studies can be made the individual vidual landowner has a choice of either using the rough estimates or building up his own cost experience. The latter is recommended and can be done by maintaining accurate records of costs and conditions pertinent to each undertaking.

DETERMINING RELATIVE PRESENT VALUES

Where a stand of free-growing seedlings might be established by any one of several alternatives, the use of simple valuation techniques provides a means by which the least expensive alternative may be determined. The first step is to choose a rotation age with its accompanying yield, an estimated future stumpage price, and an interest rate. Since these will apply equally to all alternatives and we are looking for relative and not actual values, the choice should be realistic but need not necessarily be precise. Using these items in conjunction with estimated costs of stand establishment, the present value of each alternative is computed by discounting estimated costs and returns. The alternative with the highest present value represents the best choice.

It is not possible here to cover all the many combinations of rotation, interest rate, stumpage price, and costs which might occur. Some may want to figure on a 70-year rotation to produce a maximum wood volume in the shortest time; others may prefer a sawtimber rotation. Interest rates will vary according to managerial policy or available investment opportunities. Price estimates will differ by products and costs will change not only in time but from place to place. It is essential that each landowner employ the combination of factors which most closely fits his particular circumstances.

For purposes of illustration, we might assume that a sawtimber rotation is desirable, stumpage price at end of rotation is estimated at $25 per thousand board feet, and an interest rate of 3 percent is acceptable. Cost figures will be the best estimates possible for the particular type and method of operation.

The harvest return obtained by multiplying the expected yield 1/ by $25 per thousand board feet will be similar for all alternatives,

1/ McArdle, R.E., W. H. Meyer, and D. Bruce. 1949. The yield of Douglas-fir in the Pacific Northwest. Tech. Bul. No. 201, table 4, U. S. Dept. Agric. Revised.

unless there are well-founded reasons for expecting less than normal stocking from any particular alternative. Single costs are those not normally recurring, such as planting, seeding, rodent control, etc. Annual costs for administration, taxes, fire protection, improvement, maintenance, etc. during the time period between harvest cuts should also be considered. However, it will be observed that these costs add little to the comparative valuation and could be ignored, unless it is estimated that a particular alternative might have substantially higher or lower annual carrying charges. Present values are computed by applying the appropriate discount factors obtained from compound interest tables either directly or by calculation.

The following examples illustrate the per-acre calculation of relative present value for several possible alternatives under given conditions. It is assumed that a logging unit has been clearcut, fire hazard reduced to an acceptable level by burning, and that subsequent action will result in development of a satisfactorily stocked stand; it is a predominantly Site II area and the rotation period will be 100 years. The final harvest yield is about 90 thousand board feet at $25 per thousand or $2,250 per acre. All figures are rounded to the nearest dollar.

<u>Alternative No. 1</u> - Plant immediately.

Regeneration cost year 0	$ -25	
Annual costs for 100 years ($1 x 31.60)	-32	
Yield in year 100 ($2,250 ÷ 19.22)	+117	
Present value		$60

<u>Alternative No. 2</u> - Plant immediately but anticipate partial replant and some hand release in year 4.

Regeneration cost year 0	$ -25	
Replant 200 trees per acre year 4 ($9 ÷ 1.13)	- 8	
Release cost year 4 ($5 ÷ 1.13)	- 4	
Annual costs for 104 years ($1 x 31.79)	-32	
Yield in year 104 ($2,250 ÷ 21.63)	+104	
Present value		$35

Alternative No. 3 - Natural seeding complete by year 6 with aerial brush control in year 8.

Brush control cost year 8 ($5 ÷ 1.27)	$ - 4	
Annual costs for 106 years ($1 x 31.88)	-32	
Yield in year 106 ($2,250 ÷ 22.95)	+98	
Present value		$62

Alternative No. 4 - Natural seeding a failure followed by aerial brush control and planting in year 6.

Brush control cost year 6 ($5 ÷ 1.19)	$ - 4	
Regeneration cost year 6 ($25 ÷ 1.19)	-21	
Annual costs for 106 years ($1 x 31.88)	-32	
Yield in year 106 ($2,250 ÷ 22.95)	+98	
Present value		$41

Alternative No. 5 - Rodent control and direct seeding by helicopter with repeat flight in year 4.

Poisoning and seeding cost year 0	$ -10	
Repeat in year 4 ($10 ÷ 1.13)	- 9	
Annual costs for 104 years ($1 x 31.79)	-32	
Yield in year 104 ($2,250 ÷ 21.63)	+104	
Present value		$53

None of the above alternatives takes account of the possible intermediate incomes which might be received from a well-managed stand. Although data on management over a rotation are lacking, we can make some approximations. Delayed stand establishment results in delayed intermediate incomes which, in turn, reduces present value and favors early stand establishment. The extent of this reduction will depend upon the volumes and timing of the intermediate cuts. Consider the following as one possibility: pulpwood thinnings are made in years 40 and 50 and sawtimber thinnings in years 60, 70, 80, and 90. Net stumpage returns per acre are estimated at $45 and $60, and $135, $165, $225, and $300, respectively. For a stand established immediately after logging the present value of this particular series of intermediate incomes is \$113; obtained by discounting the amounts from 40, 50, 60, etc. years. If a similar stand were established after a 10-year delay, each income in the series would be delayed 10 years and the present value would result by discounting the respective amounts from 50, 60, 70, etc. years; this present value is about \$84. Therefore, in this case the loss in present value due to delayed stand establishment averages $\left(\frac{\$113-\$84}{10}\right)$ or about \$3 for each year's delay. No practical advantage is gained by computing the separate effect of each year.

