ECONOMIC ASPECTS OF CHRISTMAS TREE PRODUCTION AND MARKETING IN VIRGINIA

by

William A. Sellers

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APPROVED:

William A. Leuschner, Chairman

Harold E. Burkhart

Warren A. Flick

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INTRODUCTION

The use of evergreens to symbolize the Christmas season is well established. Although the exact time and place of their first use is not known, several accounts trace the evolution of this custom.

The early Egyptians and Romans are reported to have used greenery in religious ceremonies to celebrate the winter solstice, or "rebirth" of the sun. Christians in the Roman Empire later accepted the use of evergreen boughs as a symbol of Christmas in A.D. 354 when Christianity became the predominant religion of the Romans and Christmas replaced the celebration of the winter solstice. The Druids of Gaul (France) and Britain, and the Scandinavians long held the superstition that branches of evergreens placed over the door of their homes would protect them from witches, ghosts, and evil spirits. The Scandinavians, after being converted to Christianity, made use of evergreens in their religious festivals by the burning of fir boughs and the Yule log.

The first use of decorated Christmas trees is thought to have occurred in Germany along the upper Rhine River. During this time, "At Christmas, fir trees were set up in the rooms and hung with roses cut from paper of many colors, apples, wafers, spanglegold, sugar, etc." (Sowder 1966 3). Martin Luther (1483-1546), the German Protestant reformer, is credited with the first use of a lighted Christmas tree. It is reported that he attached lighted candles to a cut evergreen to simulate the star-lit sky of Christmas Eve. It is thought that the Germans made near-exclusive use of the Christmas tree until the early 1700's when the custom filtered into other parts of Europe.

Christmas trees were first used in the United States by Hessian mercenaries in the American Revolution, and later by German settlers in Pennsylvania. Though Americans of English ancestry were somewhat reluctant to accept what they considered to be a quaint foreign custom, by the 1840's the Christmas tree had become fairly common in Pennsylvania, and by 1850 the use of Christmas trees had become fashionable in all of the Eastern states. The custom was apparently becoming well-entrenched in American tradition in 1856 when Franklin Pierce became the first President to introduce the Christmas tree into the White House.

Until recently, fir were the most common species used for Christmas trees. This was due to the fact that fir were widely distributed across Germany, where the tradition apparently began, and also in the eastern United States, where the custom was first practiced in America. In the last decade however, pines and other species have become increasingly popular as Christmas trees, and have begun to command a large share of, if not dominate, the Christmas tree market.

Growth and Development of the National Christmas Tree Industry

The extent of the transition in consumers' species preference should be noted as it is of importance in understanding the development of the Christmas tree industry. In 1948, the three most popular "fir" species were balsam fir, Douglas-fir, and white fir, and accounted for 59 percent of all Christmas trees sold in the U.S. In this same year, the three most popular pines, Scotch, red, and white pine, made up only

4 percent of the Christmas tree market. By 1964, the "firs" had dropped to 36 percent and the pines increased to 35 percent of the national Christmas tree volume, with Scotch pine alone commanding 27 percent of the market (Sowder 1966 31).

The fir trees which dominated the market prior to the 1960's were largely natural trees grown on wild lands. Little consideration was given by the landowners to management or cultural practices to improve tree quality. However, standards of quality are now much higher than before, and the public will no longer readily accept the open or sparse tree with occasional missing branches.

As the consumers' tastes have shifted to denser, more symmetric pines, so too has the production process changed--from the collection of wild trees to the cultivation of trees in managed plantations. As Thatch (1969) has pointed out, these plantations are the result of two factors. First, Scotch pine, the largest selling species, is not native to this country, and second, the consumers' demands for a denser and better shaped tree necessitates the use of certain cultural practices which are most efficiently implemented when trees are spaced in uniform rows. The Christmas tree industry has responded to these demands, as evidenced by the fact that in 1964, 44 percent of the Christmas trees produced in the U.S. were grown on plantations specifically designed for Christmas tree production (Bell and White 1966). The major implication of the change in species preference therefore seems to be the establishment of intensely managed plantations requiring significant investment.

The size of the Christmas tree industry is not precisely known because since 1964 there have been no national production figures tabulated. A prediction of the trend in growth is further complicated by the fact that the polyvinyl chloride tree, the most successful artificial Christmas tree, was introduced in 1963, and its effect on natural tree sales is largely unknown.

Pendleton and Garrett (1970), in attempting to estimate the impact of the artificial tree on natural tree sales, noted that approximately 10 percent of all Christmas trees sold in the U.S. in 1970 were artificial. In discussions with industry leaders, they concluded that sales of artificial trees would continue a gradual increase for at least several more years. The industry spokesmen speculated that at the end of this time the novelty of the artificial tree will then have run its course, and sales of artificial trees would stabilize. However, continual innovations in the manufacture of artificial trees makes it difficult to predict when such stabilization will occur.

Public opinion surveys have also attempted to speculate on the future of the artificial tree. In a study of the Denver, Colorado metropolitan area Christmas tree market, 71 percent of the people questioned stated that they objected to the artificial tree because it was "not traditional" (Troxwell 1969). Such objections will be difficult for the artificial tree manufacturer to overcome. However, methods of overcoming other dislikes, such as lack of fragrance and unattractiveness are available to the manufacturer and these opportunities are being exploited. These potential developments, as

well as the added safety and convenience of the artificial tree combine to insure the continuing threat the artificial tree poses to the natural Christmas tree market. There is, therefore, a continued need for the intensive management of natural trees if they are to effectively compete with artificial trees.

The other major competitor to the domestic Christmas tree grower is the natural tree imported into this country primarily from Canada. These trees are typically wild-grown, and of lower quality than U.S. trees, and hence command a lower price. The U.S. Bureau of the Census (1972) has kept a detailed record of the number of such trees that enter this country. Their record shows that the number of imports has been steadily decreasing--from 12.4 million in 1955 to 4.3 million in 1971. The reasons for this decrease can not be pinpointed, but one might conclude that the American consumer is indicating a willingness to pay a higher price for a quality product, or refusing to buy low quality as long as high quality trees are available. If this is the case, the imported tree could become an insignificant part of the national Christmas tree market.

Alternatively, Sowder (1966) points out that the wild trees of Canada are becoming scarce and inaccessible. As a result of this, the Canadians are shifting to the management of Christmas trees, following the United States' lead. If this is the case, the number and quality of trees coming from Canada could be expected to increase; and, the consumer would be indifferent, except for price, as to whether his tree

was of Canadian or American origin. In either interpretation, the need for intensively managed American plantations is indicated if the American producer wishes to maintain or increase his share of the Christmas tree market.

The Christmas Tree Industry in Virginia

Virginia is a land of many contrasts--from the urbanized areas of Richmond, Norfolk, and Washington, to the more rural southwest; from the Coastal Plain of the Atlantic Ocean, to the mile-high Appalachian Mountains. Variations in climatic, physiographic, and sociological factors have a significant influence on the production and marketing alternatives available to the grower and should be considered by the prospective grower prior to entering the production process.

Virginia's climate is generally favorable to the production of Christmas trees. Rainfall in the state tends to average between 41 and 45 inches annually, with approximately 75 percent of this rainfall (30 to 36 inches) occurring in the growing season months of March through November (Nelson and Zillgett 1969). Winters in the state are generally mild, with average January temperatures varying from the low forties in the coastal area, to the low thirties in the mountains of the west. The average freeze-free period is from 240 to 150 days for these respective areas.

The wide diversity in physiographic features across the state benefits the Christmas tree industry, because it allows the planting of many different species. The Coastal Plain and Piedmont offer good growing conditions for species common to the southern U.S., such as

Scotch pine, Virginia pine, and loblolly pine. The mountains, due to their altitude and lower temperatures, may be successfully planted with species common to the northern U.S. and southern Canada, such as eastern white pine, Douglas-fir, balsam fir, and spruces. Eight of the ten most popular Christmas tree species, which accounted for 81 percent of domestic tree sales in 1964, are either native to Virginia or have been successfully introduced into the state (Holcomb 1973). This indicates that Virginia producers are in the position of being able to supply those trees most demanded by consumers.

Virginia producers also have the advantage of being near concentrated groups of consumers, thereby lowering the costs of transporting trees to consumers. Although all of Virginia's eight cities exceeding a population of 100,000 persons are located in the coastal area, there are twenty-four cities with populations of from 10,000 to 50,000 persons and twenty-eight cities with populations of 5,000 to 10,000 persons scattered throughout the state (1970 Census). This type of population distribution gives the producer a number of options to consider in choosing his marketing system. Many Christmas tree growers in other states and regions are forced to choose one system over another because of a less favorable population distribution. In thus having such alternatives, the Virginia producer has more direct control over his operation, and therefore his profits, than growers in other areas.

These advantages for Christmas tree production have not been fully exploited, for Virginia is still a Christmas tree importer. Surveys conducted in this study show that Virginia producers sold a total of

28,799 trees in 1972, at an average price of $4.38 per tree. The total revenue received by Virginia growers was therefore $126,140. Contrasting this to the total number and value of Christmas trees consumed in Virginia in 1972, a fairly concise picture is given of the state industry. It is estimated, using the number of households in Virginia (U.S. Bureau of the Census 1971) and the average number of natural trees per household (Sowder 1966), that 1,275,000 Christmas trees were used in Virginia in 1972. At an average wholesale value of $2.00 per tree, this represents a total revenue of $2,550,000 to the growers supplying these trees. Thus it can be seen that Virginia growers supplied less than 3 percent of the Christmas trees sold in 1972, and received less than 6 percent of the revenue from the sale of these trees.

Table 1, which shows the annual number of trees planted by Virginia Christmas tree plantation owner's, indicates that this situation may be expected to change slightly in the next few years.[1] Assuming that 75 percent of the trees which are planted will be merchantable, at least by 1976 Virginia producers should be able to supply approximately 140,000 trees to consumers. For several years following 1976, the supply of Virginia-grown Christmas trees should vary between 90,000 and 140,000 trees annually. Although this represents only a small share of the market for trees in the state, it is a five-fold increase

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[1] Appendix Table V shows the number of acres planted in Christmas trees in Virginia, and the number of growers in the industry for these same years.

Table 1. Yearly number of Christmas trees planted in Virginia listed according to species.

Species	Year of Planting 1972	1971	1970	1969	1968	1967 or before	Total All Years
White pine	58,170	56,640	65,400	62,300	126,510	95,100	464,120
Scotch pine	78,120	55,670	62,400	64,400	34,800	108,620	404,010
Douglas-fir	3,500	0	3,500	500	500	10,800	18,800
Fraser fir	6,500	4,500	500	350	16,000	30,000	57,850
Spruces	6,500	8,600	2,800	10,900	3,700	36,600	69,100
Other pine[a]	650	1,020	1,000	1,380	1,500	7,300	12,850
Other species[b]	1,000	500	600	0	5,350	3,010	10,460
Total All Species	154,440	126,930	136,200	139,830	188,360	291,430	1,037,190

[a]Other pine include red, loblolly, and Austrian pines.

[b]Other species include balsam fir and eastern red cedar.

in the number of trees supplied by Virginia producers in 1972. It is difficult to project the supply pattern beyond 1980, although there appears to be a downward trend in the number of trees planted annually. In 1968, the 52 existing plantation owners planted an average of 3622 Christmas trees. The number of growers had increased to 67 in 1972, but the average number of trees planted per grower had decreased to 2305. Thus, there has been a reduction in the average annual number of trees planted per grower, and since not enough growers enter the industry each year to off-set this reduction, the total number of trees planted each year is declining. In short, it seems that Virginia will remain a Christmas tree importer for many years to come, and that state producers will be able to supply approximately 10 percent of the trees demanded in the state.

Objectives of the study

The objectives of this study were to assist Virginia's farm and other landowners to determine if investment in Christmas tree plantations is likely to be economically successful in their particular case, and to provide data and analysis systems to improve plantation management once the plantations are established. These objectives have been set by presenting:

1) a detailed description of the production and marketing of Christmas trees in the state, including the costs and revenues which may be involved; and,
2) an analytical computer program to determine the economic feasibility of Christmas tree investment, both on a state-wide and individual grower basis.

LITERATURE REVIEW

A cursory examination of the publications devoted to Christmas tree production indicates that the material falls into one of two categories. The first category contains numerous publications which emphasize the need for sound management and offer specific recommendations for cultural operations. This category will not be reviewed because its content is not entirely appropriate to this study. The interested reader is directed to the bibliographies compiled by Ellefson (1967) and Nolley (1969) for a listing of such publications. The second type of Christmas tree literature, which will be reviewed, is comprised of studies which have attempted to determine the economic feasibility of Christmas tree production. Also, studies which have developed or implemented computer programs to analyze long-term investments will be reviewed. Although these are not oriented specifically to Christmas tree production, they do add a certain amount of needed background to this study, and are therefore appropriate for review.

Economic Analyses of Christmas Tree Production

Foster and Cote (1970) have analyzed the case histories of two balsam fir Christmas tree plantations, based on the internal rate of return. Since neither operation had completed harvesting, some costs and incomes were projected from historical data, while others were based on the owner's records. The authors emphasized that their results did not apply to "typical" Christmas tree operations, but rather were examples of successful plantation investments.

