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Cost analysis of the 1967 hand-planting projects in the northern Rocky Mountain region

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COST ANALYSIS OF THE 1967 HAND - PLANTING PROJECTS IN THE NORTHERN ROCKY MOUNTAIN REGION

by

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INTRODUCTION

Forestry has achieved the status of a business in the full sense of the word, although the profit and loss is not always measured strictly in dollars.

The forest land manager must be able to evaluate the myriad of resource alternatives or combinations of alternatives that confront him. He must be able to decide the cost-benefit relationships. His ability to make an intelligent evaluation requires a knowledge of the various alternative courses of action and their corresponding costs and limitations. With the great number of alternatives open to the manager, his early evaluation and subsequent decision increase in importance.

An accurate evaluation technique is a valuable aid throughout the scope of land-use decision making. It may be applied to forestry, range management, recreation management, watershed management and a host of other alternatives. The technique is applicable to many problems of forest management and silviculture. With large tracts of land in need of reforestation, the silviculturist must decide on which tracts he will spend his limited funds. Using this evaluation technique he will be able to decide which lands have the greatest potential returns or least cost-result relationships.

Once a decision has been made to regenerate a deforested area, the method of reforestation must be chosen. The regeneration methods available to the land manager should be analyzed to determine the significant factors that affect cost. This will lead the land manager to the desired end: predictive ability of cost-benefit relationships.

This research was undertaken to determine the significant factors that affect cost of hand-planting operations on the Northern Rocky

Mountain Region. This paper is an extension of and an attempt to refine the prediction equations of Wikstrom and Alley.[1] This study uses essentially the same methods as the previous one but enlarges the scope of study under more varied conditions. No attempt will be made to correlate seedling survival with cost. This paper is concerned exclusively with factors influencing the costs of hand-planting operations. Other investigators must correlate costs with survival rate.

By utilizing the predictive measures for the available regeneration alternatives, cost-benefit relationships can be computed for any given level of project success, thus enabling the land manager to intelligently select alternatives.

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[1] J. H. Wikstrom and J. R. Alley, _Cost Control in Timber Growing on the National Forests of the Northern Region_, U. S. Forest Service Research Paper INT-42, Intermountain Forest and Range Experiment Station, 37 pp., 1967

PROCEDURE

To establish effectively a means of cost control over various projects, the factors that affect costs must be identified. Those factors that influence the cost must be isolated, and the extent of their influence must be measured. An obvious prerequisite for this determination is that the factors must be relevant and easily measured. Area, number of trees planted, site preparation, soil characteristics, and other observable characteristics are examples of relevant factors.

Ease of measurement is another important criterion of any factor. If the collection of the data entails more time and expense than could be saved through the selection of the least expensive method of regeneration, nothing has been gained. Any savings would be lost because of the unwieldy factor.

The first step was to determine which planting projects in Region One for the calendar year 1967 utilized hand tools only. This was done by consulting the Progress Work Plan Summary (PWP). (See Appendix A for sample sheet of the PWP.) The projects were selected from this PWP along with a coded identification of the tract, the total project cost, the acreage, the finance class (force account or contract), the season of planting, and, on those projects completed with Forest Service crews (force account), the paid travel miles to the planting site from the home base.

Two limitations of the PWP printout are that the costs are not itemized nor are the man-hours accurate in all cases. Itemized costs would be more desirable so that comparisons between projects could be equalized on the basis of those items that were included. This would have eliminated all but the common factors and could have made a more meaningful relationship. The inaccuracy of the man-hours list is also regretted in that if reliable figures were available, differences in pay scales could have been eliminated, thus making comparisons more definite. The man-hours are listed, but this figure is not corrected for unplanned appropriations. This means that a ranger district may charge a certain number of man-hours to the project that the compilation program should not allow. This figure is not corrected on the printout and thus may be erroneous.

The next step was to consult the Forest Service Master Forest List for a physical description of the site. (See Appendix B for sample sheet of the MFL.) The information gathered from this listing included soil characteristics, habitat type, physiographic site, and average slope, elevation and aspect.

In an effort to include in this cost analysis most of the factors that could possibly be significant, keeping in mind the two criteria of relevance and ease of collection, these following additional factors unavailable from the previous listings were chosen:

a) site preparation--method
   quality
   year completed

b) amount of brush and down material on the site at the start of the planting

c) experience of the planting crew

d) Planting stock--species
   age class
   quantity

e) paid travel time for force account projects

f) planting tool used

g) whether the cost of the planting stock was included in the cost as stated in the PWP

The importance of this last factor will become evident later. To secure this additional information, questionnaires (Appendix C) were sent to the national forests that were selected from the PWP. (For an examination of the evaluations of the above factors, see Appendix D.)

After all the questionnaires were returned and inspected, the data were compiled and listed by projects. Out of a total of 256 reported projects, seven were rejected. One project 15 acres in size planted to a density of 467 trees/acre cost $1.25/A. Another project 38 acres in size with 442 seedlings/acre cost $180.10/A. The other five rejected projects were within a few dollars of either one of these two extremes. Since itemized costs were not available, thus removing the possibility of _a priori_ knowledge of the projects, other operations in the twilight realm could not be rejected out-of-hand and were included in the statistical analyses.

The second operation that the manner of listing allowed was the preparation of a weighted average of the physical description of the site on those projects comprised of two or more stands. The use of more than one description for the same project would have been extremely unwieldy, so a weighted average was prepared. The adversity of the site, e.g. more brush, steeper slope, was the basis for presuming that a larger share of expenses went into planting it. This had to be done because the costs attributed to each part of the project were not available.

The next step was to adjust the total cost from the PWP for the cost of planting stock. This stock cost was removed as it does not accurately reflect the cost of each individual job. However, it is a common denominator. The purpose was to remove all common effects and leave only those which reflect differences in sites or preparations. As the cost of stock is consistent with quantity, e.e. cost per unit to any district in the Northern Region is the same, this does not reflect the ease or difficulty associated with planting any particular site.

After adjusted total cost was computed (total cost minus stock), adjusted cost per acre was determined. The final step in data preparation was the division of the total number of trees planted, by the project acreage, to give number of trees per acre. From this point on, the use of cost per acre or total cost means Adjusted Cost per Acre or Adjusted Total Cost, unless otherwise stated. These data were then punched on ordinary 80-column Hollerith computer cards.

The first statistical handling of the data on the CDC 3100 computer involved the use of the NCBreaks program that was designed to summarize distributions so that checks for apparent relationships and rough comparisons can be quickly and easily made[1]. This program utilizes a system of groups or classes that can rapidly show data trends. In an effort to compare cost trends from the present 1967 data with those of Wikstrom and Alley's in 1965[2] this program was used most heavily. The largest drawback to this program is that one is not able to vary any factor used as a variable except in the form of a continuum. Those variables that are present, or are evaluations of a condition, such as quality of site preparation, cannot be used. The data cards must be sorted physically into the desired groupings of the characteristic to be evaluated and then each group must be run separately on the computer.

For those factors that operate along a continuum, such as number of trees per acre (can be varied from 0 to infinity) or cost per acre (varied from $0 to infinity), the program will uncover existing relationships. But, with those factors that one cannot state as a continuum, but that are merely points on a graphical axis, such as excellent, good, or poor site preparation, the program will not evaluate these characteristics in terms of cost per acre or compare one to another as a measure of influence of the site preparation factor. Each group of data cards with a common site preparation evaluation characteristic must be run separately on the computer. Thus, one cannot prepare a graphical comparison of this factor with cost per acre, but as a series of lines using cost per acre on one axis and some other factor on the second axis.

