COST OF RAISING CONTAINERIZED TREES IN THE UNITED STATES

PART B -- A COST MODEL 1/

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Abstract.--Computerized cost models for containerized seedlings can be extended forward through establishment of the seedlings in the forest. Transportation and planting costs as well as survival rates are used to determine cost per established seedling. For planning purposes, similar cost models should be developed for other types of planting stock.

INTRODUCTION

The computer routine devised by the Forest Service staff at the Missoula Equipment Development Center represents significant progress in evaluating greenhouse systems. This program allows the rapid computation of the cost of producing containerized seedlings under alternative conditions. The user specifies the set(s) of conditions relevant to his particular situation. What I would like to suggest is the extension of this computer system in two directions: (1) (1) determination of the total cost of containerized seedlings established in the field, and (2) determination of the costs of alternative methods of seedling production and establishment.

The total cost of seedling establishment is of interest for two reasons. First, the seedlings most cheaply produced in the greenhouse may not be the cheapest in terms of the cost of trees actually surviving in the field. Thus, the costs of various methods of greenhouse production cannot be legitimately compared to each other unless the seedlings are followed through to the establishment of a stand of trees.

1/Paper presented at North American Containerized Forest Tree Seedling Symposium, Denver, Colorado, August 26-29, 1974.

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Second, the cost of establishing seedlings on certain sites can be quite high--much higher than could be justified by potential timber production. Other considerations, such as recreation, scenic beauty, and provision of a wildlife habitat, enter into the planting decision. Unlike timber, the other products of a forest are difficult to evaluate in monetary terms. A look at the costs of establishing a forest stand may give some indication of the value of these intangibles.

It is important to view the costs associated with containerized seedlings in perspective; that is, the costs of containerized seedlings must be compared with the costs of alternative methods of achieving the same objective. The bareroot nursery has been the source of planting stock for many years. Although greenhouse systems can solve some of the problems encountered in the nursery, the solution may be quite expensive. The relative merits of different methods of seedling production will vary over specific situations. A computerized system would permit the rapid evaluation of each type of planting stock in relation to the problem at hand.

The development of a total cost figure is no simple task. The costs of transportation and planting, given alternative situations, as well as the

seedling survival rate under various site conditions, must be determined. Often the desired information has not been generated, or it is not easily accessible. Available information is sometimes conflicting. There is an obvious need to develop a broader data base in the areas of transportation, planting, and survival of various types of containerized seedlings and other types of planting stock.

COST OF CONTAINERIZED SEEDLINGS

When containerized seedlings are produced, their story does not end in the lath house. The seedlings must be transported and planted. Costs from the production point forward are heavily dependent on the particular planting site under consideration.

Transportation

Transportation costs depend on (1) the size and capacity of the vehicle used, (2) the cost of vehicle operation, (3) the size of the containerized seedlings, (4) percentage survival in the greenhouse, and (5) the distance from the greenhouse to the planting site. With a particular planting site in mind, and the spacing of the trees determined, a certain number of seedlings will be required to plant the site. If the vehicles available have about the right capacity for the number of seedlings involved, the cost of vehicle operation and depreciation will be spread over that number of seedlings. If the available vehicles have excess capacity for the particular job requirements, transportation costs per seedling will rise.

The second factor, the cost of vehicle operation, may become increasingly important in the face of the energy crisis. This cost basically consists of gasoline and oil, vehicle maintenance, and depreciation. These cost figures would not be difficult to obtain on a per mile basis for several different sizes and types of vehicles.

The third factor, the size of the containers, is important to determining vehicle capacity. The larger the container, the fewer the seedlings that a given vehicle can transport, and the more expensive the transport cost per seedling. A styroblock system leads to the fourth consideration; the styroblocks are transported as a unit, with the empty containers being carried as well as ones containing a seedling. The lower the survival rate in the greenhouse, the more expensive the transportation becomes for the remaining seedlings.

The fifth factor, the distance factor, can be multiplied times the cost per seedling per mile to get the total cost of transportation per seedling.

Planting

Planting costs for containerized seedlings are not as easily obtainable as transportation costs. There is little published data, and what data there is is conflicting. There are basically two reasons for the conflict: (1) the sites reported are not uniform, and (2) the seedlings planted vary in size, and in the methods used to plant them. The following considerations enter into the determination of planting cost per seedling.

The first is site preparation. The need for site preparation is site-specific, and must be determined in individual cases. The more site preparation required, the higher the cost per seedling.