In the initial analysis, neither land cost nor property taxes were considered as production costs since the land was not purchased specifically for Christmas tree production and the property taxes would be encountered regardless of land use. Under these assumptions, and production periods of thirteen and fifteen years, the internal rate of return was determined to be 42 and 48 percent respectively. Relaxing the assumptions in a further analysis, which included a land cost of $30 per acre and annual taxes of $0.40 per acre, the internal rate of return dropped for the two respective operations to 34 and 36 percent. By varying still other assumptions concerning production length, labor costs, and federal aid funds received, it was found that the rate of return could be expected to range from a high of 52 percent to a low of 25 percent.

It should be pointed out that Foster and Cote concluded that these high rates of return were associated with a high degree of risk due to the many unknowns involved in production. Further, "It may not be unreasonable to insist that a Christmas tree plantation investment offer a rate of return of 25 to 30 percent in order for it to be equivalent to a 'secure' investment offering 4 percent."

Rudolph (1972), using basic input data from numerous sources, made a comprehensive analysis of several production alternatives for three Christmas tree species grown in Michigan. The production costs, revenues, and net income per tree, at several price levels, were calculated for Scotch pine grown on seven through nine-year rotations, and white spruce and Douglas-fir grown on a seven year production cycle. Internal rate of return varied from 7 to 42 percent, respectively.

Using his particular assumptions, notably that the price per tree did not vary with age, Rudolph concluded that the grower should strive for the shortest production period possible. However, using the more realistic assumption that price varies directly with age, it can be shown, using Rudolph's data, that harvest should be delayed several years after trees reach minimum marketability standards if the grower wishes to maximize financial returns. The computer program developed in this study will enable the grower to determine the production length with the most favorable financial outcome. Therefore, although Rudolph's economic analysis of Christmas tree production seems accurate, his attempt to interpret this analysis into a guideline for management is at best questionable.

Thatch (1969), in addition to describing the Christmas tree industry in Maryland, calculated the present net worth per acre resulting from Christmas tree management. Data on cultural and marketing techniques were collected from that state's growers; however, the costs of each operation were either assumed or taken from other studies. It was found that, at a discount rate of 5 percent, average profit per acre ranged from $86.92 for trees grown in western Maryland to $173.21 for plantations in the piedmont area. In addition, a linear programming model was developed which suggests that Christmas trees could be a more profitable alternative to Maryland farmers than the production of other selected field crops.

Utz and Balmer (1971), using assumed production costs and two hypothetical prices per tree, developed a utilitarian guide to be used by Christmas tree growers in determining the present net worth and

internal rate of return of their plantations. In the sample analysis provided it was concluded that in a seven year production period, with some harvesting done in the sixth year, the present net worth of a Christmas tree plantation, at 6 percent interest, rose from $115.55 to $1136.78 when price varied from $1.00 to $2.50 per tree. Internal rates of return varied from 13.9 to 48.5 percent, accordingly.

Computer Programs to Evaluate Long-term Investments

The use of the computer to analyze long-term investments has proven to be an invaluable asset. Not only does the computer insure arithmetic accuracy in making tedious computations, but it is also able to perform these operations with remarkable speed. These two features have largely eliminated the major stumbling blocks previously involved in evaluating long-term investment opportunities.

Far too many computer analysis programs have been developed for each to be individually reviewed. The three included in this report are intended to give the reader an indication of how they are used as a tool in investment analysis. Most such programs which have been developed use the same basic approach in that costs and revenues from the investment considered are first estimated and then used as inputs for the analysis. Primary differences arise from the flexibility of the program, or its ability to evaluate diverse alternatives. Schweitzer et al (1967) formulated the highly flexible NCRETURN program. Using this program, not only is it possible to analyze various alternatives of a single forest investment, it is also possible to compare completely different opportunities in terms of internal rate of return, rotation length, and harvest yields.

The DAMID procedure, developed by Gieske and Boster (1971), makes use of a different type of flexibility, in that it allows for one-time, constant, and cyclical costs and returns, and also data which varies only after long periods of time. Present net worths are calculated assuming both a perpetual and terminating investment life. Mantie (1973) developed a computer program to analyze three types of loblolly pine investments, incorporating yield equations and specific information supplied by individual landowners. Depending on the criterion chosen, the program will analyze proposed plantations, existing plantations, or natural stands in terms of present net worth, internal rate of return, or equivalent annual income.

TECHNIQUES AND PROCEDURES

In order to make the results of this study applicable to Virginia plantations it was necessary to collect basic production data from the state's growers. This chapter specifies the data collection procedures and the methods used to summarize and analyze the data.

Data Collection

Two types of data were needed in making this study. First were data about the cultural and marketing practices involved in Christmas tree production to be used in describing the industry. This was obtained from a survey of all known Christmas tree growers in the state. A second type of data, dealing with the more detailed financial aspects of Christmas tree investments, was needed to make the economic analyses. This data was collected from a subsampling of the state's growers, selected by their high intensity of management and experience in the production and marketing of Christmas trees.

Cultural and Marketing Data

A Christmas Tree Growers Questionnaire was prepared to survey people thought to be growing Christmas trees in the state, and pre-tested by a small group of members of the Virginia Christmas Tree Growers Association.[2] The purpose of this questionnaire was to:

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[2] Samples of this questionnaire, the cover and follow-up letters, and the Financial Questionnaire are shown in Appendix I.

1) identify Christmas tree growers in the state. The study definition of a Christmas tree grower was any landowner who had either sold one or more crops of 100 trees, or had sheared at least three acres of Christmas trees.

2) indicate the timing and extent of cultural operations employed.

3) establish the types of marketing systems used and prices of trees sold.

4) outline the history of the growers' plantations by species and number of trees planted each year.

A list of names of possible Christmas tree producers was compiled with the aid of the VCTGA, county extension agents, and records on file at VPI & SU. The VCTGA supplied a list of its membership and requested that its members submit names of non-members thought to be growing Christmas trees; extension agents also submitted the names of people growing Christmas trees in their area. The questionnaire, a cover letter, and a stamped, addressed envelope were mailed to 236 people identified as possible Christmas tree growers. Two follow-up letters were sent out at three week intervals, with a second copy of the questionnaire included with the last letter.

Response to the questionnaire was very favorable, with 184 persons (78 percent) returning the completed form. Of those responding, 67 people were classified as Virginia Christmas tree growers. The distribution of these growers is shown in Fig. 1. It can be seen that most of the plantations are located in the mountain and piedmont regions of the state. Approximately 10 percent of the state's plantations are located in the Coastal area.

x - denotes location of Christmas tree plantation identified in Christmas Tree Growers Questionnaire

o - denotes location of Christmas tree plantation selected for sampling with the Financial Questionnaire

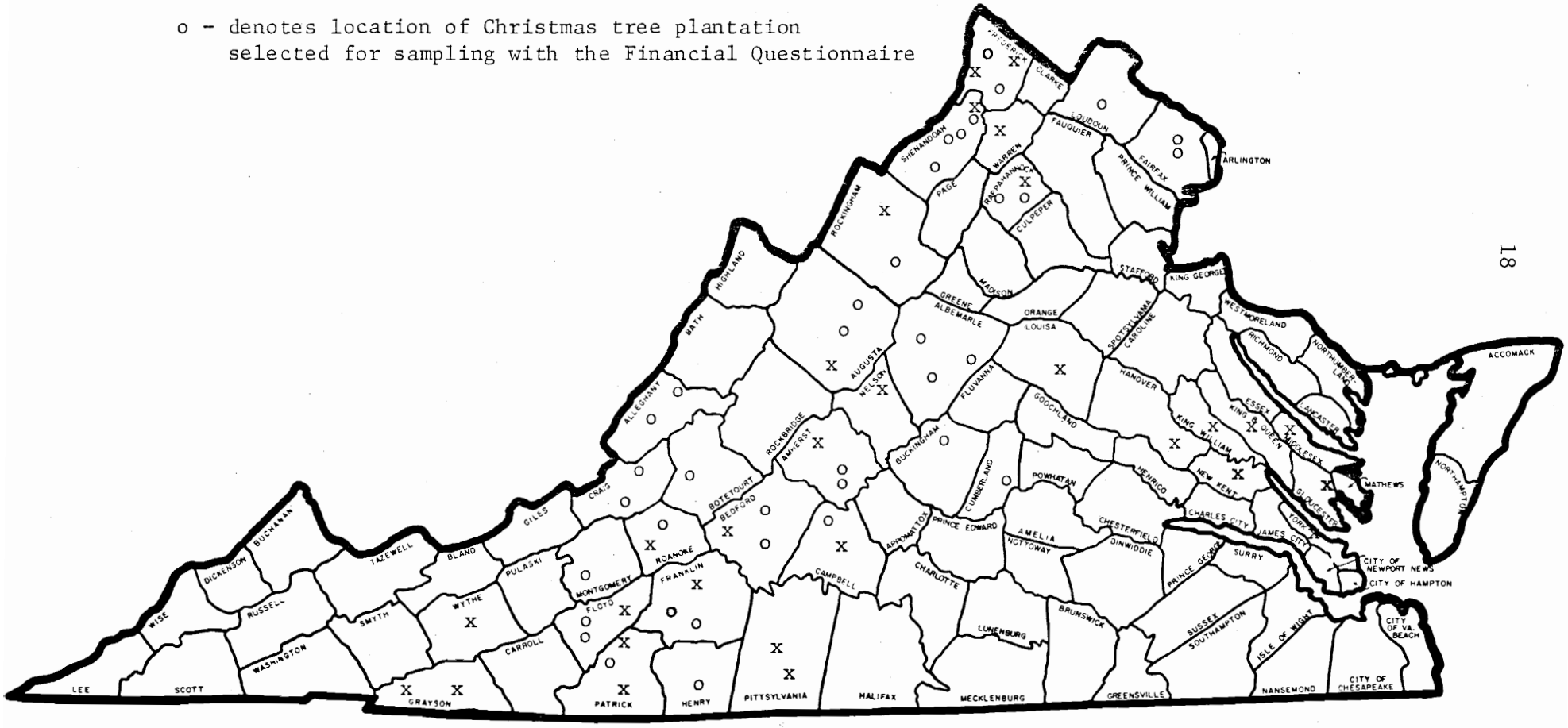

Fig 1: Distribution of Christmas tree plantations identified in Virginia

It is believed that the majority of the 22 non-respondents is made up of people who would not be classified as Christmas tree growers, and that at most only 2 or 3 growers failed to return the questionnaire. This speculation is supported by the sincere interest shown in this project at various times by the state's growers, which indicates the growers' willingness to supply the required input data. It is further believed that the few growers not responding to the questionnaire has an insignificant effect on the results obtained in this study.

Financial Data

Following the administration of the Christmas Tree Growers Questionnaire, a second questionnaire was prepared for a more intensive sampling of selected growers. This questionnaire was designed to complement the information received in the first survey with detailed production cost data. Prior to its completion, this questionnaire was also evaluated by several growers, and revised according to their suggestions.

Thirty-seven Christmas tree growers, whose plantation locations are shown in Fig. 1, were selected to provide the information in the Financial Questionnaire. These growers were deliberately selected after considering each grower's responses to the first questionnaire. Only experienced growers with intensively managed plantations were asked to provide the financial data. This method was used because of time and cost considerations, since sampling only experienced growers assured that most respondents would have encountered all aspects of Christmas tree production, and, so that the results of the study would indicate the situation to be expected under sound Christmas tree management, rather than indicative of haphazard management.

The nature of the information requested and the detail involved in the questioning required that the Financial Questionnaire be administrated by personal interview, rather than by mail. This allowed the interviewer to resolve any ambiguities in the questions as they arose and insured that the data supplied was in the form requested. Interviews were scheduled by telephone one to two weeks in advance of the desired appointment date to confirm the availability and willingness of the selected growers to cooperate.

It will be noted from Fig. 1 that no growers from the Coastal area were selected for sampling. This is because most plantations in this region are newly established; and, although one plantation met the criterion for selection, it was felt that the effort involved in going so far for one response was not justified. There is no reason to believe that the costs or practices of the growers in the Coastal area would be significantly different than those in other parts of the state.

Determination of Costs

Both variable and fixed costs are encountered in Christmas tree production. Variable costs include the costs of labor, equipment, and material and supplies. The magnitude of the variable costs is determined primarily by the landowner's management decisions and the number of trees produced. Fixed costs include the cost of land and annual property taxes, and following the decision to enter into production can not be effected by the plantation owner, except by stopping production. As will be discussed further in the section covering fixed costs, the landowner may therefore have some flexibility in determining whether or not the fixed

costs should be included in his financial analysis. A third cost, compound interest charges, arises due to the multi-year production cycles involved. Interest charges are both fixed and variable in nature in that both fixed and variable costs are discounted. For this reason, compound interest costs will be discussed as a separate type of cost. Because of the diversity in plantation management and managers, it was necessary to convert all costs to a common-unit basis prior to analysis to make the results more generally applicable to individual growers.

Variable Costs

Two methods were used to convert variable costs to a common-unit basis. The first of these was to stratify management practices into specific treatment categories for each different type of equipment used in carrying out a particular operation (Table 2). In calculating variable costs, each of the 37 growers responding to the Financial Questionnaire was placed into those categories which best describe his particular operations. Using this procedure, variations in management were less significant than if all growers practicing a general operation were taken collectively, and a more precise understanding is given of the methods in which costs are incurred.

The second method used to facilitate analysis of the state-wide industry was to standardize the cost per unit of labor, equipment, and materials and supplies. The criterion for this standardization was based on the most common types of equipment and material used by the growers practicing the treatment. The unit cost of mechanized equipment has been taken from a publication by E. S. Smith and J. D. Oliver (1972). The

Table 2: Stratification of production, harvesting, and marketing treatment categories for which direct costs have been calculated.