A series of graphs was prepared using this program to demonstrate the relationships between area and cost per acre, and cost per seedling as a function of the number of seedlings per acre. The graphs represented (1) all projects combined, (2) projects categorized according to the season of planting (spring and fall), and (3) projects grouped according to finance class (force account and contract).

After a factor has been deemed to be relevant and easily measured, its degree of influence must be determined. In preparing the regression equations those factors that did not increase the accuracy of the estimate were dropped from the equation. The most manageable prediction equations are those which contain the least number of variables. Therefore, an attempt was made to keep them as simple as possible, consistent with predictive accuracy.

Two stepwise multiple-hypenate regression programs were utilized to develop the set of prediction equations presented in this report, and to determine the order of importance of the selected variables. The first program was a stepwise addition starting with the most significant variable and adding the other variables if they significantly increased the amount of variation accounted for in the dependent variable. The second program allowed for the stepwise removal of the factors in ascending order of significance (least significant first). The first step used all variables entered, then one variable was removed at each step until all were deleted.

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[1]Schweitzer, Dennis L., A Computer Program for Preliminary Data Analysis, U. S. Forest Service Research Note NC-33, North Central Forest Experiment Station, 24 pp., 1967.

[2]Op. cit.

PRELIMINARY ANALYSIS OF DATA

The U. S. Forest Service on regional basis paid $29.80 plus cost of stock to plant the average acre of land in 1967. The average project size was 77.4 acres, ranging from 6 to 619 acres. In general, as the size of the area increases, the cost per acre decreases. (See Figure 1).

Projects were divided into two finance classes: a) force account (FA)--planted by Forest Service crews, and b) planted in contract operations. The average force account project of 63.8 acres cost $29.80/A, while the contract jobs cost $29.79/A on an average plot of 94.6 acres. This difference of 1¢/A with a difference in project size of 30.8 acres is not an exception to the rule of larger areas, smaller per acre costs because the difference in planting densities of the two finance classes was over 100 seedlings/A. This influence of the difference in seedlings per acre will be discussed in the section concerning effect of planting density. The Cost/Area trends can be examined in Figure 2. As one approaches the upper size class (approximately 250 acres) the cost per acre for the FA projects decreases slightly, while that of the contract class increases.

The projects, when divided into season of planting, showed an average cost of $3.41/A more to plant in the fall than in the spring. The average acreages and planting densities in both cases were sufficiently similar to remove any extraordinary influences. The average spring project of 76.8 acres with a density of 411 seedlings/A cost $29.75/A compared to 79.4 acres at a density of 426 trees/A for $33.16/A in the fall. (See Figure 3).

In analyzing costs as they relate to planting density, the lighter the density the per-hypenate seedling cost increased accordingly. The costs ranged from 16.8¢/seedling at a density of 163 trees/A to 5.9¢/S at 651/A. Quadrupling the number of seedlings planted per acre reduced the cost per seedling by a factor of three. (See Figure 4).

The mean cost per seedling for FA projects was 8.6¢ with the comparable cost for the contract plantings of 6.5¢/seedling. The average planting densities for the two finance classes were 346 trees/A for the FA and 456/A on the contract plantings. Thus, in spite of the higher per-acre costs from Figure 2, the cost per seedling was lower on the contract jobs. At the lower densities the contract projects had a lower per seedling cost than the force account, while above 350 seedlings/A contract planting became more expensive. (See Figure 5). The reason for this difference in cost trends can be explained, at least in part, by inadequate samples in the 600 seedlings/A range. The trend through the first five density classes is that the contract jobs cost less per seedling than the force account. But, at the upper limit of 600 S/A the cost in the FA class drops radically to 3.8¢ compared to 6.3¢ for the contract. This last class skews the curve in Figure 5. (See Table 1).

Table 1

Class Mean Seed./A	No. Obs.	Cost/Seed. (cents)	Class Mean Seed./A	No. Obs.	Cost/Seed. (cents)
159.5	6	17.0	186.0	1	15.5
244.5	32	10.2	263.8	10	12.6
337.5	23	9.1	345.1	10	8.3
433.2	48	6.9	439.1	46	6.8
521.9	29	6.9	536.3	38	5.2
600.0	1	3.8	660.6	5	6.3

The reason for the skewing of Figure 5 is probably a combination of opposite effects in the highest density class; the upswing for the contract and downswing in the FA projects. This is probably due to the inadequate sample size in this density range.

The influence of seasonal differences was found to be very slight on a cost-hypenate-per-seedling basis (see Figure 6). The cost is essentially the same except in the low, 160 seedling/A range in which the cost was 27.4¢/S in the fall but 12.1¢/S in the spring. Again, this abnormality is probably due to a very small sample size in the low-hypenate-density fall class. The average cost per seedling was 7.2¢ during the spring as opposed to 7.8¢ during the fall.

For the means, standard deviations and other statistical data, see Table 5, p.

REGRESSION ANALYSIS

The first regression program used in this analysis was an additive stepwise program that added variables if they increased or improved the R^2* of the equation. First, the computer takes the independent variable that is most closely correlated with the dependent variable and to this adds the effect of a second, third, or more variables if the addition of the next variable improves the R^2 value, meaning more of the variation in the dependent variable has been accounted for.

The computer was programed to compare Area^2 and Total number of trees planted (TNT). Wikstrom and Alley found these two variables to be the most important in their report. The R^2 of the equation using these two factors was .688 (.610 using Area^2 alone). To improve upon this result, a computer run was made using area in its linear form and total number of trees. The R^2 increased to .7206 but the computer would use only the area variable. This means that Number of Trees did not significantly improve the R^2 of the equation. The regression equation in its simplest form is as follows:

$$^{Y}\text{Project cost}_{\text{minus stock}} = 30.44 + 27.72\ (\text{Area in acres}).$$

The mean cost of the 249 projects was \$2176.00 and the standard error of the estimated Y is $\pm$ \$1380.42. As a prediction equation can only be used within the range of the variables that went into its formulation, this equation can apply to projects ranging in size from 6 to 619 acres. The equation is most accurate when used to predict cost of the average sized

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* R^2 is a measure of variation in the Y, or dependent variable, accounted for by the independent variable(s) in the equation.

project, in this case 77.4 acres.

When the computer was programed for the number of trees variable with area, the R^2 increased to .7214. With a mean of $2.76.00 the standard error of the estimated Y increased from $1380.42 to $1381.29. This means the variation in number of trees planted was so great that its value as a predictor is questionable.

One standard deviation (S.D.) around an area mean of 77.4 acres amounted to 75.0 to 79.8. The average total number of trees planted was 30,465 with a S.D. of 30,198. The corresponding figures for total project cost were $2176.00 for the mean and $2606.47 for the S.D.

The projects were broken into more manageable units and run separately on the computer to determine if the apparent lack of predictive accuracy was due to a fault in factor selection or to the variation in the dependent variable.

The projects were sorted according to the planting crew used, Forest Service force account and contract. This physical sorting was necessary as the program does not allow the use of a variable that cannot be expressed as a continuum. The equations and pertinent data are in Table 2.

Table 2

Force Account		
Avg. Size in Acres		63.8
Avg. Total Number of Trees		21,342
No. Observations		139
Mean of Y		$1721.71
Standard Error of Estimated Y		± $927.53
Standardized Regression Coefficients*		
Area	.161	
TNT	.735	

Y = 73.49 + 4.06A + .065TNT

*Standardized Regression Coefficient is a measure of change in the Y, or dependent variable, in relation to its standard deviation for a change of one standard deviation in the independent variable.