Secondly, the planting method for the seedlings must be considered. The planting method may help to determine the amount of site preparation required, so these two items are not entirely independent. The basic distinction in planting method would be whether the seedlings are planted by hand or with a tree planter (with a tree planter more site preparation would probably be required). The costs of planting the seedlings mechanically would include fuel and oil, labor, and depreciation on the planter; while the costs of hand-planting consist mainly of labor. Which method is more expensive depends on the relative costs of labor vs. fuel and oil in the area, and on seedling size.

Seedling size makes little or no difference over a large range when seedlings are planted mechanically. However, when hand planting is considered, labor costs will increase as seedling size increases. The larger seedlings are

heavier and bulkier, requiring more effort and time to plant, and necessitating more time wasted in renewing the planter's seedling supply from the on-site storage area. When laborers are paid by the hour, fewer seedlings can be planted per hour. When laborers are paid by the seedling, a higher rate will probably be necessary for the larger seedlings in order to attract labor.

Survival

By adding the production cost, transportation cost, and planting cost together, the total cost per planted seedling is obtained. In order to find the cost per established seedling, it is necessary to take into account the initial survival rate of the seedlings planted. The first year or first few years are particularly crucial. Survival rates for containerized stock tend to be higher than those for bare-root stock, particularly on adverse sites or for early-or late-season planting. This results from decreased root damage and environmental shock to containerized seedlings. However, under favorable conditions, there is no reason to believe that significant differences will occur. In the end, survival rate estimates must be made by someone familiar with previous performance of containerized seedlings on similar sites.

Cost of Established Seedlings

To find the cost per established seedling, the cost of planted seedling is divided by the initial survival rate. The survival rate is the most influential factor in the analysis, since cost per established seedling varies inversely with survival rate. In most cases the survival rate will probably be measured over the first year that the trees are in the ground. When a longer initial period is desired, the costs should be compounded over the number of years desired. This process accounts for carrying the investment in the trees for several years.

The question of periods exceeding one year involves the choice of some interest rate for the compounding process. The "proper" interest rate is a difficult question--the rates chosen usually lie somewhere between the U.S. Treasury rate on bonds and some commercial lending rate, such as the prime rate. Since the correct interest rate is so difficult to determine, it may be better to ignore it, or concentrate on the initial planting year, unless substantial losses are expected to occur later. This problem becomes more important when one wishes to compare different types of stock which take different lengths of time to become established.

Replanting must be considered when survival rates may possibly be very low, and some minimum stand density is desired. If an area is to be replanted, the costs of production, transportation, and planting of the secondary stock must be considered in addition to the costs associated with the original stock. This is a slightly more complex problem, since costs must all be adjusted to final establishment of the area. The cost of the original planting must be compounded forward until the planting area is established.

COSTS OF ALTERNATIVE SYSTEMS

The same types of information need to be systematized for other types of planting stock in order to gain perspective on the costs of establishing containerized seedlings, and to aid the decision-maker in choosing the appropriate methods of raising seedlings for his particular planting tasks. He needs to know the costs of production, transportation, and planting and the survival rates for comparable height and caliper, and with the same growth potential. In the following discussion, reference will be made to bare-root nursery stock, although similar analyses would apply to such variations as potted nursery stock.

Production

The year-by-year cost of the nursery production of bare-root stock of the species of interest must be known. Production costs include the variable costs, such as seed, fertilizer, irrigation, fuel, and labor specific to the species mentioned, plus that portion of the fixed costs of depreciation on buildings and machinery, administration, and overhead attributable to the particular species under consideration.

Many species are usually grown in the nursery concurrently, and a cost breakdown by species is often not recorded. Sometimes an average cost of production for all species is available; however, if costs vary greatly among species, the average figure may be misleading. The production cost figures should be on the basis of seedlings of a certain species that survive until they are transported to the planting site, accounting for losses in the nursery beds, and during lifting and storage.

A further consideration in computing production cost is the length of time required for nursery production. Since funds are invested in the stock and are unavailable for other uses, the costs incurred in production should be compounded annually until the trees are lifted and stored. As discussed above, the precise interest rate to be chosen is not a matter of concensus, and could be a number of different rates. The interest rate chosen should reflect as closely as possible the opportunity cost of investment funds. It would be advisable to analyze several alternative rates to test the sensitivity of the cost figure to the interest rate; costs will be more sensitive at a range of high interest rates than at a range of low interest rates.

