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Reduced Planting Cost

A PRESCRIBED FIRE BENEFIT

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Abstract

The effect of broadcast slash burning on the cost of planting a recently logged area of over-mature coastal hemlock-balsam-cedar forest was examined. Planting output and costs were measured before and after burning the same area. Three planting methods were used: bareroot/mattock; styroplug/dibble; bullet/gun. Poor spacing control in the preburn phase of the study confounded cost per acre measurements. The output results, measured in trees planted per minute, were used to calculate costs on the basis of a constant stocking (450 trees/acre) and a cost per man of $40/day. Bullet planting was the most productive and therefore the cheapest method before and after burning, closely followed by styroplug planting. Projected cost savings due to burning were substantially greater for bareroot planting ($30/acre) than for either method of container planting ($9/acre).

Reduced Planting Cost - A Prescribed Fire Benefit

How much are planting costs reduced by broadcast slash burning after logging on the coast of British Columbia? Most foresters, planting foremen and planters know from the bitter experience of planting poor burns that slash interferes with production rates, and therefore results in higher costs. But knowledge of these effects within the forest industry is not sufficient in the current debate over slash burning policy in the province. The adverse public attitude toward slash burning suggests that, if it is to be retained as a management tool, arguments in its favor must be presented more effectively. We believe that each slash burning opportunity must be examined independently. The costs (e.g. direct burning costs, air pollution, water pollution, damage to future site productivity, fringe and escape damage) and benefits (e.g. hazard abatement, savings in planting costs, manipulation of vegetation and soil factors influencing early tree survival and growth) must be appraised and the arguments for and against burning considered on a site-by-site basis.

A recent study in Coastal B. C. has estimated the average reduction in planting costs due to slash burning at $5.00/acre (Smith 1970). Our study reports on a preliminary attempt to determine more accurately differences in the cost of planting before and after burning.

General approach and study procedures

The cost of planting any site is a function of many interacting variables, including wage rates, quality of supervision, planting crew potential and morale, the method of planting used and site conditions. Thus, it is not surprising that although site characteristics have long been recognized as important cost factors, their precise effect on cost, and the effect of practices designed to alter the site (e.g. scarification, slash burning) remains unknown. Any preliminary attempt to measure the impact of a practice like slash burning on planting cost must, therefore, adopt an experimental approach in an attempt to study the variables of greatest interest.

Our solution was to choose one area with a heavy accumulation of slash fuels remaining after logging and to record the cost of planting in the area before and after burning. We examined three planting methods:

1. Bareroot/mattock - current operational technique in B.C.; most frequently uses 2-0 nursery stock.
2. Styroplug/dibble - developed by the Pacific Region, Canadian Forestry Service, and the B.C. Forest Service; trees (or 'plug' seedlings) are grown in cavities moulded in styrofoam blocks extracted at the planting site, and planted with a dibble (Matthews, 1971; Vyse et al; 1971).
3. Bullet/gun - designed by Walters (1969); seedlings grown in plastic bullets are thrust into the ground, using a planting "gun".

In the spring of 1970, 2-0 bareroot stock, vetch and grass styroplugs, and earth-filled bullets were planted. Slash burning took place in the fall of 1970 and the area was planted in spring 1971 with good quality seedling stock. Two four-man planting crews were used. Spacing was 2.4 m (8 ft) apart in lines and with 3.6 m (12 ft) between lines (approx. 450 trees/acre). Both crews used each planting method for one complete day, and were paid on an incentive bonus system devised so that they could earn approximately 25% more than their minimum guaranteed wage, regardless of method and site.

Planting output was examined in detail by two observers, using a work-study technique developed by Vyse (1973). In addition to recording the area and the number of trees planted each day, planting rate and the time spent on various activities associated with planting were sampled at intervals throughout each day.

The study area

A recently logged area at 123° 50' W long. and 48° 30' N lat., near Sooke on southern Vancouver Island was selected for this exploratory study. Rowe (1959) classed the area as C.2 Southern Pacific Coast Section. Before logging, the area supported a forest type known commonly as hemlock-balsam-cedar containing a cruised gross volume of 7.5 Mcf[1/]. The stand composition by species was western hemlock (Tsuga heterophylla (Raf.) Sarg.) 36%; true firs (Abies spp.) 30%; western red cedar (Thuja plicata Donn) 21%; Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) 11%, and other species 2%. The area, approximately 2100 feet above sea level, is on a gently undulating upland having a general southerly aspect. Soils are of till origin, and range from deep on the slopes and in the draws to shallow on the ridges, where some bedrock is exposed. A well-compacted organic layer averaging 20-25 cm (8 to 10 in) overlies the mineral soil. Slopes exceeding 40% occur adjacent to stream courses but average 20% to 30% over the area.