Table 2 (cont.d)

Contract

Avg. Size in Acres	94.6
Avg. Total Number of Trees	41,992
No. Observations	110
Mean of Y	\$2750.05
Standard Error of Estimated Y	± \$1296.88
Standardized Regression Coefficients	
Area 1.28	
TNT - .443	

$Y = -419.60 + 51.3A - .0402TNT$

The R^2 values of .786 and .832 for the force account and contract crews respectively are both larger than the .721 for all projects. This means that the projects within these classes were more homogeneous than when grouped all together. Another point is that the computer used both area and total number of trees. In fact, for the force account plantings this factor of number of trees proved to be more important as a predictor than area, as evidenced by the standardized regression coefficient. Changes in cost are more sensitive to changes in number of trees than in area. The area variable for the contract projects, on the other hand, was more closely associated with total project cost than the total number of trees. The number of trees in this case was negatively correlated with cost. This negative correlation, though it probably can be interpretated in different ways, is not satisfactorily explained at this time.

The projects were separated according to the season of planting to test the homogeneity along a different line. The results of this analysis are in Table 3.

The R^2 value for the spring projects was .679 using area and number of trees planted. On the other hand, these variables accounted for more of the variation in the fall jobs having a value of .860. The reason for this difference may be due to the number of projects sampled.

Table 3

Spring		
Avg. Size in Acres		76.9
Avg. Total Number of Trees		29,968
No. Observations		195
Mean of Y		$2100.99
Standard Error of Estimated Y		± $1372.74
Standardized Regression Coefficients		
Area	.750	
TNT	.0964	
Y = 105.98 + 22.9A + .00779TNT		
Fall		
Avg. Size in Acres		79.4
Avg. Total Number of Trees		32,259
No. Observations		54
Mean of Y		$2446.85
Standard Error of Estimated Y		± $1153.18
Standardized Regression Coefficients		
Area	1.05	
TNT	- .136	
Y = -424.79 + 42.1A - .0144TNT		

The 54 fall projects analyzed may be too small a sample to test accurately the population. The two independent variables appear similar enough in both cases indicating that something else must affect the relationship, if it is not the sample size.

To probe a bit deeper into this analysis and to produce a set of equations that later investigators may be able to use as a base, the following classifications were made--spring force account, spring contract, fall force account and fall contract. (See Table 4) This classification was chosen as the most potentially useful to the land manager in predicting future costs. Once the decision has been made to plant an area by hand, the next set of alternatives that await his evaluation is by whom it is to be done and when, force account or contract, spring or fall.

The R^2 value is slightly higher for the spring contract than for the force account projects for the same season. This may be due to differences in the accounting system or failure of the system to take

Table 4

Spring Force Account

Avg. Size in Acres	66.0
Avg. Total Number of Trees	21,723
No. Observations	116
Mean of Y	$1691.61
Standard Error of Estimated Y	± $876.82
Standardized Regression Coefficients	
Area .248	
TNT .644	

$Y = 161.15 + 5.56A + .0536TNT$

$R^2 = .772$

Spring Contract

Avg. Size in Acres	92.9
Avg. Total Number of Trees	42,074
No. Observations	79
Mean of Y	$2702.11
Standard Error of Estimated Y	± $1266.76
Standardized Regression Coefficients	
Area 1.41	
TNT - .592	

$Y = -382.13 + 55.7A - .0497TNT$

$R^2 = .841$

Fall Force Account

Avg. Size in Acres	52.7
Avg. Total Number of Trees	19,420
No. Observations	23
Mean of Y	$1873.53
Standard Error of Estimated Y	± $690.34
Standardized Regression Coefficients	
Area .760	
TNT .218	

$Y = -210.29 + 31.0A + .0232TNT$

$R^2 + .942$

Fall Contract

Avg. Size in Acres	99.1
Avg. Total Number of Trees	41,784
No. Observations	31
Mean of Y	$2872.23
Standard Error of Estimated Y	± $1343.54
Standardized Regression Coefficients	
Area 1.00	
TNT - .110	

$Y = -778.01 + 42.3A - .0131TNT$

$R^2 = .835$

into account various costs. This effect on the R^2 value is probably not of a physical nature because the effect of planting crews or finance class was not important as a factor in the general equation as will be shown later.

Part of the variation stems from the fallibility of the accounting system. The costs are probably more accurately detailed and complete for the contract jobs because contractor bids on the project and submits the bill for his expenses. The Forest Service overhead is quite limited on the contract jobs; it usually includes only a project supervisor. The system is not as accurate or as carefully itemized as it could be in the case of the force account projects. The cost records may not be as accurate on the smaller projects as those for the larger jobs. This may be due to the time factor involved in the planting. On the larger projects where several men spend several days planting, more accurate records may be kept as it constitutes a larger sum of money. On the smaller jobs this sum is not as large, or at least the costs of the individual items are smaller, and thus may not appear as important for accounting purposes and not be as meticulously recorded.

In reference to the fall planting jobs of both force account and contract crews, the reason for the difference in the R^2 values may be due to the limited number of samples in each category.

On the average-sized project of 77.4 acres, the range from 131 to 757 trees per acre and a possible range of 10,200 to 64,000 total trees planted explains why the number of trees planted was not an influential factor. This amount of variation precluded it as a predictor. When attempts were made to make the populations more homogeneous by classifying them according to planting crew or season, this removed enough of the variation in number of trees planted to allow its use as a predictor. It became more important than area in some cases. In conjunction with area, to which number of trees was most highly correlated, the latter variable assumes its importance as an influence on cost as per the following example. On the average size Forest Service crew project of 63.8 acres and 21,342 trees, or 335 trees per acre, the total cost is $1721.88 or $26.95 per acre. Increasing the number of trees to 27,722 or 100 per acre more, the cost increases to $2137.22 or $33.50 per acre. This is an increase of $6.55 per acre or 24 percent.

Many projects used more than one species and/or age class of stock, so use could not be made of these data. No reliable way was available to feed this information to the computer and come out with an intelligible relationship.

To determine the degree of importance of the many variables collected or generated in this study, another stepwise regression program was utilized. The difference between this program and the first one used is that this program allows for the stepwise removal of the variables in ascending order of importance. The most important point of this program is that all variables were evaluated and printed whether they were significant or not.

The factor that was consistently proved by the stepwise removal to be the most important was size of the area planted. This factor accounted for 72 percent of the variation encountered in the dependent variable of total project cost. The R^2 of the equation with this variable and area was .721.

The next most important variable was Reciprocal of Number of Trees per Acre*. The R^2 of the equation with this variable and area was .726.

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*This is a statistical technique used to transform the curvilinear relationship of an independent and dependent variable into a linear one.

A new variable was generated (Area x Number of Trees per Acre) to test the interrelationship of these two variables because Number of Trees per Acre had a higher correlation with size of area than with total cost. When entered into the regression, the R^2 was increased by only .0006.

When 24 other variables were put into the regression the R^2 was increased to only .752 (See Table 6). One could continue to present the various equations using combinations of the 27 independent variables, but this would serve no particular purpose.

One must examine the presumptions and premises to analize the resuts. The results cannot be more accurate than the factor. This look behind the results will lead into three areas of contention. They are (1) validity of factor selection, (2) precision of factor measurement, and (3) the accurancy of the measure of the final result--project cost.

A factor may have been overlooked that could help to account for more of the variation than has been accounted for. But, at the same time one must keep in mind the valid criteria mentioned previously--relevance and ease of collection. Without a doubt, other factors influenced the final cost that were not measured for each project. The quality of the crew boss or weather conditions were not evaluated because of the difficulty of collecting this information and evaluating it. These factors and others like them might tend to compensate over the range of projects analyzed.

In the second area of the selected independent variable measurement, much work remains to be done. The subjective evaluations that various people were called upon to make in reference to the quality of site preparation, amount of brush and down material, etc., left too much to personal interpretation, thus opening the door for invalid comparisons. In the absence of objective criteria, i.e. physical measurements to be taken, this point may well be one of the weaker links in this study.