Operation/Treatment category	Operation/Treatment category
Site Preparation	Insect Control
clearing	by power applicator
cultivation	by hand
mowing	
herbicide	Artificial Coloring
	by power applicator
Planting	
with machine planter	Partial Harvest
with hand planter	
	with hand saw
Replanting	with chain saw
following mortality	with mounted circular saw
following partial harvest	
	Balled Stock Harvest
Shearing	
with shearing knives	dug by hand
with hand shears	
	Clearcut Harvest
Pruning	
done with shearing	with chain saw
done separately	
	Transporting to the Roadside
Vegetation Control	
by mowing	by hand
by herbicide	by truck
	by tractor and trailer
Fertilization	
by power applicator	Bundling
by hand	
	with hand operated funnel
	Loading at Roadside
	Unloading at retail lot
	Choose and Cut Sales

cost of manually operated equipment was taken from a forestry equipment catalog (Forestry Suppliers, Inc. 1973), while the unit cost of chemical materials was based on price quotations from a Roanoke, Virginia chemical distributor commonly supplying these materials to Christmas tree growers (Higgs and Young Co. 1973). The unit cost of labor is that allowed by the Virginia Division of Forestry (Commonwealth of Virginia 1971) in subsidizing landowners for forestry work done on their property. The standardized unit costs of all equipment, labor, material, and supplies used in analyzing Christmas tree production are shown in Appendix II.

With the stratification of treatments and the standardization of unit costs, the only variables left for consideration are the labor- and equipment-hour requirements, and the amount of material used by each grower practicing a particular treatment. These are taken from the Financial Questionnaire. Thus, the cost of any treatment may be expressed as:

$$Cost_i = \frac{\sum_{j=1}^{n} L_{ij}}{n} LC_i + \frac{\sum_{j=1}^{n} E_{ij}}{n} EC_i + \frac{\sum_{j=1}^{n} M_{ij}}{n} MC_i$$

where, $cost_i$ = the average cost per 1000 trees (or per acre) of the ith treatment

L_{ij} = the manhours of labor per 1000 trees (or per acre) required by the jth grower practicing the ith treatment

LC_i = the standardized labor cost of the ith treatment

n = the number of growers practicing the ith treatment

E_{ij} = the equipment hours per 1000 trees (or per acre) required by the jth grower practicing the ith treatment

EC_i = the standardized equipment cost of the ith treatment

M_{ij} = the amount of chemical material used per 1000 trees (or per acre) by the jth grower practicing the ith treatment

MC_i = the standardized material cost of the ith treatment.

The unit basis of production costs is dependent upon the treatment being implemented. The cost of some treatments tends to vary by the number of trees treated, while the costs of other treatments vary by the acreage treated. Thus, the costs of all site preparation treatments, and vegetation control by mowing has been calculated on a per acre basis; the costs of all other treatments has been calculated on a per 1000 tree basis. This is intended to provide a more accurate and useful expression of production costs than would be possible with a single basis of measure.

Fixed Costs

The fixed costs of production may or may not be considered for inclusion in the financial analysis of Christmas tree investment. The decision as to whether these costs are appropriate must be made by the individual grower upon considering his investment objectives and alternatives. If the land was not purchased specifically for Christmas tree production, or would lie idle if not producing Christmas trees, both the cost of the land and the property tax may be disregarded. However,

it is a rare situation in which an investor has no alternative uses of land, and therefore the cost of land should be included for a complete analysis.

In this study, a $200 per acre land value is assumed. This figure is entered as a cost in the first year of the production period, and its sale as a revenue in the last year of the cycle. Unless the value of the land increases as a direct result of its production of Christmas trees, the sale value used should be the same as its initial purchase value. Thus, the cost of using the land is a type of rental fee, represented by the compounded interest charge on the initial purchase.

Annual property taxes have not been included in this analysis, as its effect would be minimal. The tax may be expected to range from $0.50 to $3.00 per acre per year, while the costs of production may vary from $50.00 to $700.00 per acre per year. Therefore, the annual tax would commonly be expected to account for less than 1 percent of the annual costs. For the individual wishing to carry out a completely thorough analysis, property taxes may be included by entering the tax as an annual cost of production.

Compound Interest Costs

Compound interest costs are meant to reflect the value of time in multi-year production cycles, and represent one of the most expensive and elusive costs associated with the production of Christmas trees. Its elusiveness results from the indiscernable nature of the cost, in that a direct cash payment may not be involved; particularly if the grower uses his own finances in the investment. Nonetheless, time is

a definite input of production, and the forfeiture by the landowner of alternative investments represents an implicit or opportunity cost which must be considered in determining the economic potential of Christmas tree production investments.

In this study, a 12 percent interest rate will be used to discount future costs and revenues to a common point in time so that they may be compared on an equal basis. This rate may be thought of as the unit cost of time, and it is an arbitrary figure in that it is based as much on personal judgment as it is on specific criteria. There are those who would argue that the discounting rate should be the rate of interest charged for borrowed capital--perhaps 7 or 8 percent. Others, including Foster and Cote (1970) would maintain that a much higher rate of 25 or 30 percent should be used. However, the 12 percent compound interest rate which has been chosen is intended to reflect the potential earnings of alternative, risk-free investments, and the amount of risk involved in Christmas tree production, and it is thought to be justified.

The assumed 12 percent interest rate is used only in the calculations of present net worth and break-even price per tree. The calculation of internal rate of return is for the determination of the actual rate of interest earned on the investment, and therefore does not necessitate the assumption of a discount rate.

In order to efficiently use discounting formulas for repeated revenues and costs, it is helpful to make certain simplifying assumptions concerning the time of occurence of each cost and revenue. In the analytical calculations, it is assumed that all costs and revenues occur

on the last day of the year in which they occur. This enables the use of an annual interest rate, rather than a monthly or weekly rate, and greatly aids in the calculation procedure. This assumption will decrease the present value of costs and revenues which occur in the early part of the year, becoming less significant as the actual timing of the transaction approaches the end of the year. Hence, the present value of costs will tend to be slightly under-estimated since production costs occur throughout the year, while revenues, which occur primarily in November and December, will tend to be estimated at their true value.

Determination of Revenue

The major source of revenue in the production of Christmas trees is from the sale of trees. Some few growers receive additional income from the sale of by-products, such as wreaths and boughs. This study will consider the sale of trees to be the sole source of revenue, due to the insignificant proportion of Virginia Christmas tree growers' income derived from the sale of by-products.

The determinants of income are the number and price of trees sold. The selling price is in turn primarily determined by the species being sold and the marketing system used. In calculating income, rather than standardizing unit price from outside sources as was done with production costs, unit price will be standardized according to the average price received by Virginia growers selling a particular species using one of the five possible marketing systems.[3]

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[3] The average prices for trees, cross-referenced according to species sold and marketing system used, are shown in Tables 7 through 11, beginning on page 83.

The formula used to determine revenue may be shown algebraically as:

$$\text{Revenue}_{ij} = \frac{\sum_{k=1}^{n} P_{ijk}}{n} \quad 1000$$

where, Revenue_{ij} = the average revenue received per 1000 trees from the sale of the ith species using the jth marketing system.

P_{ijk} = the price of the ith species sold using the jth marketing system by the kth grower

n = the number of growers selling the ith species using the jth marketing system

Methods of Analysis

The cost and revenue formulas which have been presented are useful in comparing various production, harvesting, and marketing alternatives, but they provide little insight into the economic expectations of the investment, or whether a particular operation is financially justified. In order to evaluate the economic aspects of long-term investments it is necessary to view all costs and revenues from the same point in time. This is done by the use of compound interest, although the procedure is somewhat computationally tedious. To eliminate this problem, a computer program was developed which, given a set of input data, will perform all of the calculations needed for the economic analysis.

Although there is but one underlying concept in the use of compound interest, there are many variations in the approach taken and formula used, depending on the investor's financial objectives. Three methods will be used in this study to analyze the economic aspects of Christmas

tree production. Each provides a slightly different view of the potential of the investment. Present net worth (PNW) determines the amount by which an investor's assets will be increased or decreased by the investment; internal rate of return (IRR) establishes the average rate of growth of invested capital; and, break-even price per tree (BPT) represents the minimum price the grower must receive for discounted costs to exactly cancel discounted revenues.

Present Net Worth

The meaning of present net worth is essentially the same as the meaning of net profit, except that "profit" implies the annual difference between costs and revenues, while present net worth refers to the present value of all future profits. In this context, profit is applicable to firms with yearly production periods, while present net worth is of interest to firms with multi-year production cycles (Bentley and Teeguarden 1965).

The following formula is used in this study to calculate present net worth:

$$PNW = \sum_{t=0}^{r} \frac{R_t - C_t}{(1+i)^t}$$

where, R_t = the revenue received in year t

C_t = the cost encountered in year t

i = the compound interest rate

r = the length of the production cycle in years

t = the year in which income is received or cost is incurred

In this formula, net annual cash flow is first calculated for each year of the production cycle. These are then individually discounted to the first year of the production period. Present net worth is then expressed as the summation of the present value of the various net annual cash flows.

Interpretation of present net worth is fairly simple. A negative present net worth indicates that discounted costs are greater than discounted revenues; and, if the discount rate used is the rate of return promised by an alternative investment, investment should be made in the alternative rather than in Christmas trees. Similarly, a positive present net worth indicates that investment in Christmas trees is more financially attractive than the alternative investment. A zero present net worth results if the rate of interest earned on Christmas trees exactly equals the alternative rate of return, in which case the investor would be financially indifferent toward the two investments.

Internal Rate of Return

The internal rate of return approach establishes the rate of growth of an investment. This is done in this study by determining, through trial and error, the compound interest rate which equates discounted costs to discounted revenues.

The formula for internal rate of return is:

$$\sum_{t=0}^{r} \frac{R_t}{(1+i)^t} = \sum_{t=0}^{r} \frac{C_t}{(1+i)^t}$$

where, R_t = the revenue received in year t.

C_t = the cost incurred in year t

t = the year in which income is received or cost is incurred

r = the length of the production cycle in years

i = the compound interest rate, for which the equation is solved. IRR equals the value of i for which this formula is true.

The advantage of this method of analysis is that it eliminates the need for establishing an arbitrary discount rate, or alternative rate of return. If the yearly revenue and cost data can be supplied, this procedure will calculate the growth rate of the invested capital. A comparison between this rate and the rate promised by other alternatives can then be made to determine which is the most attractive. For example, if using this procedure the internal rate of return from Christmas tree investment is calculated to be 20 percent, and it is found that the best alternative investment offers 6 percent, the investor would no doubt choose to invest in Christmas trees.

If the internal rate of return of an investment equals the discount rate, then the present net worth must be zero. However, if the internal rate is greater than the discount rate, the present net worth must be positive. This implies that the investor will continue to invest his capital into Christmas trees since his rate of return is higher from this investment. Therefore, largely the same conclusions concerning investment potential will be reached regardless if the criterion is internal rate of return or present net worth.

Break-even Price Per Tree

The break-even price per tree calculation is essentially the same as present net worth, except that revenue is divided into price per unit and number of units sold, and solved for price. Thus, the price calculated will be the one needed to make present net worth zero, given the number of trees sold. Alternatively, it is the price needed per tree in order to obtain the chosen interest rate as a percent return on the investment (IRR).

The general formula for break-even price is:

$$BPT_r = \frac{1}{Q_r} \sum_{t=0}^{r} C_t \, (1 + i)^{r - t}$$

where, BPT_r = price required for trees sold in year r for discounted revenues to exactly cancel discounted costs

Q_r = the number of trees sold in year r

C_t = the cost encountered in year t.

r = year in which trees are sold

i = the compound interest rate

t = year in which cost is incurred

However, this formula cannot easily accommodate the grower selling t rees from a given stand over a period of two or more years. In such a situation only the costs of producing the trees which are sold in a given year should be used to determine the price. Otherwise, the calculated break-even price for trees sold the first year would be prohibitively high, while the break-even price for trees sold in succeeding years would be zero. To allow for this possible variation, the following formula for break-even price will be used:

$$BPT_t = \frac{1}{Q_r} \sum_{t=0}^{r} P_t C_t (1 + i)^{r - t}$$

where, P_t = the number of trees to be sold in year r dividied by the number of trees in the stand in year t. This number is calculated internally by the computer program, and will always be greater than zero but less than or equal to one.

This formula allows for a prorating of costs directly proportional to the number of trees sold. Using this analysis, it is possible to evaluate the effect of staggering the harvest, and determine the optimum number of trees to offer for sale each year by maximizing the difference between expected price and break-even price.

PRODUCTION OF CHRISTMAS TREES IN VIRGINIA

The production of Christmas trees is a relatively new industry in Virginia, particularly when one considers the time span between the initiation of production and marketing the product. Over 40 percent of the 67 Christmas tree plantations identified in the state have been established since 1966, and have yet to produce a crop of 100 trees. Thus, the industry is still in its infancy, with many growers lacking experience in the total production process. This inexperience, though unavoidable, has hindered plantation management. Through conversations with other growers, common pitfalls may be avoided. However, many novice growers have expressed problems in determining how and when to market their trees, securing adequate labor, and in selecting quality planting stock.

The majority of plantations have been established with the intention that the landowner and his family would provide virtually all labor for the operation. Therefore, plantations tend to be small. Including all planting through the 1972 planting season, a total of 13 acres per grower have been planted with Christmas trees.[4] This figure may seem exceedingly low, unless viewed from the standpoint of a grower.