Preburn conditions

Logging by high lead and by rubber tired skidders was completed in

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[1/] Converted from board foot measure using a conversion factor of 6 board feet to 1 cubic foot.

April 1970. The combination of an "intermediate" level of utilization and the decadent stand produced conditions that allowed us to test the effect of burning under slash accumulations nearing the maximum expected with today's logging technology in these forest types.

An aerial mosaic of the study area (Fig. 1) illustrates three main types of slash accumulation commonly found on coastal logging operations. First, there is the inner portion of the high lead settings closest to the yarder, with a heavy fuel loading (160-180 tons/acre) of large compacted logs oriented toward the spar tree, chips, broken and compacted branches and a disturbed organic soil layer. Second, there is the outer portion of the high lead settings that has moderate to heavy fuel loadings (120-160 tons/acre) of non-oriented large logs, branches and foliage interspersed through the fuel bed. In addition there are small patches of residual stems and little disturbance of the organic layer. Third, there is the area yarded by rubber tired skidders with frequent clear skid roads and heavy fuel loads between the roads.

While fuel loading descriptions are useful for predicting the effects of burning, they are not necessarily related to the difficulty of planting. Branches, for example, are often a greater impediment to travel than logs lying on the ground. A method of classifying the effect of various site factors on planting productivity was devised. It uses a "planting difficulty" scale, (1 - 9), which accounts for slope, vegetation and ground conditions in addition to slash. At Sooke slash was the major factor influencing planting productivity and the difficulty classes are described in these terms. The deep organic layer lowered the quality of planting.

Rating based on 9 point scale

1 No planting difficulty - no branches or foliage; scattered

logs less than 30 cm (1 ft) in diameter and less than 30 cm (1 ft) above ground; little or no ground vegetation.

2 Little planting difficulty - a few scattered branches and foliage; many logs less than 60 cm (2 ft) above ground; some ground vegetation.

5 Moderate planting difficulty - patches with dense branches or brush less than 120 cm (4 ft) high; many logs of varying diameter, some overlapping but less than 120 cm (4 ft) above ground; small patches of dense ground vegetation and residuals.

7 Great planting difficulty - patches with dense branches above head height; many logs, most overlapping with some over 120 cm (4 ft) above ground; large patches of dense ground vegetation and residuals.

Figures 2 and 3 illustrate areas representative of "great planting difficulty" and "no planting difficulty", respectively.

The proportions of the area occupied by each planting difficulty class (Table 1) illustrate the difference between the areas logged by skidder and those logged using a high lead system (Fig. 1).

Prescribed fire treatment

The area was ignited at 1545 PDT on September 16, 1970. On this day, the moisture codes and Fire Weather Index from the Canadian Forest Fire Behavior System (Anon 1970) were as follows:

Fine fuel moisture code	87
Duff moisture code	19
Drought code	336
1:1 ADMC	34 (Buildup Index)
4:1 ADMC	63

FWI	10

Winds at noon were 7 miles per hour.

Weather measurements were obtained from the Sooke Combined Fire Organization weather station located approximately 2 miles S.E. of the area and at slightly lower elevation. The last previous rain, totalling 2.49 inches, ended on September 7. Rain, starting on the evening of the 16th and continuing into the evening of the 18th, totalled 2.95 inches.

Circumstances did not permit Canadian Forestry Service observations of the prescribed burn, but the moisture codes suggest that the fire had extremely high intensity. Spectacular fire behavior was later mentioned by those involved. The values of the moisture codes suggest total energy production to be at least 20,000 Btu/ft^2 despite the onset of rain.

Postburn conditions

Following burning, 93.1% of the area was rated in the "no planting difficulty" class compared with only 4.6% before burning (Table 1).

This marked contrast in pre- and postburn slash conditions reflects a burn of excellent quality for both hazard abatement and reforestation purposes. The paired vertical photographs (Fig. 4) further emphasize the effects of the better-than-average job of prescribed fire treatment. The location of these photographs, taken by a camera mounted 3 m (10 ft) above ground, is shown in Fig. 1.