The third area is project measurement by cost. The presumption was that one could achieve identical results of one planting operation at another time and another place as long as the conditions were strictly controlled. To plant 80 acres with a crew of 20 men planting 500 trees per day each would cost X dollars no matter where it was done if the pay scale and conditions of the site and stock were constant. But, one can see this presumption will fall apart rapidly because of the difficulty in controlling something of this nature.

This study is an attempt to uncover the reasons for the variation on a physical basis i.e. that which can be attributed to changing conditions of the site and other such factors. But, the other more subtle or untraceable source, that of the peculiarities of the measurement of the result itself, is unaccounted for. If one were able to account for, or at least hold constant, the subtle source, then the prediction equations would have been more useful. But, the data used for this study were such that this was not possible. Itemized costs, time spent in planting or other available measurements might have been more useful as dependent variables than total cost. The conditions under which the 249 projects were planted were so varied that meaningful relationships may have been hidden. For instance, some of the force account projects included those conducted by groups of Boy Scouts and high school students.* There was no way to determine which of the projects were done under unusual circumstances such as these. The examples of the force account projects are mentioned as a basis for the presumption that the cost accounting system was more uniform for the contract jobs, or at least more detailed and complete. More of the variation was accounted for in this

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*Personal conversation in the Regional Office.

finance class as opposed to the Forest Service crews. Contractors probably kept better record of their costs because the job was undertaken with profit as their motive.

SUMMARY AND RECOMMENDATIONS

The 1967 hand-planting projects conducted in the Northern Rocky Mountain Region were analyzed to uncover cost trends and to determine the factors that influence cost.

To plant the average acre of land in that year cost $29.80 less cost of stock. The larger the size of the area planted the less per-acre cost.

Comparisons were made between those areas planted by Forest Service crews and those conducted under contract. The average cost per acre was $29.80 and $29.79 for the force account and contract crews respectively, with the contract plantings averaging over 100 seedlings per acre more than the force account. When reduced to a cost per-seedling basis, the average cost was 8.6¢ for the Forest Service crews and 6.5¢ for the contract arrangement.

In comparing the areas planted in the spring with those in the fall, it cost an average of $3.41 per acre more to plant in the fall. The cost was $29.75 per acre in the spring and $33.16 in the fall. The average cost per seedling amounted to 7.2¢ in the first half of the planting year and 7.8¢ in the latter half.

In the regression analysis a set of prediction equations were developed allowing for the calculation of future costs according to finance class or season or both.

The regression analysis also allowed the determination of factor importance. Size of the project in acres was determined to be the most closely correlated with total project cost less cost of stock. Among the other factors used none was important enough in all projects to be used as a predictor. The reason for this was either the variation encountered in the variable, or the lack of definitive physical guidelines for judging the factors that were evaluations of existing conditions of the planting sites.

This report recommends that the next planting analysis include specific measurements of the amount of brush and down material.

Some enforceable system of cost accounting also should be developed on a regional basis that will allow for a practical comparison of costs. If this is not possible, an alternative would be to make available itemized costs for each project so that only those items common to all projects would be used in the analysis.

A third recommendation is that regional planting guides be established to limit to a degree the variation in number of trees planted. This factor in certain classes of projects was an important predictor, even surpassing area at times. But, on an overall regional basis it was deemed to be unimportant as the variation was so great as to preclude its use as a predictor. When the variation is limited to a degree its importance will then be realized and the accuracy of the prediction equations increased.

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                                                   PROJECT  WORK  PLAN  SUMMARY
                                                                                                     01/14/68
FOREST  COEUR D ALENE                         DISTRICT/UNIT  FERNAN                                                            PAGE    3
                                                                                                                          0000FIRST-EST.
PWP  STATUS        TYPE OF WORK               AREA COMP SUB  STANDS    SUB    STANDS    APP/FUN  APP/FUN  APP/FUN  EST/TOTAL  MONEY  ACRES
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

008  COMPLT  HAND PLANTING                    145  02   5  01 02 03     00 00 00    824/033  000/000  000/000   6,236     6,236   145
                                                                     YEAR-TO-DATE          APP/FUN        EXPEND.  MEALS   MILES    HOURS
                                                                      INFORMATION

                                                                                           824/033       3,228.42          633.0    104.0

                                                            FIRST/EST FINAL/EST   EST/UNIT  UNIT COST    ACCRUED

                                               TOTALS         6,236.00 6,236.00     43.00      22.26    3,228.42          633.0    104.0*


009  COMPLT  HAND PLANTING                     54  01   2  03 00 00     00 00 00    824/033  000/000  000/000   2,867     2,867    54
                                                                     YEAR-TO-DATE          APP/FUN        EXPEND.  MEALS   MILES    HOURS
                                                                      INFORMATION

         UNPLANNED APPROPRIATION AND/OR FUNCTION ......                                    735/031          -4.64
                                                                                           824/033       3,994.88          222.0     64.0

                                                            FIRST/EST FINAL/EST   EST/UNIT  UNIT COST    ACCRUED

                                               TOTALS         2,867.00 2,867.00     53.09      73.89    3,990.24          222.0     64.0*


010  APPROV  HAND PLANTING                     30  71   1  02 00 00     00 00 00    824/033  000/000  000/000   2,220     2,220    30
                                                                     YEAR-TO-DATE          APP/FUN        EXPEND.  MEALS   MILES    HOURS
                                                                      INFORMATION