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[4] This figure should not be regarded as an average plantation size because it includes land which has been harvested, and therefore, planted more than one time. Thus, average plantation size is somewhat less than 13 acres.

The typical Christmas tree grower relies on his plantation only as a secondary source of income, and may consider it nothing more than a potentially profitable hobby. An absentee landowner may be limited to working on his plantation solely on weekends and holidays. The seasonality of the work aids a grower in this situation. However, when certain critically-timed operations, such as shearing or harvesting, can not be deferred, the grower is forced to take a leave from his primary occupation, or to secure enough labor to complete the task in one or several weekends. Thus, though plantation size is small, it is as would be expected upon considering the owners' investment objectives.

The Production Process

The production of Christmas trees is characterized by intensive management operations implemented over a production cycle commonly ranging from six to fifteen years. In this report, Christmas tree production combines the aspects of agricultural production, in its labor- and/or capital-intensity, and of forest production, in its need for multi-year production cycles.

There are four main functions to be performed in growing and selling Christmas trees--stand establishment, stand improvement, harvesting, and marketing. Only the first two of these will be considered here, with a discussion of harvesting and marketing being given in Chapter IV. Appropriate to each function are various operations which the grower may or may not decide to implement.

The operations included in the category of stand establishment are site preparation, planting, and replanting. Site preparation, if practiced, will be the first operation implemented by a Christmas tree

grower, generally done one week to a year before planting. It is intended to improve the planting site for the seedlings, thus reducing the mortality, and also to facilitate planting. The planting operation, almost always implemented in the spring, consists of introducing seedlings to a previously unplanted area, or replacing seedlings on an area following the complete harvest or mortality of a previous stand.

There are two types of replanting a grower may practice. Replanting following mortality is designed to replace trees which have died prior to harvest, and is commonly carried out in the first two springs following the initial planting. Replanting following a harvest is used to replace trees removed in a partial harvest. It may be implemented any time, following perhaps the sixth or seventh year of the production cycle.

The stand improvement operations are intended to improve the quality and quantity of marketable trees. Included in this category are the shearing, pruning, fertilization, vegetation and insect control, and artificial coloring operations. Shearing and vegetation control are generally practiced each year of the rotation, while the other operations are used only if, and as, the need arises. Due to the repetitive use of these operations, the majority of costs involved in the production of Christmas trees will be charged to stand improvements.

The Christmas tree grower is faced with many alternatives to be considered in deciding how, when, and if a particular operation should be implemented. The remainder of this chapter is devoted to a discussion of the application methods, costs, and timings of the various production operations which may be considered for use by Virginia Christmas tree producers.

Stand Establishment Operations

Although there are only three operations (site preparation, planting, and replanting) included in the stand establishment, each operation may be carried out in several ways. Each of these alternative procedures is termed a "treatment". This additional distinction allows for more specific reference to a particular operation. Thus, in general, one refers to the site preparation, planting, or replanting operations; however, when referring specifically to the planting operation, for example, it may be more meaningful to speak in terms of hand planting or machine planting, which are the possible treatments appropriate to the planting operation.

Within a given operation, the various treatments may be substitutes for one another, and a grower selects the one most suitable to his situation. For this reason, each treatment in an operation is first described individually, and then compared in terms of effectiveness, requirements, and costs to the other treatments. It is hoped that this method of presentation will aid the grower in setting his management practices.

Site Preparation

Site preparation is one of the most variable operations practiced by Virginia growers in terms of the number and combinations of treatments applied. Twenty-five of the interviewed growers (68 percent) have in the last two years prepared the site prior to planting. Information from these growers indicates there are four primary treatments which may be used. These include the clearing of a wooded or brush-covered

area, the cultivation of an open field, the mowing of a weed-infested area, and the selective use of herbicide to control undesirable vegetation. An individual grower may find it necessary to use two of these treatments jointly to adequately prepare the site for planting.

Clearing

The clearing of an area of brush and timber is the most costly site preparation treatment a Christmas tree grower can practice, and generally involves the use of large crawler-type tractors. Five growers have cleared sites in the last two years, with two of them using equipment in the D-6 Catepillar class, two using the smaller D-4 class, and one grower using both classes.

On the average, land is cleared 33 weeks before planting, which would place its occurrence in the late summer before a spring planting. The average time required to complete clearing was 6.03 hours per acre with a D-6 and 10.00 hours per acre with a D-4.

In no case was the equipment used owned by the landowner. Therefore, the equipment rate used in determining the cost of clearing is that used by the Virginia Division of Forestry (Commonwealth of Virginia 1971) when subsidizing landowners for forestry work done on their property. Their list indicates that a landowner may rent a D-6 crawler tractor with an operator for $18.00 per hour, and a D-4 with operator may be rented for $14.00 per hour. Thus, the average cost of clearing is $108.54 per acre when done with a D-6 size tractor, and $140.00 per acre when done with a D-4 size tractor.

Clearing by itself is generally an incomplete method of site preparation. Of the five growers recently using this treatment, two had to supplement it by cultivating the cleared area two to four weeks before planting, and one grower found it necessary to first apply herbicide four weeks prior to the clearing. Based on these figures, the grower contemplating the clearing of an area should expect additional measures other than clearing will be needed to prepare the site for planting.

Cultivation

Cultivation prior to planting was carried out by seven growers (19 percent) in the last two years. The intensity of cultivation varied with the individual area being treated, and consisted of various combinations of ploughing, disking, dragging, and sub-soiling. Few growers used the same combinations of treatments. In all but one case the cultivation was done in the spring, at an average of 3 weeks before planting; one grower ploughed his planting site one year before planting.

Table 2 summarizes the costs, labor hour, and equipment hour requirements of the variations in cultivation. Equipment rates are based on the usage of a 30 horsepower tractor, a two-bottom plough, an eight-foot lift type disk, and a chisel plough-subsoiler, which were the most common equipment types used. Each column entry may be added to another entry in that column to obtain information on combinations of treatments. That is, if ploughing and disking are to be used jointly, the grower may expect to use 7.08 manhours per acre (3.84 + 3.24) at a total cost of $80.55 per acre ($3.39 + $37.16).

Table 3. Costs of cultivation treatments used in preparing Christmas tree planting sites.

Type of Treatment	Equipment Hours per Acre	Equipment[a] Cost per Hour	Labor Hours per Acre	Labor[b] Cost per Hour	Total Cost per Acre
Ploughing	3.84	$7.80	3.84	$3.50	$43.39
Disking	3.24	7.97	3.24	3.50	37.16
Dragging	1.55	7.97	1.55	3.50	17.78
Sub-soiling	4.50	7.44	4.50	3.50	49.23

[a] Source: E. S. Smith and J. D. Oliver, "Farm machinery performance and costs", 1972. See Table I, Appendix II for a detailed listing of equipment costs.

[b] Source: Virginia Division of Forestry, "Rates suggested as guidelines for work completed by private contractors, and/or landowners for reforestation of timberlands projects", 1971.

Cultivation is the most complete form of site preparation. In the last two years it has been using only in connection with clearing, and then to improve the effects of the clearing operation. None of the seven growers used additional methods to improve the site following cultivation. Five growers used cultivation as the sole method of site preparation.

Mowing

Mowing as a site preparation treatment involves the cutting down of all grasses and weeds on an area to be planted. This is distinguished from mowing done in the years following stand establishment, which is carried out only in the corridors between the trees. Also, on the average, the equipment used for site preparation mowing is larger than that used in later mowing, since operating space is not a limitation in site preparation.

Mowing is the most common type of site preparation, with 13 growers (35 percent) having practiced it in the past two years. Eight growers use a 30 to 40 horsepower tractor and a brush mower; and, five growers use a smaller riding mower, ranging in size from 7 to 12 horsepower. Treatment timing is equally divided for both sides of equipment between that done immediately before planting and that done in the fall preceding planting. There are no apparent advantages to either of the timings.

The grower mowing his planting site with a farm tractor and mower used an average of 0.91 machine hours and 1.03 manhours per acre to complete the job. Applying the appropriate machine rates and a labor

charge of $3.50 per hour results in a total cost of $10.23 per acre. The average grower using a 12 horsepower tractor required 5.5 machine hours and 7.1 manhours to mow an acre, at a cost of $28.28 per acre. More labor hours than machine hours are needed apparently because the operator had to remove certain debris from the area before mowing.

Although the cost of site preparation mowing is more than twice as costly when done with a small tractor, other factors may be of importance when considering the equipment to be used. If, for example, the grower is contemplating the purchase of a tractor, he may find the smaller tractor to be of more over-all usefulness to him in the management of his plantation. Use of a large farm tractor will in most cases be restricted to the early years of plantation development, before trees begin to grow outward and equipment manuverability becomes an essential consideration. Also of importance in selecting equipment is the availability of labor. In general, as in the case of mowing, as capital intensity increases, labor intensity decreases, and vice versa. The use of small equipment may, therefore be limited to those growers having a surplus of available labor.

Mowing is a fairly complete method of site preparation. It has been used in connection with herbicide treatments by four growers in the last two years. However, 9 growers felt that mowing by itself adequately prepared the site for planting.

Chemical treatment

Chemicals used for vegetation control in site preparation are generally applied in strips or small circular plots where the seedlings

will be placed, rather than broadcast over large areas. Many different brand name chemicals are used by the different growers, the most common being Simazine (2-chloro-4,6-bis (ethyl-amino)-5-triazine), and 2,4,5-T(2,4,5-trichlorophenoxy-acetic acid). Most growers, however, apply the chemical with one of two types of equipment. Three growers have used 30 to 40 horsepower tractors with 50 to 100 gallon pressure sprayers, while five growers in the last two years used manually operated backpack sprayers or small lawn spreaders.

Herbicides are applied at various times depending on the type of vegetation to be controlled and the chemical used. It is recommended (Dept. of Plant Pathology and Physiology 1969) that treatment be made in the late summer or early fall to control perrenial grasses or low-growing shrubs, such as blackberries or dewberries. Control of other types of vegetation may be made in either the fall or spring before planting. Following the application directions supplied with the herbicide, five growers treated the site in the spring at an average of 5 weeks before planting, while three growers applied the herbicide in the preceding fall, 23 weeks before planting.

The cost of herbicide treatment depends on the method of application and type of chemical used. The most common chemical applied with a tractor and power sprayer was 2,4,5-T, at a rate of 0.75 gallons per acre, and a cost of $16.00 per gallon.[5] Treatment time required .92

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[5]The cost of this and other chemicals used by Virginia Christmas tree growers is based on the selling price quoted from a Roanoke, Va. chemical distributor. See Appendix II for a complete listing of these costs.

machine hours and .92 manhours per acre. The average total cost per acre of chemical treatment with power applicator was $20.63.

Simazine was used most often with a hand applicator, at a recommended rate (Dept. of Plant Pathology and Physiology 1969) of 3 pounds per acre. The landowner typically used his own labor, treating one acre in 5.5 hours. The total cost per acre was $24.90.

When herbicides and mowing were used together in site preparation, in most cases the area was mowed in the fall and then treated with herbicide immediately before planting. However, one grower carried out both treatments at the same time, one week before planting. The particular timing scheme used should be determined after consulting an extension specialist or the suggested application methods attached to the chemical container; and may vary with the particular chemical used.

Planting

Planting is perhaps the most critical operation carried out by the Christmas tree grower, for it directly influences the liberty with which subsequent management decisions may be made. Prior to the actual planting, a grower must select a spacing or density which will allow, as the trees grow in size, ample space to operate equipment without damaging the trees. At the same time, trees must be close enough together to make efficient use of the area. The grower must select a species to be planted, giving consideration to future consumer preferences, and match the biological and cultural requirements of the several species to the resources available to him. A reliable source of seedlings must be found to insure planting stock with desirable traits; such as, color, growth rate, resistance to insects and disease, and so forth.

Results from the Financial Questionnaire show that 26 (70 percent) of the 37 Christmas tree growers interviewed have planted trees in the last two years. Eight of these growers made their last planting in 1972 and planted an average of 8750 trees per grower. The average spacing used in 1972 was 5.6 feet by 5.6 feet, or 1389 trees per acre. Thus, in 1972, the typical interviewed grower planted 6.30 acres in Christmas trees. There was a significant drop in the number of trees planted in 1973, although the number of growers planting increased to eighteen. In 1973, the average number of trees planted was 3841 per grower, while the number of acres planted per grower was 2.86, at an average density of 1342 trees per acre. These results indicate a downward trend in annual planting acreage, which is verified by responses to the Christmas Tree Growers Questionnaire.

Growers planting in the last two years have utilized both machine and hand planters, although hand planting is far more popular, accounting for over 70 percent of the planting. Scotch pine and eastern white pine are the most widely planted Christmas tree species in Virginia. In 1973, 40 percent of the Christmas trees planted were Scotch pine, while 32 percent were eastern white pine. The remainder of trees were primarily Fraser fir, Douglas-fir, Norway spruce, and red pine, in descending order, none of which individually accounted for over 7 percent of the 1973 plantings.

Mechanical planting

The typical mechanical planting crew in 1972 and 1973 consisted of a tractor operator, a laborer feeding seedlings into the planter, and the landowner following the planter, resetting and straightening the seedlings.

The crew spent an average of 7.14 manhours planting 1000 trees. At an average wage rate of $2.95, the cost of this crew was $20.71 per 1000 trees planted.

Various types of equipment were used in planting, ranging from a D-8 catepillar and three-point planter to a 30 horsepower tractor and a home-made planter. The average equipment time required to plant 1000 trees was 2.73 hours. Assuming usage of a 30 horsepower tractor and a wildland-type planter, average total machine cost per 1000 trees was $20.31.