Effect of slash burning on planting productivity

The data in Table 1 confirm what most foresters, planting foremen and planters already know - planting is easier on burned than on unburned sites. Postburn productivity was in all cases substantially greater than preburn productivity when measured in terms of the number of trees planted per man (Table 2). However, when productivity was measured in terms of acres planted, the differences were not as great because of the poor spacing control during the preburn planting. This resulted in an unimpressive reduction in direct planting costs per acre as a result of burning (Table 2).

Another way of examining the effect of slash on planting productivity related planting speed (sampled as planters walked over the site) to the planting difficulty class involved (Fig. 5). This method has the advantage of showing the sensitivity of production rates for each technique to the planting difficulty class. Bareroot and bullet planting were most sensitive to changes in planting difficulty.

For all methods, the inverse relationship between planting speed and planting difficulty is almost wholly explained by variations in the 'walk' element (the time taken to walk between, and to find, planting spots). Other elements, such as dibbling or digging a hole for the tree, were apparently unaffected by slash density. As planting difficulty increased so did the average "walk" time. This may be explained by the increasing physical difficulty of movement, and the increasing difficulty of finding suitable planting spots. In some areas of very heavy fuel loading, bareroot planting was impossible without moving slash to open up a planting spot. This is reflected in the rapid decline of bareroot planting speed (Fig. 5) and the poor spacing of bareroot seedlings (Table 2). Styroplug planting was not so severely affected by increasing planting difficulty. Spacing was better and planting speed was more stable than with bareroot planting. Bullet-planting speed declined more rapidly under increasingly difficult conditions than styroplug planting because the planter is required to do "little else" but walk when planting bullets. The spacing of bullet seedlings was unaffected by slash conditions because the planting gun allows the planter to reach small areas of open ground several feet below him.

Our measurements of the effect of slash on planting performance must be qualified on a number of counts. First, the preburn and postburn planting was done by different crews. The preburn crew was more experienced but the enthusiasm of the post burn crew was such that the effect of burning was probably exaggerated.

Second, the output of the preburn planters while fighting through dense slash may have been influenced by the fact that grass and vetch plugs and earth-filled bullets were being planted. Although an incentive pay schedule was in operation, this may have been insufficient to counter any feelings of futility.

Thirdly, the results suggest that a relatively small increase in planting difficulty (e.g. from 1 to 3) has a marked effect on planting performance (see Fig. 5). However, on the preburn site, where there was a mixture of planting difficulty classes, performance on the less difficult sites may not have been independent of performance on the remaining areas. Planting speeds may have been depressed by the slow pace of work before the easy areas were reached, and by the prospect of more difficult areas to come.

Application of results

Planting productivity can be significantly increased by high quality slash burning. Gains will be less on areas of lighter slash and with less complete fuel consumption. More detailed work is required to determine the sensitivity of planting productivity to the type and quality of burn and to slash conditions. However, by relating the planting productivity data (Fig. 5) to planting difficulty classes, an estimate of the potential benefits of quality burns was derived (Fig. 6). To provide the relationship shown in Fig. 6, the estimated mean planting speeds for difficulty classes 1 to 7 shown in Fig. 5 were converted to a daily output using an estimate of 5½ hrs planting per 8 hr day, and assuming that the planting speeds would not be affected by a constant spacing of 450 trees per acre.[1/] A wage rate of $32.00 per day plus 25% fixed cost allowance was used regardless of planting method. These calculations produced base labor costs for sites of planting difficulty Class 1 of $7.10, $11.10 and $19.10 per acre, for bullets, styroplugs and bareroot stock, respectively. The base costs were then subtracted from the costs for all other difficulty classes to estimate the increased cost of planting more difficult sites.

From Fig. 6 we conclude that

1. Good quality slash burning of areas with heavy slash may produce bareroot planting cost savings of $30/acre and container planting cost savings of $9/acre.
2. On areas of heavy slash where no treatment is planned, container planting will be very much cheaper than bareroot planting.

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[1/] This assumption is only correct if the time spent walking longer distances between planting spots than required (eg. 12' instead of 8') is equivalent to the time required to find suitable planting spots at the specified spacing.