                                                            FIRST/EST FINAL/EST   EST/UNIT  UNIT COST    ACCRUED

                                               TOTALS         2,220.00 2,220.00     74.00


011  APPROV  SLASHING                          56  11   3  04 05 06     07 00 00    824/033  000/000  000/000     649       649    56
                                                                     YEAR-TO-DATE          APP/FUN        EXPEND.  MEALS   MILES    HOURS
                                                                      INFORMATION
```

Sample of Project Work Plan Summary

STAND EXAMINATION AND MANAGEMENT STATUS RECORD

(Reference FSH 2411.15 R1)

MASTER LIST FOR 04/02/68

R1-2410-17 (REVISED 6-66)

Basic Land Data (State, County, Forest, Working Circle, Block, Compartment, Sub-Compartment, Stand or Area, Land Class, Multiple Use Zone)	Soil Class, Habitat Type, Physiographic Site, Elevation, Slope, Aspect, Area	General Forest Data (Forest Type, Site Index, Damaging Agent, Damage Rating)	Date of Origin	Immature Stands (Crop Trees / Excess Trees)	Overwood / Non-Stock / Treatment	Regeneration	Stand Improvement	Harvest or Other Drain, Hazard Reduction, Site Preparation	Protection	Date Examined	Scheduled Examination	Purpose
46019071229102121	113124 13	1227	96?	7 1	33	26713		26511 16746 16743		168	711	5
46019071229103221	113134013 4					693		26511 6743			9691	5
46019071229104121	132323843 172028		934	7 5		1653	1663	16521		168	715	5
46019071229105221	113153813 20		966	6 4 1	33	26713		16511 16746 16743		168	711	5
46019071229107121	113153515 17 737		965	6 4 1	33	26713		16511 16746 16743		168	711	5
46019071229110121	112323523 8 73							16621	26643		762	5
46019071229111121	113133523 5 73				35	26763		26511 16746 16643		168	691	5
46019071229112121	1123537151 09 73							16621	16643		9765	5
46019071229113121	112253916 10122		965	6 1	33	26713		[illegible]		[illegible]	711	5
46019071229114121	113153616 34 73		965	6 1	33	26713		[illegible]		[illegible]	711	5
46019071229119121	113153714 5122		965	7 1	33	26713		26511 16746 16643			2681	5
46019071229116121	112333727 7							16621			9672	5
	264 SUB-C											
	262 CMPRT											
46019071230206121	12239432A269 739		932	11 78 7 31361 9	12 3						974	5