The average cost of seedlings for machine planting was somewhat higher than the cost of seedlings hand planted. It is not known if this is a result of the landowners' intent, or if it is merely a result of poor averaging. For illustrative purposes, the cost of seedlings for both types of planting will be taken as $32.10 per 1000 trees, which is the average cost for all growers planting in the last two years. Many growers indicated that they were aware that lower priced trees could be obtained, but felt that the additional quality gained justified the more expensive seedlings. The majority of seedlings were purchased from independent nurseries in Pennsylvania.

The total average cost of planting was $73.12 per 1000 trees. The survival rate for these seedlings averaged 75.22 percent, ranging from a low of 40 to a high of 95 percent survival.

Hand planting

Hand planting crews were commonly made up of the landowner and two common laborers. The twenty growers hand planting in the last two years

spent an average of 21.49 manhours, at a cost of $53.72, in planting 1000 trees. Most growers exercise great care in planting to insure that seedlings are properly set and that spacing is uniform. This care is partially rewarded by a 5 percent higher average survival rate (81.06 percent).

The cost of equipment for hand planting is rather insignificant. The majority of growers use planting bars, which cost approximately $7.00 each. It would not be unrealistic to assume the useful life of this tool to be ten or fifteen years. Therefore, the cost of the planting tool is not included here, although it has been used in the economic analysis given in Chapter V. The cost of hand planting is therefore given by the cost of labor and of seedlings. In the last two years this averaged $85.82 per 1000 trees.

A comparison of planting and site preparation treatments

Due to unaccounted for differences in site quality, it is difficult to compare the effectiveness of each of the site preparation treatments. However, by cross-classifying survival rates attained by the type of site preparation and planting used, the average survival rate may be used as a general indication of the results which may be expected for a particular set of treatments. Table 3 summarizes the average survival rates attained by four of the most common site preparation treatments according to the type of planting done.

Of interest in this table are the relative values, and not so much the absolute figures shown. It is somewhat surprising to note that the highest survival with hand planting was achieved when no site preparation

Table 4. Average survival rates attained by machine and hand planting using selected site preparation treatments.

Type of site Preparation	Average survival rate attained by hand planting	Average survival rate attained by machine planting	Weighted average survival rate attained
Mowing	74.00%	60.00%	70.00%
Cultivation	82.33	80.00	81.20
Mowing and Herbicide	83.75	87.50	85.00
Clearing and Cultivation	65.00	81.00	71.40
No Treatment	90.25	62.50	81.00
Weighted Average survival rate attained	81.06	75.22	79.04

was made, thus indicating that site preparation is certainly not required in all cases. General recommendations on the combination of site preparation treatments and planting methods can be made based on these average values. It appears that the grower using cultivation or mowing treatments should hand plant his trees in order to realize the highest survival rate. In the cases of joint mowing and herbicide, and clearing and cultivation treatments the data would suggest that survival rates will be higher with machine planting rather than hand planting.

The two types of planting can be effectively compared both from a labor requirement standpoint and a financial standpoint. Although it may appear that mechanical planting holds an advantage in both areas, the average 5.84 percent higher survival rate attained by hand planting is of significance. With this higher survival rate, the grower planting by hand has an average of 77 more trees per acre (5.7 feet by 5.7 feet spacing) at the end of the rotation. Applying an average selling price per tree of $4.38 (Christmas Tree Growers Questionnaire), and discounting this eight years at 12 percent interest to the beginning of the production cycle, results in a marginal revenue received by hand planting of $136.21. The marginal cost of hand planting as compared to machine planting is $12.70 ($85.82 minus $73.12). Thus, the grower may expect to receive a marginal present value profit of $123.51 by hand planting. A secondary financial benefit of hand planting which cannot be quantified is the uniform spacing achieved from hand planting, which aids in the ease and speed with which future work in the plantation may be done, particularly when this work involves the use of cumbersome equipment.

Mechanical planting is most advantageous to those growers with a limited source of labor, as it requires one-third the labor time of hand planting, and to those growers with large areas to be planted. However, from a management standpoint it may be concluded that mechanical planting should be used only if the landowner is severely limited in the amount of time that can be devoted to planting, or if the grower has used joint mowing and herbicide or clearing and cultivation site preparation treatments.

Replanting

As previously stated, there are two types of replanting a grower may practice; however, they are not substitutes for one another and will not be considered as such. Replanting following mortality is intended to supplement the initial planting operation by replacing those trees which die soon after planting. Replanting following a partial harvest may act as a substitute for planting, especially if the grower is limited in the amount of land that can be included in the plantation.

Replanting following mortality

Twenty-six (70 percent) of the 37 interviewed growers have replanted following mortality in the last two years. Several growers with small, intensive operations replant a given stand each year in which mortality occurs, attempting to maintain a completely stocked plantation. This has the effect of generating an uneven-aged stand comprised of trees varying in age from those just planted to those approaching marketability.

Many growers felt that cultural and harvesting operations would be hampered while working in uneven-aged stands and that management would need to be directed more toward individual trees. Therefore, yearly replanting following mortality is not a common practice, and this study has considered only that replanting done in the first two years following the initial planting.

The majority of growers concentrate their replanting effort in the first year following planting. In 1972 and 1973, 21 growers replanted an average of 382 trees per acre one year after the initial planting. For these same years, 14 growers replanted an average of 274 trees per acre two years after planting.

For unknown reasons, replanting in the first year requires considerably more time than replanting in the second year. Average labor time to replant 1000 trees one year after the initial planting was 19.90 manhours, while that required in the second year following planting was 12.10 manhours. Applying a wage rate of $2.50 and the average cost of seedlings of $32.10, results in a total average cost per 1000 trees replanted of $81.85 one year after planting and $62.35 two years following planting. In all cases hand tools were used in replanting, and the cost of these tools is not considered here.

Replanting following a partial harvest

Replanting following a harvest is generally carried out by those growers wanting each acre to produce the maximum number of trees possible, and by those growers unable to include additional acreage in their plantations. It is not a common practice, being carried out by five

growers (14 percent) in the last two years, since it causes the same previously discussed problems concerning uneven-aged management. An indication of the severity of uneven-aged management problems is given by the data, which shows that growers with uneven-aged stands spent an additional 50 percent more labor time shearing and harvesting 1000 trees than did those growers with even-aged plantations.

The average number of trees replanted following a partial harvest was 371 per acre, varying from a high of 714 to a low of 52 trees per acre. The average labor time required to replant 1000 trees was 29.98 manhours. Adding to this the cost of seedlings and a $2.50 wage rate results in a total cost of replanting following a partial harvest of $107.05. This is substantially higher than the cost of initial planting. When this increased planting cost is added to the higher labor costs resulting from uneven-aged management it is seriously doubted that replanting following a harvest can be financially justified. Without further quantifying the comparative costs and benefits, it appears that even the grower with limited land area should, from a financial standpoint, forego replanting following a partial harvest in favor of initial plantings.

Stand Improvement Operations

The operations included in the category of stand improvements are those implemented to improve the quality and vigor of the existing stand. Several of these operations are in common use by Virginia producers while others are used infrequently. If the six types of stand improvement are ranked by the percentage of Virginia growers using each type its found that

shearing is considered to be the most important with 62 growers (92 percent) having sheared their trees at least once. This is followed by control of vegetation competition (80 percent), pruning (70 percent), control of insects (36 percent), fertilization (20 percent), and artificial coloring (9 percent).

Table 4 contains the answers given by growers responding to the Christmas Tree Growers Questionnaire as to why trees in their plantations are never sold and must be removed before re-establishing the stand. A comparison of the rankings given above and the responses shown in Table 4 leads to several apparent discrepancies.

Clearly, the most prevalent causes of not being able to market certain trees are the result of insect and disease attack, insufficient shearing, and poor tree color, in descending order. This would appear to contradict the ordering of the importance of each cultural operation according to its use and popularity, since remedies to control insects and tree color are among the least exercised. A number of factors could be considered in explaining this paradox. It is possible that Christmas tree growers are, either through misinformation or mismanagement, incorrectly evaluating the importance of certain stand improvements. However, it is equally possible that each grower, limited in available labor time, must carry out those operations which will net the highest number of marketable trees, and to limit one in favor of another may actually reduce the number and value of salable trees. Judging from the large percentage of growers not responding to the question, implying no problem is encountered by them in selling their trees, it

Table 5. Major reasons for the nonmarketability of Christmas trees

Response	Percentage of growers listing this as the most important reason	Percentage of growers listing this as the second most important reason	Percentage of growers listing this as the third most important reason
Poor shape due to insect or disease attack	19.40	8.96	5.97
Poor shpae due to lack of time to shear	17.91	5.97	0
Poor color of trees	5.97	4.48	5.97
Poor shape due to fire damage	0	1.49	0
Other reasons, including: crowding of trees inferior genetic traits animal browsing snow damage	10.45	4.48	2.98
Lack of buyers	5.97	1.49	0
No response given	40.30	73.13	85.07

appears that the latter explanation is the more correct, and that the majority of growers do implement the proper improvement operations.

With this background in mind, a discussion of each type of stand improvement is given, based on the responses obtained from the Financial Questionnaire. The presentation will be similar to that used in discussing the stand establishment operations, with comparisons between different operations and treatments being given where appropriate.

Shearing

Shearing, as defined in the Financial Questionnaire, is the cutting of the ends of branches and the terminal leader. Its purpose is to reduce the outward growth of the tree, thus increasing the density of the tree, and to give the tree a symmetrical, tappered appearance.

A Christmas tree will grow relatively little above ground in the first several years following planting, while a root system is being developed and the tree becomes established in the plantation. In perhaps the second or third year the tree will begin to grow much more rapidly, with the terminal leader growing as much as 15 to 24 inches in a single growing season. If left unchecked, this type of growth would result in a spindly tree with sparse foliage and low value. Shearing thus increases the value of the tree and the number of merchantable trees.

Shearing is usually performed in the second through eighth years after the initial planting, although a tree may be sheared each year, following the second year, until it is harvested. It is recommended (Bell and White 1966) that pines be sheared in the late spring or early summer after the new growth has completed its elongation and before it

hardens to woody tissue. There is at this time a period of about ten days when conditions are ideal for shearing, although the occurrence of this period will vary from one area to another. Spruces and firs may be sheared at any time of the year, although shearing during the dormant season may prove less detrimental to the trees. Virginia producers largely conform to these recommendations, with the majority of shearing being done in the month of June. Those growers having both pines and spruces and firs in their plantations may shear the spruces and firs in the winter, although for efficiency all shearing is generally done in the summer.

One of two types of equipment is usually used to shear trees--hand shears and shearing knives. Hand shears may be purchased for $8.25, and shearing knives for $9.00: this cost has not been included in the cost figures given in this section although they are in the economic analysis in Chapter V. In addition to these tools, two growers have used electric shears on an experimental basis. Due to the small sample size, the use of electric shears will not be discussed; available data indicate the time required to shear with electric shears is approximately equal to that required with shearing knives.

The time required to shear various sizes of trees with the two types of tools is shown in Table 5. As may be seen, shearing with knives tends to be faster than when done with hand shears. However, knives are less accurate than shears, and also pose more of a safety hazard to unskilled labor. The time required to shear, regardless of equipment used, varies directly with tree size. This increasing labor time is reflective of both the increased size of the trees and the extra care which must be taken when shearing trees that are nearing the merchantable age.

Table 6. Manhours required to shear 1000 trees of varying size by type of tool used

Height of tree	Manhours required when sheared with hand shears	Manhours required when sheared with shearing knives
under 3 feet	16.43	18.48
3 to 5 feet	25.68	20.75
over 5 feet	33.15	23.67

The type of equipment chosen to shear seems at least somewhat dependent upon the number of trees the grower must shear. In 1972 and 1973, 21 growers sheared an average of 1091 trees per acre with hand shears, while 9 growers used shearing knives and treated an average of 1214 trees per acre. Thus, it seems that if a grower has many trees to shear he will use the faster shearing knives. If a relatively few trees must be sheared, the slower, more accurate hand shears may be used.

Applying a wage rate of $2.50 for the shearing crew results in an average cost of shearing 1000 trees of $64.20 when done with hand shears and $51.88 when done with knives.

Pruning

Pruning was defined in the Financial Questionnaire as the complete removal of a branch. Branches are typically removed from the base of the tree to form a handle which facilitates mounting. Also, deformed or infected branches may be removed to improve tree vigor, and multiple leaders removed to improve the appearance and shape of the tree.

Many growers interviewed (24 percent) failed to distinguish between shearing and pruning, and stated that both operations were implemented simultaneously. When this is done, the labor time required is much less than if each operation is carried out separately. This is apparently due to the general efficiency achieved in combining tasks. Specifically, with regard to shearing and pruning, it means that a laborer need only walk to a given tree once, whereas otherwise he must walk to a tree to shear it and walk back to the tree again to prune it. Combining the two operations thus eliminates much of the time wasted in going from tree to tree.

The average time required to prune and shear 1000 trees under 3 feet tall was 23.40 manhours, while 29.07 manhours were required to prune and shear 1000 trees 3 to 5 feet tall. Both of these times are significantly more than the average time needed just to shear 1000 trees of these sizes. However, the time to prune and shear 1000 trees over 5 feet tall was 33.59 manhours, which is for all practical purposes the same as the labor needed to shear 1000 trees with hand shears. This apparently indicates that the pruning operation is completed by the time the trees reach this size, and is verified by those growers pruning separately.