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TABLE 1. Occurrence of planting difficulty classes on the Sooke study area

Planting difficulty Description	Rating	Preburn conditions High lead yarded	Machine yarded	Total	Postburn conditions Total
		% area	% area	% area	% area
No difficulty	1	0.7	12.0	4.6	93.1
Little difficulty	3	6.3	16.0	9.6	6.9
Moderate difficulty	5	64.9	48.0	59.1	-
Great difficulty	7	28.2	24.0	26.7	-
Total		100.0	100.0	100.0	100.0

TABLE 2. Actual planting productivity and costs before and after burning - Sooke study area

Site condition	Reforestation system	Daily production per man (trees)	Trees planted per acre (trees)	Area planted per day (acres)	Labor cost per man day ($)	Labor cost per M trees planted ($)	Labor cost per acre ($)
	Bareroot	450	260	1.7	27.00	59.94	15.61
Preburn	Styroblock	1090	320	3.4	31.50	28.89	9.24
	Bullet	1280	480	2.7	27.00	21.06	10.11
	Bareroot	990	410	2.4	36.00	36.36	14.94
Postburn	Styroblock	1450	410	3.5	30.00	20.70	8.47
	Bullet	2510	470	5.3	37.50	14.92	7.02

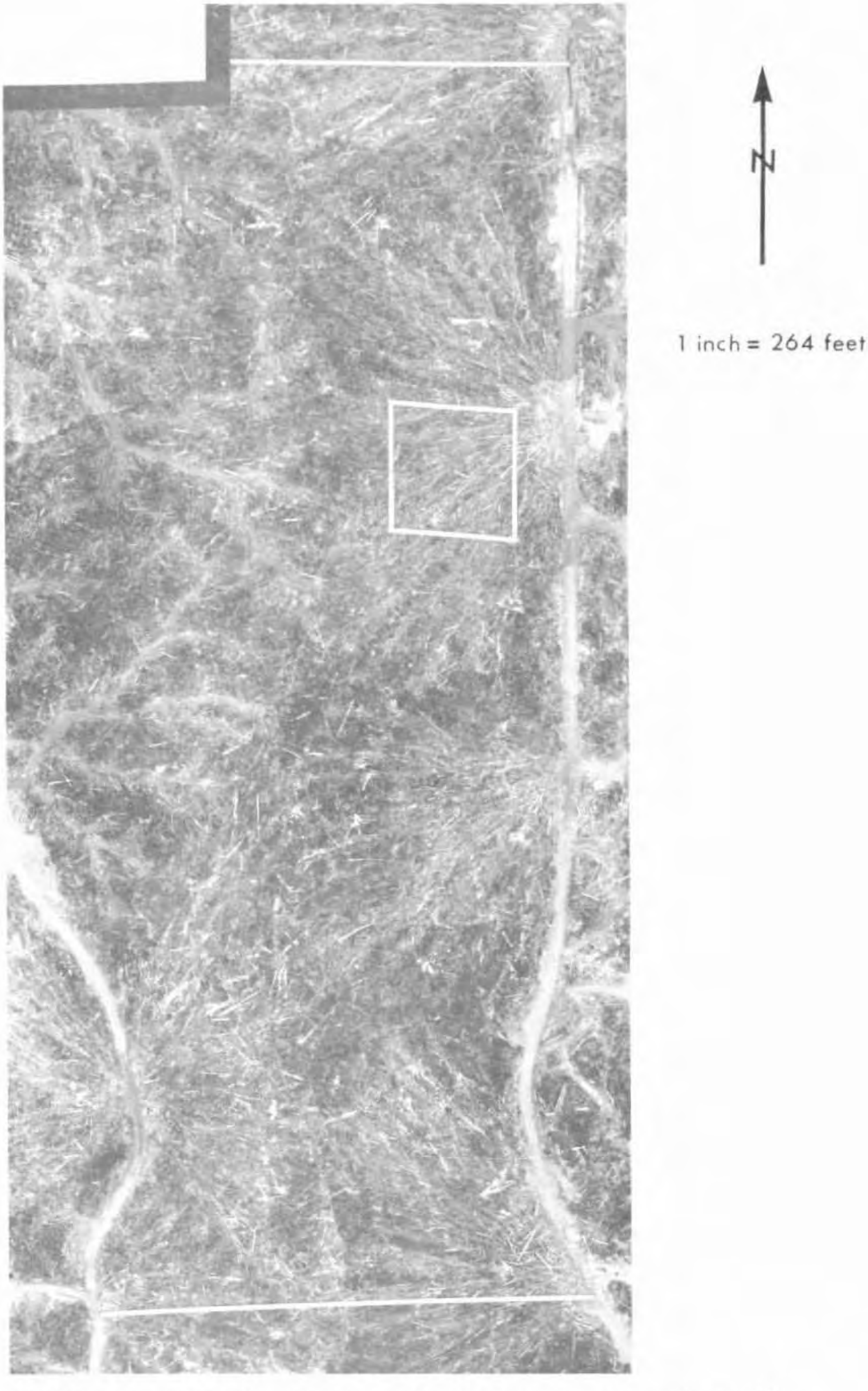

Fig. 1. Aerial view of Sooke planting site before burning. Scale 1" - 260'. Top and bottom white lines and roads show boundaries of study area. Locations within the small outlined area were photographed before and after burning (Fig. 4).

Fig. 2. Styroplug planting on the unburned site.

Fig. 3. Styroplug planting on the burned site.

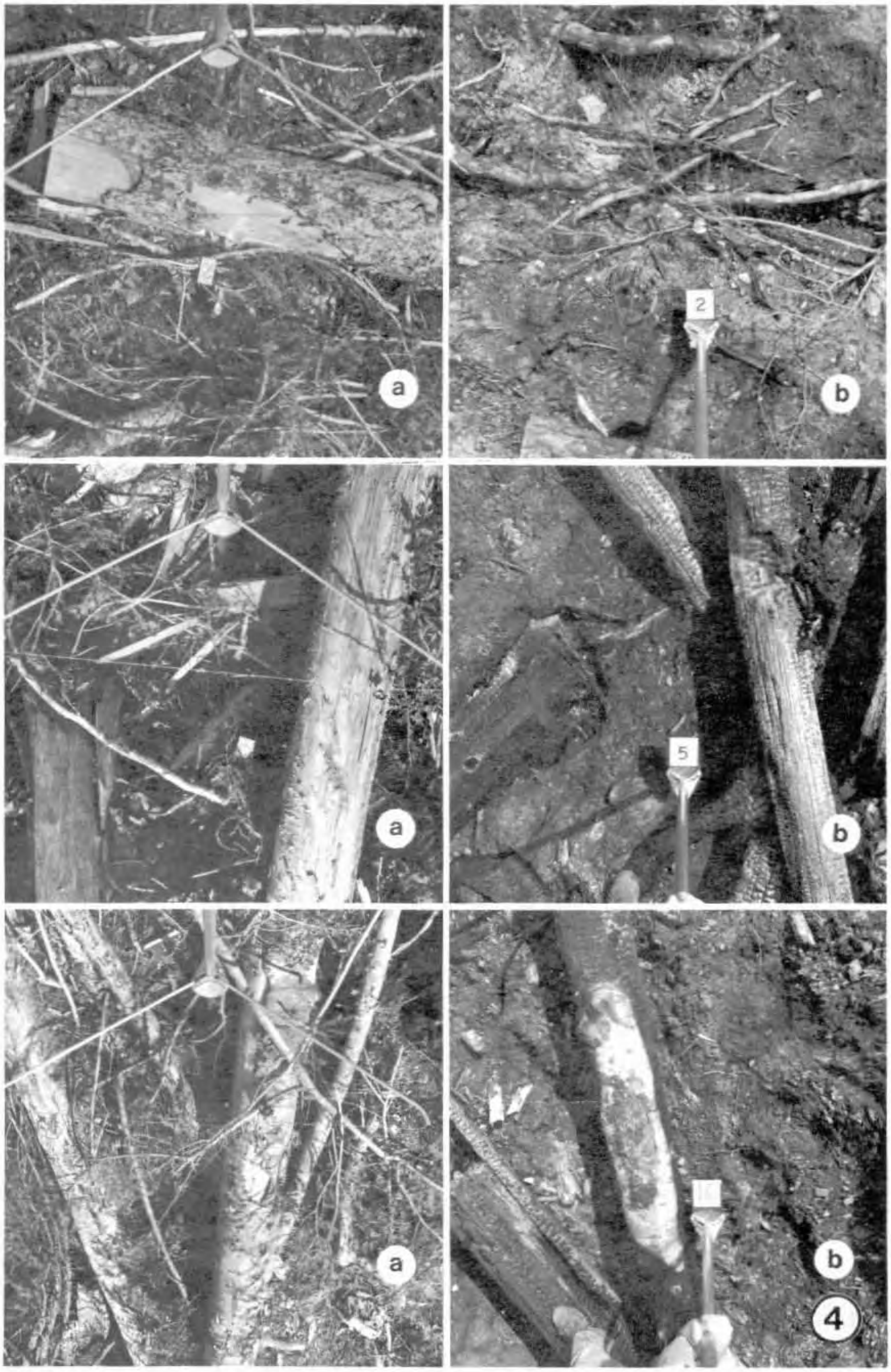

Fig. 4. Vertical photographs of similar locations before and after burning (Camera height 3 M (10 ft)).