	264 SUB-C											
46019071230403121	13215441410310 86		930	20 7815 311 6	11 4						974	5
46019071230407121	12225571422910 86		930	2197820 9 3 8 9	11						974	5
	334 SUB-C											
46019071230501121	1323347213111086		930	16 8714 311 5	11 4						974	5
46019071230502221	142324028 29 7				3331	6913		16611 6946 6913 16743		267	701	5
46019071230503121	122235719803 735		930	5 88 5 1 8 5	11 3			26821			9742	5
46019071230504221	142334022 11				7131	6913		16611 6946 6913 16743		267	701	5
	1-15 SUB-C											
46019071230701121	116133622 80							16621			9672	5
46019071230702221	116133822 15					693		16611 6743			9691	5
46019071230704221	132224022 40					6913		16511 6746 6743			681	5
	SUB-C											
	1-90 CMPRT											

Sample of Master Forest List

Appendix C

Special
Form

SUPPLEMENTAL INFORMATION FOR ANALYSIS OF PLANTING COSTS

Stand Identification:

Forest__ __; Block__; Compartment__ __; Subcompartment__; Stand__ __; Area__ __

Description of Trees Planted:

Species __________ Age Class __________ No. Planted __________

Species __________ Age Class __________ No. Planted __________

Species __________ Age Class __________ No. Planted __________

Total Planted__________

Planted by Contractor: ______________; Force Account ______________ (check one)

Planting Tool Used: R-1 Mattock ____________; Other (specify) ____________

Site Preparation:

Method Used____________________

Year Completed ________________

Quality ______________________ (in terms of interference with planting crews)

Site Conditions:

Brush Light ________ Medium ________ Heavy ________

Down Material Light ________ Medium ________ Heavy ________

Accessibility: _______(paid travel time per shift per man to nearest hour)

Crew Experience: New __________ Experienced __________ (check one)

Is stock cost included in PWP total cost? Yes _____ No _____ (check one)

Remarks:

APPENDIX D

VARIABLE DESCRIPTION AND EVALUATION

1) Soil Depth
   a) More than 18"
   b) Less than 18"

2) Soil Type
   a) Sandy, Gravelly, or Loamy
   b) Rocky

3) Slope
   a) Less than 35%
   b) More than 35%

4) Aspect
   a) N, NE, E, NW, Level or Rolling
   b) SE, S, SW, or W

5) Season of Planting
   a) Spring
   b) Fall