Over one-half (53 percent) of the 15 growers who prune separately indicated that pruning was done only as it is needed, and were not able to identify any particular timing sequence. The remaining growers tended to prune during the second through fifth years following planting.

No attempt was made to determine variations in pruning time due to tree size. The average time spent pruning 1000 trees was 15.73 manhours. At an average wage rate of $2.50, the total cost required to prune 1000 trees averaged $39.32.

Vegetation Control

The control of vegetation is important to the Christmas tree grower for several reasons. Weeds compete with the trees for moisture and nutrients, and their presence thus hinders the growth of the trees. Also, weeds may choke young trees, resulting in a poorly formed, unmerchantable Christmas tree. A dense growth of weeds may also slow the rate at which a worker may move through the plantation, thereby increasing

the labor costs of cultural and harvesting operations. Finally, of importance to the grower selling his trees directly to the consumer, is the appearance the undesirable vegetation gives to his plantation. Therefore, controlling weeds is an important operation to the Christmas tree grower from the time of planting to the time of harvest.

Thirty-four (92 percent) of the interviewed growers practice some type of vegetation control. Mowing is by far the most popular type of control, followed by combined mowing and herbicide treatments. Only three growers completing the Financial Questionnaire used herbicides alone to control weeds.

Weed control by mowing

Growers use various types of equipment in mowing their plantations, depending upon the size of the operation and the spacing between trees. The size of the mower used varies from one pulled behind a 30 horsepower tractor to a 2 horsepower lawnmower.

The most common type of mower used is a 10 to 15 horsepower horticultural tractor with a mounted retary or sickle blade. Fifteen growers using this type of mower average four mowings per year. Each mowing required an average of 1.84 manhours per acre. Including labor and machine rates, this generates an average cost of $7.86 per acre per treatment.

Twelve growers use a smaller 5 to 8 horsepower tractor in mowing their plantations. The use of this smaller tractor increases the time required to mow an acre to an average of 2.35 manhours. The average

cost per acre of this mowing is $11.03 per treatment. Growers using this type of mower, however, generally mowed their plantations but three times per year. This difference in the yearly number of treatments carried out is probably the result of differing site requirements--some areas needing to be mowed more than others. There appears to be no relationship between the number of yearly mowings required and the type of equipment used.

A surprisingly large number of growers, 6 of the 37 interviewed, use lawnmowers. This indicates either a very small operation, a great deal of available labor, or a low capital base. These growers typically mowed their plantations three times per year, requiring an average of 3.22 manhours per acre. The average cost of such mowings, including labor and equipment, is $13.68.

The final type of mowing equipment, used by 4 growers, is a 30 to 40 horsepower farm tractor and brush mower. The growers using this equipment generally mow a given area only two times per year. The time required to mow an acre with this equipment, 1.25 manhours, is less than any other type; however, the higher machine rates make this type of treatment more expensive than when mowing is done with either of the two types of horticultural tractors. The average cost of mowing with a farm tractor was $11.60 per acre.

In deciding on the type of equipment to be used in mowing, the grower should consider at least two factors. The first of these is the size of the equipment to be used. In general, the larger the equipment used, the less time required to complete the job. This of course depends

on the individual plantation being considered. If, for example, a 60-inch strip between trees must be mowed, mowing with a 36-inch cut mower may require no more time than a 48-inch cut mower, as two passes will have to be made regardless of which type mower is used. Judgment on equipment size may then be made without considering labor time involved, as this will not be affected by the decision. In this situation the decision should be made primarily on the initial cost and operating cost of the alternative equipment types.

A second factor to be considered in selecting a mower is the ease with which it operates between tree rows. It should be expected that the less manuverable, larger mowers will be more difficult to handle in close quarters, and may result in a significant amount of damage to the crop. Many growers have found it necessary to change to the smaller mowers after trees grow upward and outward.

Therefore, the size mower selected should be determined by the amount of time the grower can devote to the mowing operation, and by the space within which the mower must be operated. The grower may find it necessary to have two sizes of mowers--one large mower to be used when trees are small, and another smaller mower to be used when trees become larger and the space between rows narrows.

Weed control by the use of herbicides

Fifteen growers (40 percent) completing the Financial Questionnaire have used some type of herbicide treatment to control undesirable vegetation in their plantations in the last two years. Three of these used

herbicides exclusively for weed control, while twelve growers used some combination of mowing and herbicide. In general, when mowing and herbicides are used jointly, the herbicide is used to treat the area immediately around the trees where it is difficult to mow, and on vegetation which is difficult to control by mowing, such as vines or briar bushes.

In 1972 and 1973, Simazine was the most common type of herbicide used, followed by 2,4-D, 2,4,5-T, and Princep. Methods of applying the chemical included eight growers using hand applicators, three growers using horticultural tractors and pressure sprayers, and four growers using a farm tractor and pressure sprayer. Costs of the three methods of application were very similar, differing largely as a result of the various amounts and types of chemical used.

The average time required to treat 1000 trees when applying the herbicide by hand was 2.31 manhours, for an average labor cost of $6.93 per 1000 trees. Growers in this category applied an average of 3.3 pounds of Simazine per 1000 trees, resulting in a total cost of $16.17 to control the vegetation in a 1000 tree area.

Labor time for the mechanized application was much less, averaging .81 hours to treat 1000 trees with the horticultural tractor and pressure sprayer. Application rates averaged 3.5 pounds of Simazine per 1000 trees, at a total cost of $12.23 per 1000 trees.

Application with the 30 horsepower tractor required still less time, averaging .74 manhours per 1000 trees. Typically, Simazine was applied at 3.2 pounds per acre, bringing the total cost of this treatment to $11.18 per 1000 trees treated.

Fertilization

Fertilization is understandably one of the least practiced operations on Virginia Christmas tree plantations. It has been carried out by ten (27 percent) of the interviewed growers in the last two years.

Fertilizers are customarily used in agriculture to increase the growth or yield of crops. Such use in Christmas tree production is unwarranted, as any growth beyond a certain point will only have to be removed in shearing. Thus, in most cases, the use of fertilizer would add unnecessarily to the cost of managing the plantation. This is indicated by the fact that those growers fertilizing their trees spent an average of 15 percent more time shearing 1000 trees than those growers who did not. It is not known if any increased income derived from fertilization cancels the cost of the fertilization treatment and increased shearing time.

Bell and White (1966) point out that certain species with high site requirements, such as spruces, Douglas-fir, and white pine, may be favorably affected both in height growth and vigor by the use of fertilizers. If the grower wishes to increase growth they recommend the fertilizer be applied in the spring just prior to the start of new growth. If tree color or vigor is to be improved, fertilizers should be applied in midsummer, so as to have the least effect on growth rate.

Eight of the ten growers using fertilizer apply it by hand, placing approximately two ounches (207 pounds per acre, 5 feet by 5 feet spacing) around the base of each tree. This is the most effective method after planting, as it insures that fertilizer is placed only where needed.

In all cases when applying fertilizer by hand, some type of nitrogen-phosphorus-potassium fertilizer, commonly 10-10-10, was used by itself. The typical grower treated 1590 trees per acre, requiring 2.73 manhours to fertilize 1000 trees. The total cost of this treatment, including fertilizer, was $14.04 per 1000 trees.

Of the two remaining growers, both applied the chemical prior to planting; one grower used a horticultural tractor and cyclon spreader, the other having his done by the chemical company from whom the chemical was purchased. The amount of fertilizer used was much greater than when compared to hand application, averaging 477 pounds of fertilizer per acre, and 3263 pounds of lime per acre. This is because the chemicals were broadcast over the entire planting area, rather than placed in the specific area around the tree. The average cost of chemical used with mechanized application was $38.12 per 1000 trees. Application was made without charge by the fertilizer company, while the horticultural tractor applicator cost $3.22 per 1000 trees.

Broadcast application of fertilizers before planting should be avoided if at all possible. Even though the grower may know in advance of planting that the trees will need to be fertilized, broadcast applications aid vegetative competition as much as the Christmas trees, and the increased competition may negate the benefit of fertilizer. Also, as may be seen, the cost of broadcast treatment is more than twice as expensive as applications after planting. Even when applying fertilizers after planting, care must be taken to time the application so as to result in the least side-effects as possible. It may be that if tree color

is the only problem, the use of artificial coloring would better serve the grower than would fertilizers. Although coloring is more expensive than fertilization, it does not have the effect of increasing tree growth.

Insect Control

Insects pose a major threat to a Christmas tree plantation because they can strip it of value in any year of the production cycle. Other things being equal, the financial loss resulting from a severe insect attack increases as the trees increase in age. If, for example, the plantation is destroyed in the year following its establishment, the grower need invest only in another planting operation; however, if the attack occurs in the year before harvest, the grower will have lost not only the retail value of the trees, but also the time and money required in bringing the trees to that stage of development.

The threat is compounded by the unpredictability of insect attacks, in that neither the time of the year nor year(s) in which control measures will be needed are known in advance. The producer can most effectively control insects by being prepared for an attack when it occurs. This requires a familiarity of the types of insects most likely to infest the plantation, the control measures needed, and the types and sources of the needed pesticides. It should be expected that the cost of control will increase as the time between infestation and treatment is increased. The most effective and least expensive control will be possible immediately following the outbreak; this also will result in the least amount of income lost through reduced tree quality.

Twenty interviewed growers (54 percent) have used chemicals to control insects in the past two years. Methods of applying the pesticide tend to vary with the severity of the attack--small infestations may be handled by treating individual trees, while heavy infestations may require broadcast treatment of entire areas. Accordingly, 12 growers applied the pesticide with hand applicators, while 8 growers used tractors and power sprayers. The amount and type of pesticide used also varies with the particular situation under consideration. The most common chemicals used were Malathion, at a rate of .157 gallons per 1000 trees, and a cost of $1.14 per 1000 trees; Cygon, .100 gallons per 1000 trees, at a cost of $1.55 per 1000; and, 1.25 gallons of Sevin, costing $10.62 per 1000 trees.

The typical grower applying the chemical by hand used a backpack sprayer, and spent an average of 3.11 hours treating 1000 trees. This type of treatment cost an average of $8.19 per 1000 trees, excluding the chemical cost. Power application equipment generally consisted of a horticultural tractor and mechanical sprayer. An average of 2.02 labor hours were required to treat 1000 trees in this manner, resulting in a total cost, excluding chemical cost, of $11.20 per 1000 trees.

Methods other than chemical treatment are available to the Christmas tree grower in controlling insects. These include both biological and cultural measures, and serve to prevent rather than control insect infestations. An example of biological control is the propagation of those insects which feed upon the more damaging insects. An example of cultural control is in the timing of the shearing operation so that new tree

growth is removed immediately before the immergence of harmful insects that feed upon this growth. The grower may find such preventive measures are more effective and less costly than common types of chemical control.

Artificial Coloring

The grower contemplating the need to artificially color his trees is at somewhat of a disadvantage. Trees will not begin to fade or turn yellow until late fall. However, to be most effective, the coloring material must be applied in the early fall before the temperature drops below 45 or 50 degrees. Thus, the decision to treat the trees must be made before the actual need arises, and the grower must recall past experience rather than evaluate present circumstances. This, although, also serves as a type of advantage, for if trees actually turn yellow, in most cases it will be easier and less expensive to prevent off-color than to cover it up.

The three growers using artificial coloring in the last two years have applied the color spray with some type of horticultural tractor and power sprayer. They treated an average of 1463 trees per acre, applying the chemical at a rate of 18.02 gallons per 1000 trees, or 2.31 ounces per tree. An average of 10.99 manhours per 1000 trees were needed to complete the coloring. Applying the appropriate unit costs generates an average total cost of $169.11 for artificial coloring. For this cost to be justified, the grower must expect the coloring to raise the average selling price $0.17 per tree ($169.11 divided by 1000 trees), which is not an unrealistic expectation.

Many growers would perhaps object to the use of artificial coloring as jeopardizing the concept of natural Christmas trees. However, with the use of improved coloring materials it is difficult to distinguish a tree which has been treated from one which has not, provided the recommended procedures are followed in coloring. The importance placed on proper tree color by Christmas tree buyers warrants the use of artificial coloring as an emergency measure to be implemented by the producer. Such treatments could realistically raise both the price and number of trees sold and therefore improve the financial standing of the plantation owner.

HARVESTING AND MARKETING OF CHRISTMAS TREES IN VIRGINIA

In the management of Christmas trees, all operations from the severing of the tree from its roots, or its removal from the ground, to the delivery of the tree to the consumer are included in the functions of harvesting and marketing. An arbitrary divisional line must be drawn between these functions, as in many cases there are over-lapping operations which could be classed either as a part of the harvesting function or as part of the marketing function. In this study, this line has been drawn according to who has title to the tree immediately after it is cut. If the grower owns the tree after it is cut, the operation is classed as harvesting, and all subsequent operations are a part of marketing. If anyone other than the grower owns the tree after it is cut, the operation is classed as a part of marketing, as are many following operations, and the harvesting function is bypassed.

Virginia Christmas tree growers have implemented three types of harvests in the last two years--partial harvests, in which the landowner cuts only those trees meeting certain requirements; clearcut harvests, in which the landowner cuts essentially all trees from a stand; and, a harvest of balled stock in which live trees are removed with their roots attached.