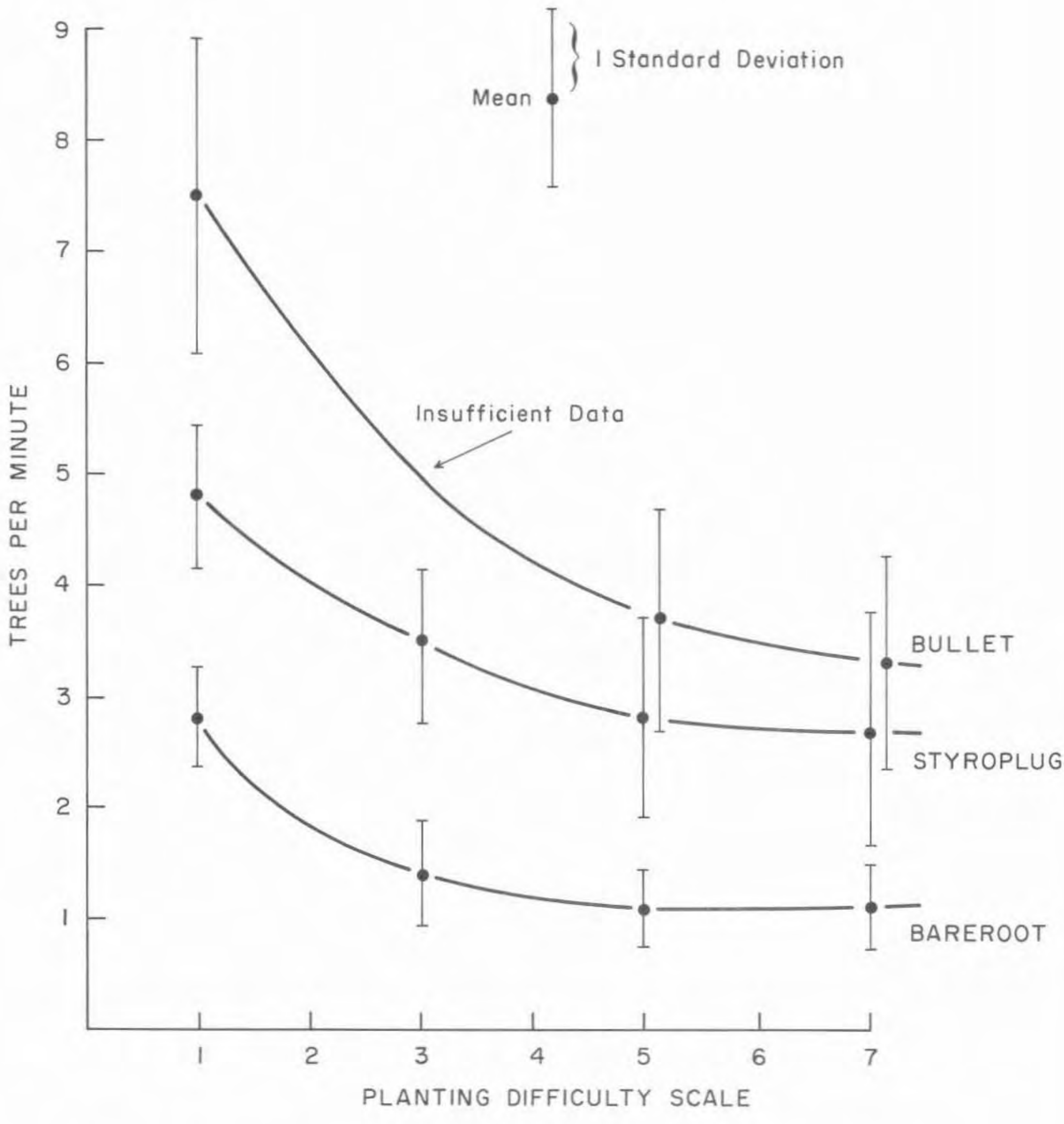

Fig. 5. Effect of planting difficulty on planting rates for three planting methods. (Curve shape is based on data from other productivity studies.)