Transportation

Analysis of transportation cost would essentially be the same as for containerized seedlings, except that container size is not a variable when bare-root seedlings are considered, and percentage of survival during production is of no consequence, since there is no need to transport dead seedlings. Transportation cost of bare-root seedlings will most likely be the same or lower than that for containerized seedlings. For a given site, a particular vehicle will hold at least as many bare-root as containerized seedlings, and to the extent that a smaller or cheaper vehicle can be used for the required number of bare-root seedlings, transportation cost per seedling will be lower. For large jobs, fewer vehicles and/or trips will be required. Only in the case where the greenhouse would be located closer than the nursery to the planting site would transportation cost per seedling be greater for bare-root stock than for container stock. Any difference in transportation cost between the two types of stock would become increasingly important if the price of energy increases relative to other costs.

Planting

Once again the major differences in planting costs are in the degree of site preparation required and in the planting method used. Less site preparation may be required for the bare-root stock than for containerized stock.

The planting method will vary among sites. If trees are planted with a tree planter, the costs will be essentially the same as those for containerized stock planted by the same method. Bare-root seedlings may be somewhat cheaper to plant than container stock if fewer breaks are needed to replenish the seedlings from on-site storage.

If bare-root seedlings are planted by hand, planting will probably be accomplished more quickly than with containerized stock, since it is less bulky, lighter, and the planter need make fewer trips back to the storage area. If a flat rate per seedling is used, regardless of the type of seedling, then the planting cost per seedling is the same for the bare-root and containerized stock.

Survival and Cost per Established Seedling

The field survival rate is the key factor to cost per established seedling. With favorable sites and weather, the survival rate of bare-root seedlings may compare favorably with that for containerized seedlings. In that case, if the total cost of the planted bare-root seedlings is less than the total cost of planted containerized seedlings, the bare-root seedlings will be the cheaper of the two types of stock to establish. On the other hand, if the site considered is difficult, and/or planting is done late or early in the season, the survival rate for containerized seedlings is likely to be higher than for bare-

root stock. In this case, the containerized seedlings may be cheaper to establish. Ultimately, the relative survival rates that are likely for a given site under a particular set of conditions must be estimated by someone familiar with both bare-root and container plantings on a similar site.

Replanting must be considered for bare-root stock, using the same general procedure as discussed for containerized stock. Potential replanting becomes a major consideration when the projected survival rate for bare-root stock is low enough that is must be replanted, but containerized stock on the same site is expected to survive reasonably well. The difference between cost per established bare-root seedling and cost per containerized seedling will increase dramatically.

When comparing any two seedling establishment systems, it is important to note the magnitude of the cost difference. If the absolute difference is small, then a slight change in one of the cost components or in the survival rate may reverse the result of the analysis. Sensitivity analyses should be conducted by varying the cost components most subject to fluctuation, and by adjusting survival rates over the range most likely to occur.

CONCLUSIONS

This paper has discussed the kinds of data needed to develop a complete seedling cost model. Specific figures appropriate to a particular case would be supplied by the planner. However, many important items, such as the survival rate, cannot be determined with certainty beforehand. In order to do a thorough analysis, each likely variation of the case should be examined. As the number of modifications to the case increases, the number of calculations required increases exponentially.

Although a simple analysis can be performed by hand 3/, the speed of the computer is essential to planning for a large number of cases, each with many possible variations. To my knowledge no computer system of the total cost model for containerized seedlings, or for any other seedling system, now exists, but such systems could be devised using the Missoula Equipment Development Center's production cost model for containerized seedlings as a base.

3/ For an example of a single case analysis, see Forest Service Research Paper RM-108, Economics of Containerized Conifer Seedlings, by Marilyn K. Colby and Gordon D. Lewis.

Question: Did you say there was no computer today that could handle a total-cost model?

Nicholson: No. I said that no one has written a program for a total-cost model. There are a large number of computers capable of handling such a program. I think a program should be written, and I work for a company that would be very happy to do it for a price.

Question: What does it cost to construct such a computer program and collect relevant data to use in it?

Nicholson: I can't tell you what the programming would cost but if each of you jotted down some figures as you go about your work, the data needed would not cost much.

Question: Has any consideration been given to include rate of growth in the cost-determination model rather than stopping at seedling establishment or survival?

Nicholson: My analysis did not include growth rate or any other quality factor. Where quality differs, it should be incorporated in the cost analysis. It would make the analysis much more complicated.