Using any of these harvesting operations, the grower must select from various marketing alternatives a method of distributing his trees to consumers. Trees may be sold at the plantation roadside, in which case the marketing function will consist of transporting the trees from

the plantation, and perhaps leading the trees onto the buyer's vehicles. Also, trees may be sold to retail lots distant from the plantation, in which case the grower must lead the trees onto his own vehicles, transport them to the lots, unload the trees, and either retail the trees to the public or sell them to a wholesaler-retailer. An auxiliary operation which may be implemented is the bundling of the trees at the roadside to protect the branches from damage in transport.

Two popular types of combined harvesting-marketing operations are choose and cut sales, and sales on the stump to a wholesaler. In each of these cases, the trees are sold before they leave the plantation, and the grower need not furnish the labor for harvest. For this reason, these operations are included in the marketing function. In choose and cut sales, individual consumers select a tree from the plantation, and generally harvest the chosen tree themselves. Sales on the stump are made to a wholesaler who agrees to harvest a certain number of trees from the stand using his own labor in cutting and transporting the trees.

The following section gives a discussion of the costs and methods of harvesting Christmas trees in Virginia. Discussion of the methods and operations involved in selling trees is deferred until the section concerning marketing.

Harvesting Christmas Trees in Virginia

A great deal of risk is immediately assumed when a grower severs a tree from the ground because the tree must either be sold in a relatively short time or it must be discarded. If it is discarded, all time and money invested in the tree are lost. The grower can ill-afford

to allow many of his harvested trees to remain unsold, and therefore must reduce the risk involved in harvest to insure that the maximum number of harvested trees are sold. There are several ways in which this can be done.

Perhaps the most effective, though long-term, step the grower can take is to strive through his cultural practices to produce the type of tree demanded by consumers. This tree in recent years has been characterized by fragrant, dense, green foliage with a symmetrical, tappered appearance, and an ability to retain its needles at least through the Christmas season. To produce such a tree requires not just a certain set of cultural operations, but more a management philosophy oriented toward a desire to give the consumer a quality product. If such a philosophy is adopted, the problem of finding buyers for trees will be greatly reduced.

An immediate step which can be taken to reduce the number of unsold trees is in the proper timing of the harvesting operation. Bell and White (1966) state that the factor which largely determines the timing of harvest is the advent of heavy snow and bad weather conditions which prevent transporting trees out of the plantation. However, weather conditions are not a serious constraint in Virginia and most growers may freely choose their harvesting date, so long as they allow enough time between harvesting and Christmas day to market the trees. In 1972, the majority of harvesting on Virginia plantations was begun in the first week of December, and ended in the third week of December. This seems to be a nearly ideal time as it insures the delivery of fresh trees to the consumer and also allows for a reasonable marketing period.

Other measures which will aid in minimizing less from the harvest of unsold trees are for the grower to inventory the type and number of trees available for sale, and advertise these trees to potential buyers. The accumulated investment the grower has made over the length of the production cycle justifies any reasonable cost required to insure that trees are sold after harvest.

Fourteen of the 37 interviewed growers (38 percent) have harvested trees in the last two years. However, several growers used more than one type of harvesting operation. Thus, 14 stands were partial-harvested, 3 stands produced balled stock, and one stand was clearcut.

Partial Harvests

Partial harvests are commonly used because all trees in a given stand may not reach marketing standards in the same year. In general, a financial benefit is obtained by selling trees at an earlier age because income is received sooner than if harvesting were delayed until the majority of trees were merchantable. There may, however, be exceptions to this rule if the price of older, larger trees is greater than the price of younger trees.

The financial benefit may further be off-set by the opportunity cost of idle acreage, in that following the partial harvest the area is not being used to its full potential. The magnitude of this cost increases as the time required to completely harvest the stand is increased. For the growers completely harvesting the stand in two partial harvests, this opportunity cost may be insignificant; while the cost may be quite

high for those needing three or more years to remove all trees from the stand. If replanting following the partial harvest is used to bring the stand to its full potential, it is possible that an uneven-aged stand will be generated; the problems associated with this have already been discussed. Thus, if partial harvests are to prove financially beneficial, it is recommended that the stand be completely harvested in two cutting seasons.

In 1972, approximately one-third of all trees sold by the 37 interviewed growers were removed in partial harvests. Of the 9200 trees, 3300 were sold by the growers to retail lots, and 5900 were sold after moving the trees from the plantation to a convenient road siding.

A summary of the labor requirements and costs of partial harvesting is given in Table 6. It appears that the decision as to which type of equipment will be used in harvesting is based, as it should be, largely on the amount of time that can be devoted to harvesting, and the number of trees to be removed from the stand. As would be expected, as equipment sophistication increases, the labor time required to harvest decreases. In the case of partial harvests, this decrease is dramatic, and more than compensates for the hourly cost of operating the equipment.

Other things being equal, it is quite logical to conclude that in the partial harvesting operation, mechanized equipment should be substituted for labor as much as possible. However, other things generally are not equal, and conclusions are not so easily drawn. For example, the hourly cost of operating a chain saw, $1.20, is based on its being used 100 hours per year, or used to harvest 5000 trees per year. But

Table 7. Average number of trees removed per stand, labor requirements, and costs of partial harvesting by type of harvesting equipment used

Type of Equipment	Average number of trees removed per stand	Manhours required to harvest 1000 trees	Total cost of harvesting 1000 trees
Bow saw	375	40.00	$120.00
Chain saw	635	19.47	81.77
Circular saw mounted on horticultural tractor	900	7.77	36.60

if the grower harvests 2500 trees per year, the chainsaw will be used only 50 hours per year (19.47 hours per 1000 trees times 2.500 thousand trees), and its hourly cost increases to $2.47. The total cost of harvesting with a chainsaw, $106.50, then closely approximates the cost of harvesting with a bow saw. A similar illustration could be given for harvesting done with a horticultural tractor and circular saw, however, the meaning should be clear--the grower must select the equipment most suited to his operation. If mechanized equipment is purchased and used only infrequently, any expected benefit from substituting capital for labor may be cancelled by the higher-than-expected machine costs.[6]

Harvests of Balled Stock

The harvest of balled stock receives only limited use in Virginia; the three growers using this harvesting operation harvested fewer than two percent of all Christmas trees sold by growers in 1972.

A balling harvest will require either one or two men, depending upon the size of the trees being harvested. The tree must first be dug and removed from the ground with a sufficient quantity of roots and soil that will allow the tree to survive its transplanting by the consumer. The ball of roots and soil is then wrapped in burlap to protect it from eroding. Following this, the tree may be marketed as are trees harvested in the more conventional severing operations.

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[6] See Appendix II for a more thorough discussion of the effect of hours of annual machine usage on hourly equipment costs.

There are at least two distinct disadvantages to harvests of balled stock. The first of these is the damage to the plantation resulting from the creation of large holes and the removal of substantial amounts of soil through out the area. This not only makes future production and harvesting operations more difficult to implement, but also with time will result in a lowering of the productivity of the site.

The other disadvantage is that balled harvests require considerably more labor time than conventional harvests. In 1972, an average of 240.50 manhours were needed to harvest 1000 trees. At a wage rate of $2.62 per hour, this represents a total cost of $630.11 per 1000 trees harvested. As would be expected with such high labor requirements the three growers harvested an average of only 83 balled trees each, and the majority of trees sold by them were harvested with procedures other than balling.

Despite the disadvantages of balled harvests, there is a potential for this type of harvesting operation to increase in popularity. From a producer's standpoint, balling incorporates less risk against loss due to unsold trees because a balled tree which is harvested in one year, but not sold, may survive to the following marketing period. Also, trees may be harvested at a younger age if balled and sold at prices comparable, if not above, the price received by larger, more mature severed trees. From a consumer's standpoint, balled trees are only relatively more expensive than cut Christmas trees and may be transplanted after use to enhance the appearance of lawns or gardens. Thus, the demand for balled trees may be expected to increase in the future.

Also, many growers interviewed who had not experimented with balled harvests expressed an interest in learning more about this method, indicating that the number of balled trees harvested in the next several years could be expected to increase.

Clearcut Harvests

A clearcut harvest was used by only one grower in 1972. Although a discussion of labor requirements and costs must be made guardedly, the labor required in other types of harvesting operations implemented by this grower approximate the calculated averages, indicating that his experiences may be those typically expected by other growers.

Clearcutting is the least expensive and most efficient method of harvesting Christmas trees. Its efficiency stems from the fact that all trees may be harvested at one time by one harvesting crew rather than having the harvest staggered over a period of two or more years. Its inexpensiveness results from the fact that the harvester may go from tree to tree rather than harvesting one tree and then searching throughout the plantation for other trees to be harvested.

The grower implementing a clearcut harvest spent 3.30 manhours in harvesting 1000 trees with a 7 horsepower tractor and mounted circular saw. Cost of harvesting was $15.54 per 1000 trees. Comparing this to partial harvesting with a horticultural tractor, it is seen that clearcutting is less than half as expensive as partial harvesting. This cost differential may seem unimportant since the cost of both harvesting operations is relatively inexpensive. However, when the opportunity cost of partial harvests is included in the comparison, the marginal cost of partial harvests increases significantly.

A comparison of clearcut and partial harvests in terms of opportunity cost

As has been stated, there is an opportunity cost associated with partial harvests resulting from an area not being used at its full potential. In clearcut harvest there is no such cost, since immediately following harvest the area is planted and returned to full production. An attempt to quantify this cost has been made by examining the difference in present net worths resulting from the two harvesting alternatives.

Two simulated Christmas tree operations were evaluated using the analytical computer program developed in this study. The management of the plantations were identical except for the method and timing of harvests, and the prices received for trees. In the first case, 1810 trees, or 1.5 acres, were partially harvested in the eighth year of the production cycle, and sold for $3.93 per tree. The remaining 3621 trees, or 3.5 acres, were harvested in the ninth year and sold for $4.57. The present net worth of this investment was $4672.73. In the second case, the entire 5 acre stand of 5430 trees was clearcut in the ninth year and sold for $4.57 per tree. The present net worth of this alternative was $5071.15.

The difference in the present net worths of these two alternatives, for one rotation, $398.42, represents the opportunity cost of harvesting the stand over a period of two years. In perpetuity, the present value of this cost is $623.12, which represents a perpetual annual cost of $74.77. Although no cash payment will be involved in meeting this cost, the landowner has incurred a cost since the opportunity of increasing his

assets approximately $400 in one rotation, and $75 annually for continuing rotations, has been foregone.

It is possible that the opportunity cost of partial harvesting may become insignificant if the price differential between trees of increasing size is decreased, or if the number of trees sold at the earlier age is decreased. The individual grower should therefore attempt to estimate for his particular situation the magnitude of this cost. However, all costs and revenues used in the above example are based on responses given in the Financial Questionnaire, and therefore the calculated opportunity cost is that which can be reasonably expected by Virginia Christmas tree growers. For this reason, it is recommended that clearcut harvests be substituted for partial harvests whenever possible to receive a more favorable return from the investment.

Marketing Christmas Trees in Virginia

A Christmas tree marketing operation includes a variety of possible actions all intended to prepare the trees for the immediate transfer of ownership. The choice of the proper marketing system can mean the difference between the investment being a financial success or disaster. The grower must therefore carefully select the marketing system that best fits his individual operation.

Four distinct types of marketing operations have been identified in Virginia, although within a given operation there may be variations according to whether or not auxiliary operations such as bundling, loading, and unloading are implemented. The most simple method of marketing is the sale of trees on the stump, in which an entire portion of a stand

is sold to one buyer who then harvests and transports the trees from the plantation. Two methods of marketing used by growers who harvest their trees are the sale of trees at the plantation roadside, and the sale of trees at a retail lot. In both of these cases, trees may be sold either wholesale to a middleman or retail to individual consumers. In choose and cut sales, as has been mentioned, individuals enter the plantation to select and harvest the tree of their choice.

A discussion of the costs, prices received, and methods of implementing each of the marketing systems will now be given. If the grower understands the financial, labor, and capital requirements of each system he will be better able to design his marketing strategy. Any conclusions drawn in this study in comparing marketing alternatives must be in general terms. The final decision as to which is the preferred system must be left to the individual grower after considering such factors as the amount of risk he is willing to assume, the accessibility of his plantation, and its proximity to concentrated groups of consumers.

Sales on the Stump

In marketing trees on the stump the grower may sell the trees either to a middleman wholesale dealer or to a retail outlet. In general, a higher price will be received if the trees are sold to a retailer since a large part of the price mark-up usually assigned by a middleman will fall to the grower. However, a retailer may purchase only a relatively few trees, whereas a middleman dealer may purchase several thousand trees from one source. Regardless of which type of buyer is selected, the grower should arrange a commitment early in the season, specifying

the number and price of trees to be sold. A partial payment at the time of the agreement will insure that the buyer is acting in good faith; the remainder of the payment should be made before the trees leave the plantation.

Perhaps as a result of the simplicity of sales on the stump, this was the second most popular method of marketing trees in 1972, with 7830 trees (27 percent) being sold in this manner by seven growers. However, associated with this simplicity are several disadvantages.

The lack of control of the harvesting is one of the most important drawbacks of sales on the stump. Without close supervision, the buyer may harvest trees which were not intended to be cut, or he may leave trees which were to be taken. Also, the buyer may carelessly do damage to the plantation in moving equipment into and out of the cut area. The grower must do all that is possible to prevent this, including the selection of a reputable buyer, entering into a formal contract, and if necessary, supervision of the harvesting operation. As a minimum, clear instructions must be given about which trees to harvest and the parts of the plantation not to be entered.