Referring back to the five alternatives chosen as examples, Nos. 1 and 3 represent the best choices with No. 1 definitely the better when intermediate incomes are taken into consideration. Whenever there are small differences between planting and natural seeding alternatives it would be well to recognize some of the known advantages of planting. Among them are less risk of losing the site to brush, spacing and species control, more immediate soil protection, and possible introduction of superior genetic characteristics.

PLANTING VERSUS NATURAL STAND ESTABLISHMENT

A question that commonly arises is the simple choice between planting immediately or waiting for natural regeneration. The economics of the problem is to determine what time lapse in stand establishment is the financial equivalent of a given planting cost. It is necessary here to base the choice on actual values rather than relative values as was done in the comparative analyses of the several alternatives. Thus, the calculations become more sensitive to volume yields and prices and are no more accurate than the data on which they are based. Also, if there is a possibility there will be costs other than those incurred at initial planting, the process of comparative valuation described earlier should be used.

Theoretically, each year of delay in stand establishment results in a corresponding deferrment of incomes receivable during the stand rotation. The reduction in present value for each year's deferrment of the estimated final harvest income is shown in table 1 for a range of sites and stumpage prices. Sawtimber rotations of 90 years on Site I, 100 years on Site II, and 110 years on Site III are assumed; normal yield table volumes (trees 12 inches d.b.h. and larger, Scribner rule) without deductions are used to estimate attainable final yields for managed stands, and the interest rate is 3 percent.

Table 1.—Reduction in present value for each year's deferment of final harvest income—per-acre basis 1/

Estimated stumpage price per M.B.M.	Site class 2/		
	I	II	III
Dollars	Dollars		
10	2.00	1.20	0.70
20	4.00	2.40	1.40
30	6.00	3.60	2.10
40	8.00	4.80	2.80

1/ Normal yield table volumes (trees 12 inches and larger, Scribner rule) and a 3-percent interest rate used.

2/ Rotation 90, 100, and 110 years for Sites I, II, and III, respectively.

The range of income possibilities from intermediate cuttings is determined largely by intensity of management, degree of utilization, availability of markets, and going stumpage prices. When management policy calls for infrequent cuts and the utilization, market, and price factors are relatively unfavorable, the income possibilities are only fair; if frequent cuts are made and the other factors are favorable, the possibilities are good. An average falling somewhere between the two would result from various combinations or degrees of the four factors. Sets of conditions which would fit the several levels of intermediate income possibilities were developed and the respective series of incomes discounted to obtain present values. The average reduction in present value for each year's deferment of an income series due to delayed stand establishment is shown in table 2. Rotations and interest rate are similar to those used in the final harvest yield calculations.

Table 2.—Reduction in present value for each year's deferment of intermediate incomes—per-acre basis

Income possibilities 1/	Site class 2/		
	I	II	III
	Dollars		
Fair	1.50	1.00	0.60
Average	2.90	2.00	1.30
Good	4.25	3.00	2.00

1/ "Fair" indicates infrequent cuts and relatively unfavorable utilization, market, and price conditions; "good" indicates frequent cuts and favorable conditions; "average" results from various combinations or degrees of the foregoing.

2/ Rotation 90, 100, and 110 years on Sites I, II, and III, respectively; interest rate 3 percent.

Using the data from tables 1 and 2 it is possible to establish guidelines for determining the number of years' delay in natural stand establishment that is financially comparable to a given planting cost. For instance, assume an area has been logged and that a new stand could be established now by planting, or eventually by natural seeding without subsequent cost such as for brush control. It is Site I land, planting cost is estimated at $25 per acre, stumpage price at time of final harvest is estimated at $30 per thousand board feet, and the factors of management intensity, utilization, markets, and price, add up to good income possibilities for the intermediate cuttings. The table 1 figure of $6.00 plus the table 2 figure of $4.25 totals $10.25 per acre reduction in present value for each year's delay in stand establishment. Dividing the planting cost of $25 by $10.25 indicates that natural stand establishment, in order to be financially comparable to immediate planting, should occur within two years. There may be some who feel timber will be worth less in the future than it is today. Under such conditions a Site III area with a $25 per acre planting cost, stumpage price at end of rotation estimated at only $10 per thousand board feet, and nothing better than fair income possibilities from intermediate cuttings, could withstand almost 20 years' delay for natural stand establishment.

It is apparent from the foregoing that the poorer the site or the less confidence a landowner has in the future value of his timber crop, the less justification there is for incurring planting costs on areas where nature can be depended upon eventually to do the job. Also, if funds, manpower, or seedlings are limited, planting efforts should be directed to the best sites and deferred on the poor sites. It is emphasized again that this simple choice between planting or waiting for natural regeneration does not take into account other costs which might, on some areas, necessarily be incurred to guarantee stand establishment.

A forest land manager faced with the problem of getting a new stand established is well aware that an inability to predict accurately the silvicultural or biological results of actions taken might seriously affect the outcome in choosing alternatives. If, in addition, little effort is made to obtain reliable job costs, there is no point in seeking a professional solution. Even a casual opinion of the most economical way to establish a new stand is based primarily on a knowledge of these things. Use of the valuation techniques presented here permits a more positive approach in choosing the best alternative from an economic viewpoint.