6) Finance Class
   a) Force Account
   b) Contract

7) Method of Site Preparation
   a) Burned--Prescribed Burn, Wildlife, Slash and Burn, and Machine Pile and Burn
   b) Unburned--Machine Pile, Machine Scarify, Machine Terrace, Furrowed, and Hand Scalping

8) Quality of Site Prepartion
   a) Excellent to Very Good
   b) Good to Poor

9) Planting Tool
   a) R-1 Mattock
   b) Long handled Mattock, Planting Bar, Auger, R-5 Rindt Planting Tool, Shovel and Dibble Stick

10) Site Condition--Brush
   a) Light or Medium
   b) Heavy

11) Site Condition--Down Material
   a) Light or Medium
   b) Heavy

12) Accessibility--Paid travel time to planting site
   a) One hour or less
   b) Two hours or more

13) Crew Experience
   a) New
   b) Experienced

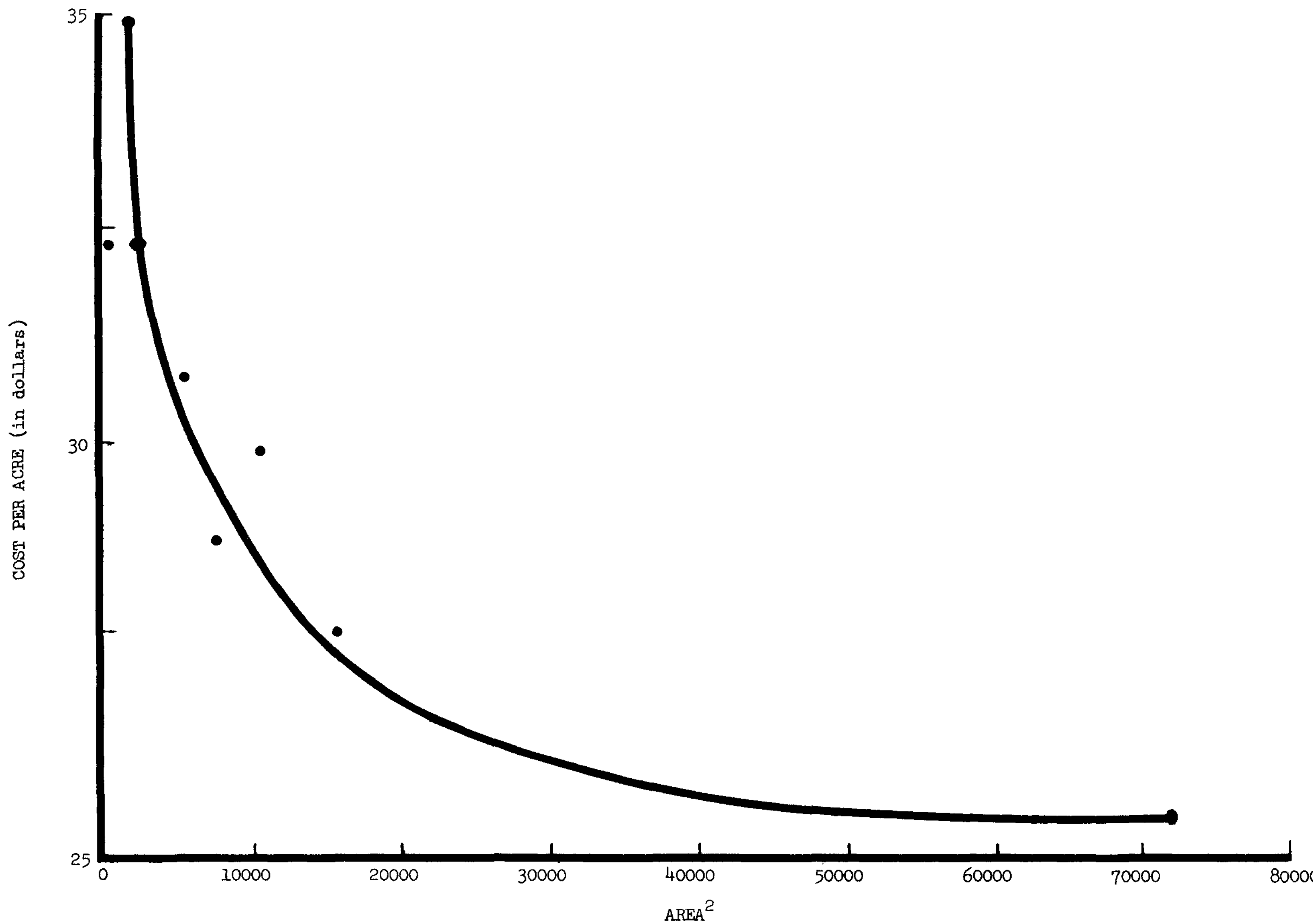

Figure 1 -- Relationship of area^2 to cost per acre for all hand planted projects

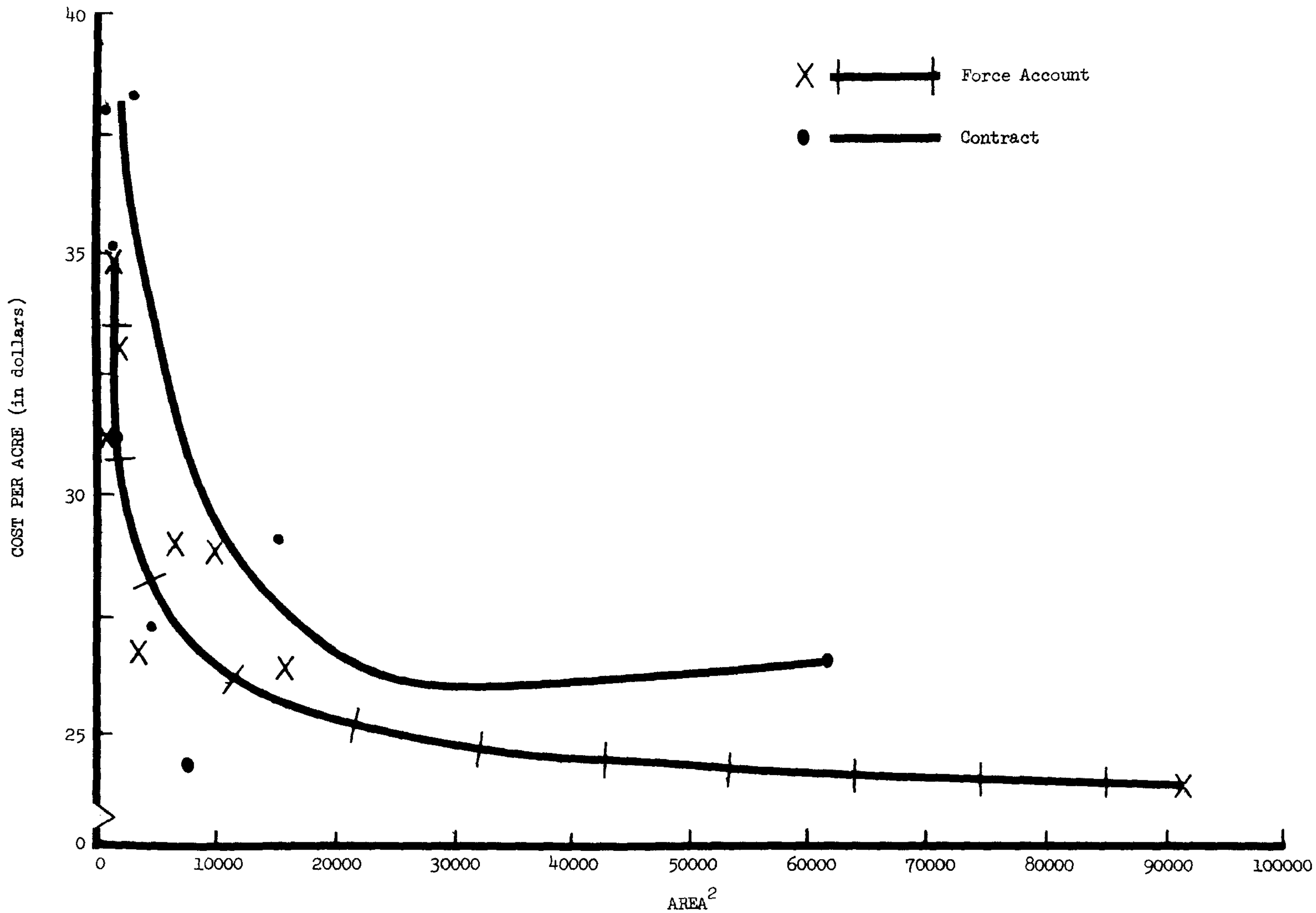

Figure 2 -- Relationship of area^2 to cost per acre for hand planted projects separated as to planting crew - Force Account or Contract

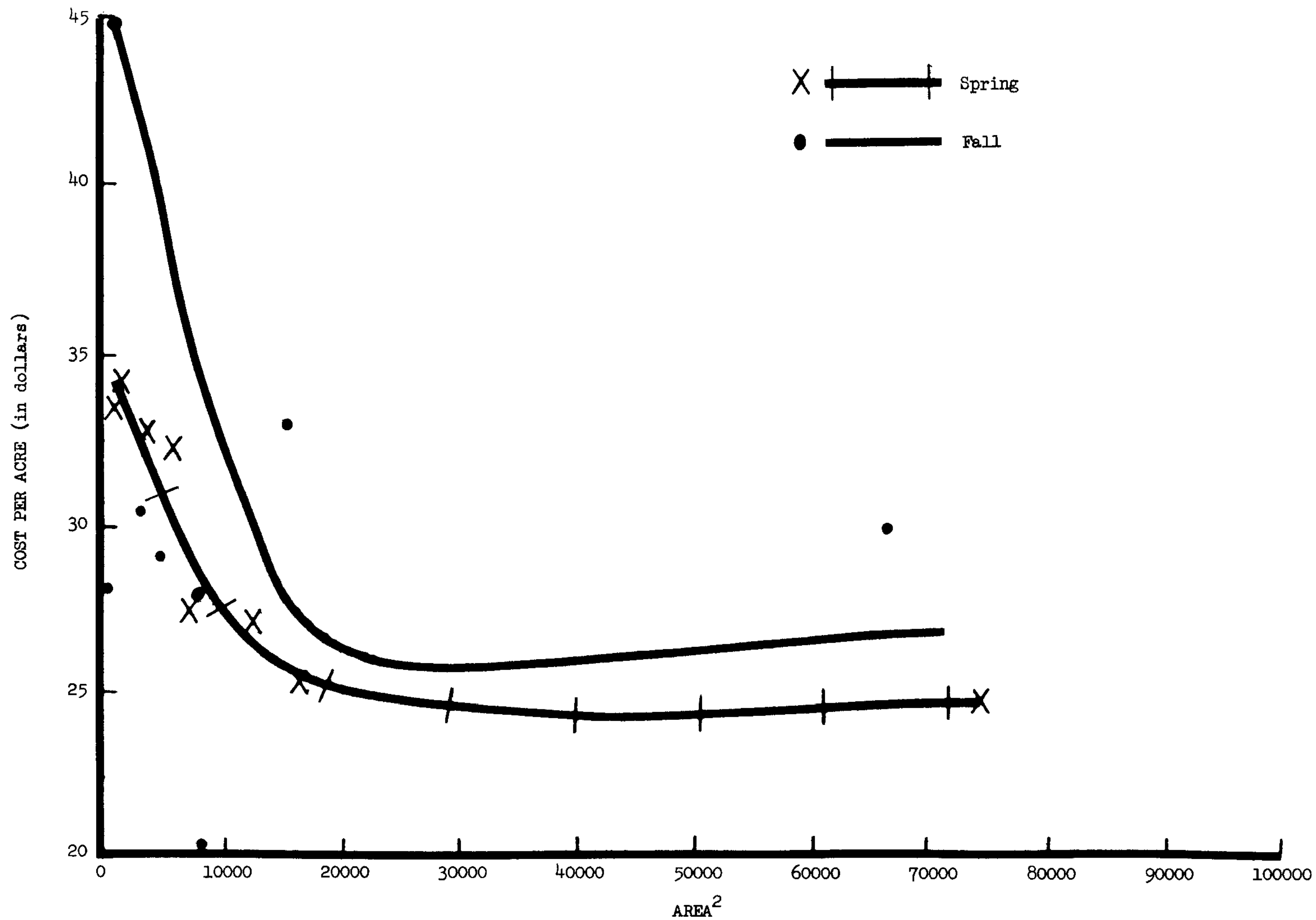

Figure 3 -- Relationship of area² to cost per acre for hand planted projects separated as to season of planting - Spring or Fall

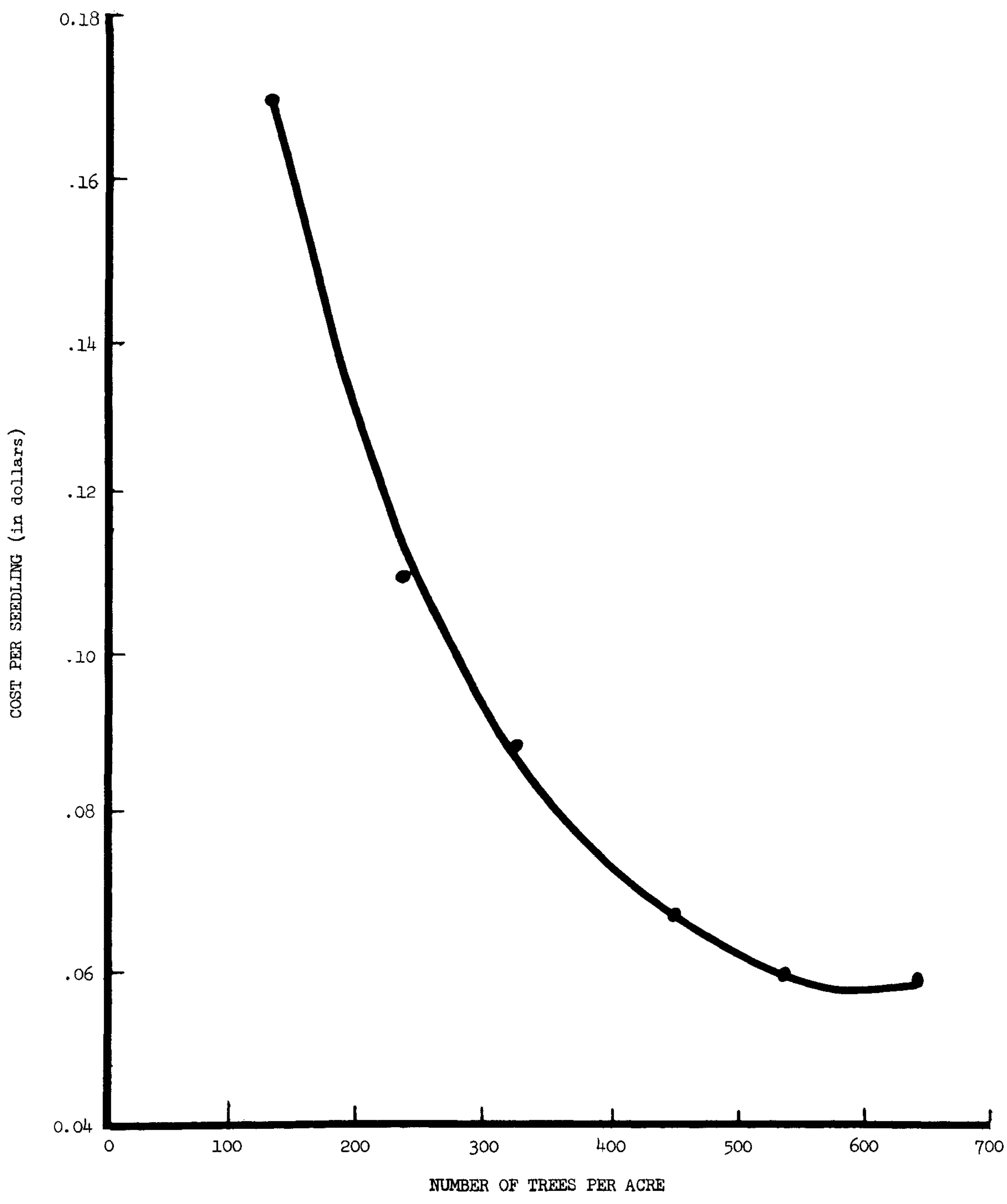

Figure 4 -- Relationship of number of trees per acre to cost per seedling for all hand planted projects

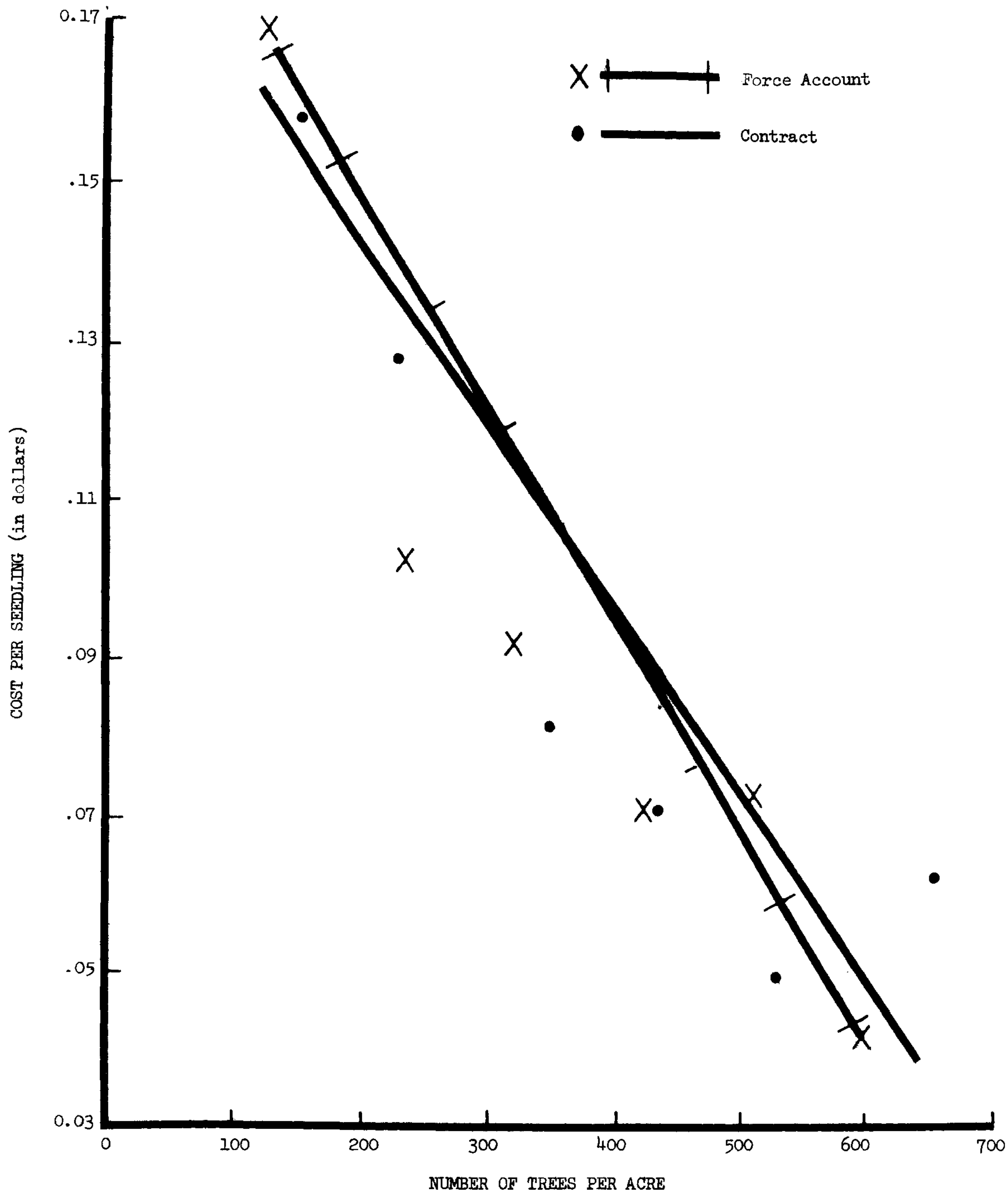

Figure 5 -- Relationship of number of trees per acre to cost per seedling for hand planted projects separated as to planting crew--Force Account or Contract

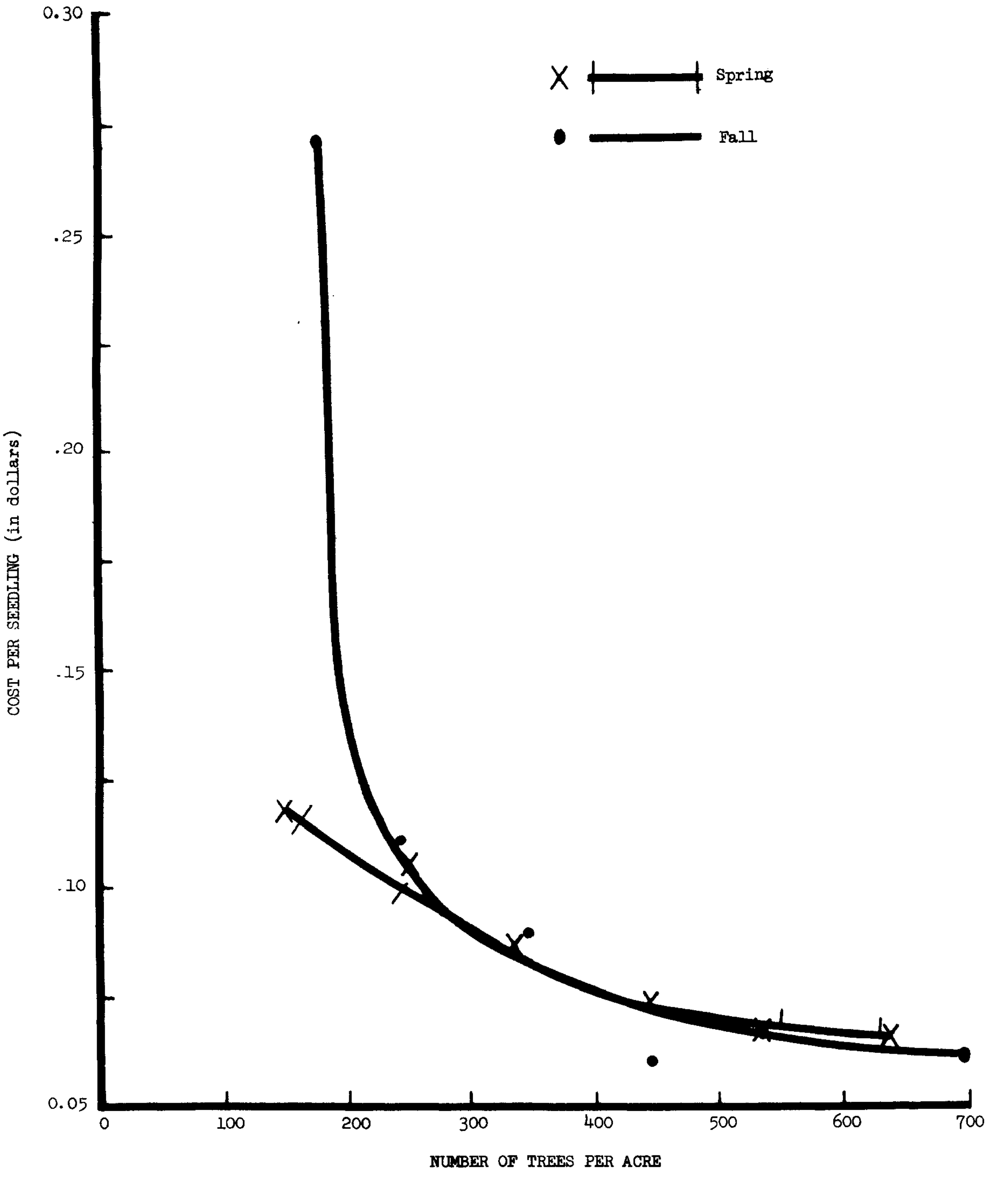

Figure 6 -- Relationship of number of trees per acre to cost per seedling separated as to season of planting - Spring or fall

TABLE 5

Statistical Data for Selected Variables

Variable	Mean	Standard Deviation	Range
All Projects (249 Observations)			
Area (in acres)	77.4	79.8	6-619
Total Number of Trees	30,465	30,198	2000-208,000
Number of Trees/ Acre	414.6	114.3	131-757
Total Project Cost (less cost of stock)	$2176.00	$2606.47	$67.31- $25,441.05
Cost/A (less cost of stock)	$29.80	$14.35	$4.08-$94.56
Force Account (139 Observations)			
Area (in acres)	63.8	78.9	6-619
Total Number of Trees	21,342	22,467	2000-151,000