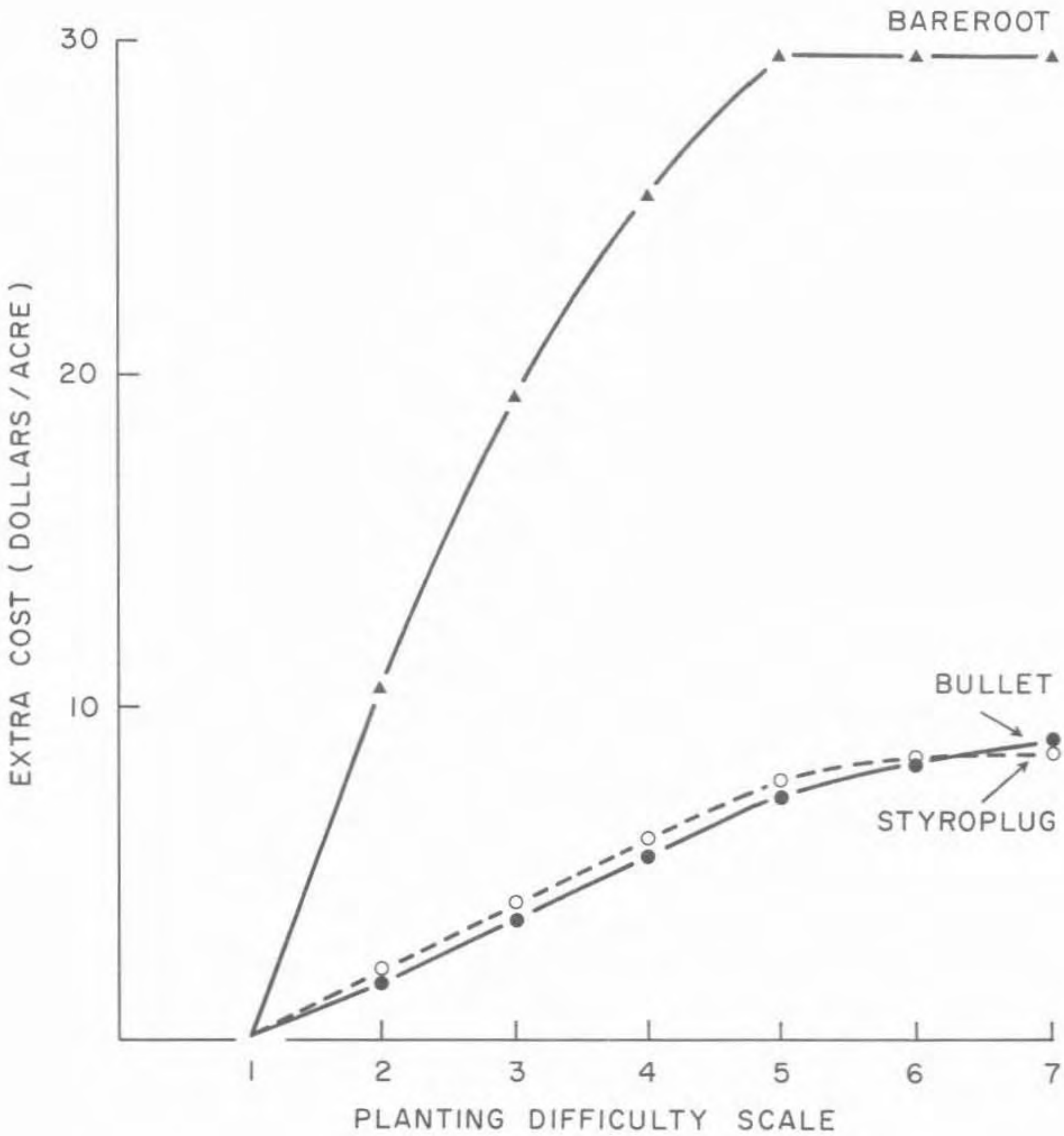

Fig. 6. Effect of planting difficulty on estimated planting cost. Planting cost based on estimates of output from Fig. 5, 5½ hrs of planting per 8 hr day, $40 per man per day total cost and spacing of 450 trees per acre.