Number of Trees/ Acre	345.8	-------	131-600
Total Project Cost (less cost of stock)	$1721.71	$1988.33	$67.31- $11,000.69
Cost/A (less cost of stock)	$29.80	------	$4.08-$94.56
Contract (110 Observations)			
Area (in acres)	94.6	78.0	14-478
Total Number of Trees	41,992	34,576	7000-208,000
Number of Trees/ Acre	456.0	-------	186-757
Total Project Cost (less cost of stock	$2750.05	$3139.44	$445.85- $25,441.05
Cost/A (less cost of stock)	$29.79	------	$8.89-$86.94

(continued on following page)

Variable	Mean	Standard Deviation	Range
Spring (195 Observations)			
Area (in acres)	76.9	81.2	6-619
Total Number of Trees	29,968	30,746	2000-208,000
Number of Trees/Acre	411.4	------	131-673
Total Project Cost (less cost of stock)	$2100.99	$2482.89	$67.31-$25,441.05
Cost/A (less cost of stock)	$29.75	------	$4.08-$94.56
Fall (54 Observations)			
Area (in acres)	79.4	75.2	13-419
Total Number of Trees	32,259	28,329	5000-115,000
Number of Trees/Acre	425.8	------	159-757
Total Project Cost (less cost of stock)	$2446.85	$3021.34	$277.00-$18,304.21
Cost/A (less cost of stock)	$33.16	------	$10.65-$63.93

TABLE 6

R^2 VALUES OF THE GENERAL EQUATION

The format of this section will be as follows; the R^2 value stated is that which corresponds to the equation after the factor listed has been removed.

1)	All variables entered	.751543223
2)	Reciprocal Total Number Trees	.751542417
3)	Reciprocal Area	.751542291
4)	Site Condition--Down Material	.751541133
5)	Log Number Trees/Acre	.751494551
6)	Soil Depth	.751410266
7)	Site Condition--Brush	.751310189
8)	Finance Class	.751162798
9)	Slope	.750980495
10)	Aspect	.750810493
11)	Accessibility	.750657483
12)	Quality of Site Preparation	.750298967
13)	Log Total Number Trees	.749604308
14)	Total Number of Trees	.748289777
15)	Area x Number Trees/Acre	.747684499
16)	Soil Type	.746462311
17)	Planting Tool	.745587543
18)	Log Area	.743963368
19)	Season	.742286007
20)	Method Site Preparation	.740765933
21)	Crew Experience	.738027583
22)	$Area^2$	.734390704
23)	Area x Total Number Trees	.732981268

24) Total Number Trees^2 732681591

25) (Number Trees/Acre)^2 727003330

26) Number Trees/Acre 725522377

27) Reciprocal Number Trees/Acre 720640144

28) Area--Linear 000000000