A second apparent disadvantage of this system is the low price commanded by trees sold on the stump. The average price received by the grower for these trees was $2.16 in 1972, ranging from $2.00 to $2.34. However, since there are no marketing costs using this method, all of this price may be applied to meeting the production costs of developing the tree. A hypothetical situation was analyzed using the investment analysis computer program which showed that even with an

intensive ten year production cycle the breakeven price was under this $2.16 selling price. Although a grower may receive a higher profit by implementing a more integrated marketing system, it is not doubted that sales on the stump are the most attractive method of marketing for certain growers.

Sales at the Roadside

If a grower has decided to harvest his trees, the first opportunity to sell them will be at the plantation roadside.[7] In order to do this, it is necessary to first transport the trees to the roadside, and may be necessary to bundle the trees and load them onto vehicles. The following description of the costs and procedures used in implementing these alternatives, along with the average price received for the trees, provides an analysis of the financial expectations of sales at the roadside.

Since both the growers selling trees at the roadside and the growers selling trees at a retail lot may carry out the above operations, information from these two groups of growers has been pooled in describing these operations. This is justified since there is no reason to believe that the costs or procedures used by one group would be different than those used by the other group. In the section concerning sales to a

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[7] The roadside refers to the central location to which trees are transported in moving them from the plantation. Although it is not necessary that this point be a "roadside", it should be adjacent to an all-weather road to facilitate traffic into and out of the area.

retail lot the reader is asked to refer back to these operations, remembering that they apply equally to both methods of marketing.

Nine of the interviewed growers sold a total of 12053 trees (41 percent of all trees sold) at the roadside in 1972. The average selling price of these trees was $3.56, ranging from $2.60 to $4.35. If this price is compared to that received for trees sold on the stump, which may be thought of as the basic stumpage price, it is seen that the grower is allowed an average of $0.49 per tree to cover the costs of harvesting, transporting to the roadside, bundling, and loading. If the cost per tree of carrying out these operations is greater than this, the grower should re-evaluate this marketing procedure.

Transporting to the roadside

Sixteen of the 37 interviewed growers transported trees to the roadside in 1972. Methods of moving the trees included trucks, flat-bedded trailers, and hand labor when the distance to the roadside was relatively short. Transporting by hand proved to be the least expensive and time consuming, indicating the desirability of having a plantation near a suitable roadside.

Seven growers moved an average of 602 trees to the roadside using hand labor. Each worker typically carried one to two trees per trip, depending on the size of the trees and the distance to be travelled. The average time required to move 1000 trees in this manner was 34.79 manhours. At a standard wage rate of $2.62, this represents a total cost of $91.15 per 1000 trees transported from the plantation.

Four growers hauling an average of 1312 trees with a farm tractor and flat-bedded trailer encountered the next lowest cost. An average of 35.52 manhours and 10.24 equipment hours were needed to transport 1000 trees. The differences in these figures indicates the relatively large amount of time needed to load the trees onto the trailer; the actual moving time is much less than when trees are transported by hand. Applying the machine rates for a 30 horsepower tractor and a trailer, with a $2.62 wage rate, produces an average cost of $159.62 for transporting 1000 trees. The average size load on a flat-bedded trailer was 44 trees.

Transporting trees to the roadside with trucks demanded sustaintially more time than the other methods. Furthermore, with an average load of 48 trees per trip, there appears to be no advantage to using a truck rather than a trailer to transport since the number of trips required to move a given number of trees will be approximately the same with either type of equipment. The four growers using trucks averaged hauling a total of 630 trees to the roadside. The average time required to move 1000 trees was 153.33 manhours and 87.50 equipment hours. Thus, the total cost of this type of transportation was $664.22 per 1000 trees.

A direct comparison of these costs of transporting is not possible since the distance travelled using the three methods may have differed. However, if the distance to be travelled is short, hand labor is probably the best alternative, costing an average of $0.09 per tree. The use of trucks to transport trees for sale at the roadside can not be recommended, since its cost of $0.66 per tree is much greater than the other two methods of transporting. The grower having to move trees long distances

to the roadside should therefore consider a tractor and flat-bed trailer as his best method of transporting, since its cost of $0.15 per tree allows for more additional income than can be expected from sales on the stump.

Bundling

Christmas trees may be individually bundled to prevent them from excessively drying, to make them easier to handle, and to protect them from damage in transporting. Only five Virginia producers bundled trees sold in 1972--generally when trees were to be shipped long distances or when customers specifically asked for this service. Of the 3575 trees bundled, 2525 (70 percent) were sold at the roadside, and 1050 were sold at retail lots.

The only type of equipment used in bundling was some type of hand-operated funnel and Vexar, a type of plastic mesh netting material. Typically, three or four men were needed in the bundling operation. One man carried trees to the funnel, one fed the tree butt-first into the funnel, and one to two men pulled the tree thorugh the funnel, the netting enclosing the tree as it moved through. There are mechanical funnels which may be purchased and greatly reduce the time and number of men needed to bundle. However, justification of the purchase of such equipment is doubted unless large numbers of trees are to be bundled. The Virginia producers bundled an average of 715 trees each in 1972, which would not be considered as a large-scale operation.

The cost of bundling is more or less equally divided between the cost of labor and the cost of material. The average labor time required

to bundle 1000 trees was 62.66 manhours, at a cost of $156.65. The cost of the netting material was $177.50 per 1000 trees. Thus, the total cost of bundling was $334.15, or $0.33 per tree. This cost may be reasonably incurred by any grower transporting his trees to the roadside by hand or trailer, particularly, since the buyer is generally willing to at least partially compensate the buyer by increasing the purchase price of the bundled trees.

Loading at the roadside

If trees are to be distributed to the final consumers at a point some distance from the plantation, it will be necessary to load them onto vehicles at the roadside for shipment. Trees may be loaded by the grower onto a buyer's truck, in which case the trees are considered to be sold as soon as the loading is completed; or, they may be loaded onto the grower's truck for sale at a retail lot. In the former case, trees will typically be sold at wholesale, while in the latter case, they may be sold either at wholesale or retail.

The average time required by the ten growers loading trees at the roadside was 32.00 manhours, at a cost of $83.84, per 1000 trees. Of the 7915 trees loaded at the roadside, 3865 trees (49 percent) were sold by three growers at the roadside, while 4050 trees were sold by seven growers to retail lots.

Accumulated costs of sales at the roadsides

If it is assumed that trees can be sold on the stump for $2.16, the grower must keep his costs of harvesting and marketing under $1.40 per

tree if he is to be as financially well-off selling his trees for $3.56 at the roadside. A number of harvesting and marketing options can be implemented within this cost constraint. However, several options can not be carried out at this cost.

Due to the various operations and variations within an operation, it is difficult to state what the cost of marketing trees sold at the roadside will be. It is further difficult to determine on an individual basis if the auxiliary operations of bundling and loading should be performed. Many of the conclusions which must be drawn about this marketing system are therefore left for the grower to make.

Sales at a Retail Lot

If the grower has harvested trees he may consider the alternative of selling his trees to a retail lot. The majority of the 4682 trees marketed in this manner were sold to a wholesaler, although several growers operated their own retail lots. No data was collected which would indicate the higher prices received or the higher marketing costs incurred by the growers selling trees at retail. Therefore the only additional marketing operation which will be considered is the transportation of these trees to the retail lots. The grower wishing to sell his trees at retail should add to the transportation cost his estimate of the labor cost required to distribute his trees to the public and the rental cost of the lot.

Transporting to a retail lot

Seven growers interviewed furnished the labor and equipment needed to transport trees to retail lots. The cost of this transportation will

depend primarily upon the distance to be travelled. Although this information is not directly available, it is known that the average time required to make a one-way trip to the lot was 1.24 hours, ranging from 4 hours for one grower and 40 minutes for another. This would place the average distance travelled very close to 50 miles (at an average speed of 40 miles per hour), and certainly less than 75 miles. Thus, when transportation costs are paid by the grower, trees tend to be distributed in a fairly limited area around the plantation site.

The average cost of transporting trees to a retail lot is relatively inexpensive--more than half as time consuming and expensive as it is to transport trees to the roadside with trucks. The typical grower transported 200 trees per load, requiring 58.97 manhours and 32.66 equipment hours to transport 1000 trees. Applying the equipment cost and a $2.62 wage rate, the total cost of transporting to a retail lot was $259.01, or $0.26 per tree.

Unloading at a retail lot

Following the transportation of trees to a retail lot, it is common for the grower to also furnish the labor for unloading the trees off of the trucks. This, however, is a rather small cost, and does not actually involve the investment of any more of the grower's time since he would be detained at the lot regardless of whether the grower or the buyer unloaded the trees.

All seven growers selling trees to a retail lot furnished the labor for unloading the trees, requiring an average of 17.08 manhours to unload

1000 trees, or approximately one minute per tree. At an average standard wage rate of $2.62, a total cost of $44.75 was involved in unloading 1000 trees, or $0.04 per tree.

Recommendations for sales at a retail lot

The average price received for trees sold to a retail lot was $5.09, ranging from $3.70 to $7.00. If this is compared to the price received at the roadside, it is seen that the grower is allowed an average of $1.53 for transporting trees to a retail lot. This more than compensates the grower for the actual cost of such transportation. Therefore, it may be concluded that if trees are to be moved to the roadside, they should be transported at the grower's expense to a retail lot. In doing so, the grower may expect to receive an additional net revenue of $1.27 per tree. This should be of particular interest to those growers who must move their trees to the roadside with trucks, since the cost of such transportation may not be justified if trees are sold at the roadside. The cost is easily met if trees are sold at a retail lot.

Choose and Cut Sales

Although a choose and cut marketing operation need not involve any direct labor on the part of the plantation owner, it is still one of the most time-consuming methods of marketing. The seller must be present at any time a customer may arrive, and much time is wasted when workers are continuously present to aid customers and the customer arrive at sporadic intervals. The grower may post a schedule stating when purchases may be made, thereby compelling customers to arrive in larger numbers over

a shorter time. Even with this, however, the average grower was required to spend over 500 manhours in selling 1000 trees.

The term choose and cut is somewhat of a misnomer when applied to Virginia producers, for of the 3900 trees sold in 1972, 49 percent were cut by the grower rather than by the buyer. When harvesting is done by the buyer, he is almost always supplied with a bow saw; however, when cut by the grower, either a bow saw or a chainsaw may be used. Differences in the labor time required by the grower in comparing the three methods of cutting would be meaningless as the seller must be on the plantation regardless of cutting method. Labor is therefore a fixed cost, and the marginal cost of labor is zero in comparing the cutting alternatives. The average time required by all growers to market 1000 trees was 503.82 manhours at a total cost of $1320.00, or $1.32 per tree.

The average price of trees sold choose and cut was $4.56, which allows for a $2.40 marketing cost when compared to selling trees on the stump. The marginal profit received by choose and cut sales is therefore $1.08 per tree when compared to sales on the stump. If, however, the grower also wishes to consider the possible alternatives of harvesting his trees and marketing them either at the roadside or to a retail lot, choose and cut may not appear so financially attractive. Again, due to the variations in harvesting and marketing costs it is difficult to reach any specific conclusions about which marketing system is preferred, and this is left for the individual grower to determine. In general, marketing at a retail lot will prove more profitable than choose and cut, and marketing at the roadside will be the least profitable of all marketing options.

The grower should never expect to market an entire stand using a choose and cut operation, for this is in effect a partial harvesting procedure. The time required for individual consumers to completely harvest an entire stand may reasonably be expected to range from two to four years. The opportunity cost of idle land must be considered for choose and cut operations just as it was for partial harvests. A recommended procedure for the grower to follow is to allow a choose and cut operation in his plantation in the year when some of his trees are just reaching marketing standards. The following year, the grower may clearcut the remaining portion of his stand, and market these trees at a retail lot. This procedure, which is analyzed in the following chapter, avoids much of the opportunity cost of idle land, while at the same time allows the grower to receive a higher price for his trees than would otherwise be possible.

Species Price Variations

Up to this point, it has been implied that the method of marketing was the primary factor affecting the price of Christmas trees. However, one would suspect that the species and quality of the trees being sold would affect the selling price also. Unfortunately, there is no data available which would allow a conclusion to be drawn about the effect tree quality has on price. The U.S. Department of Agriculture has (1962) developed a quality-grading system for Christmas trees, but this receives very limited use in Virginia. There is, therefore, no method of distinguishing variations in price due to tree quality for trees sold by

Virginia producers. The interested reader may, however, refer to Leuschner (1973) for an indication of the effect tree quality had on trees sold at retail lots in the Roanoke, Virginia area in 1972.

A two-way analysis of variance procedure was used to determine, for Scotch pine and eastern white pine, the amount of price variation that could be attributed to the species being sold and that which could be attributed to the method of marketing (Appendix III). It was found that the variations in selling price of these two species were not significantly affected, at the 95 percent confidence level, by the species sold, but that the difference in price was significant between the marketing system used. This would appear to indicate that consumers and wholesalers show no particular preference in these two popular species, and that trees of the same general quality may be expected to command the same price under a given marketing system. This means that the grower contemplating the planting of Scotch pine or white pine may make his decision more in terms of the cultural and biological requirements of the species, and place less emphasis on the buyer's preferences between species.

The following tables are intended to provide an idea of the popularity among growers, the average age, and the selling price of the several species sold in 1972.

Summary of alternative marketing procedures

Four types of marketing alternatives have been identified in Virginia. Two of these, sales at the roadside and sales to a retail lot, are options available to growers that harvest their trees. It has been

Table 8. Number of trees, average age, and price of trees sold on the stump in 1972.

Species	Number of trees sold	Average age	Average price
Scotch pine	1,945	8	$2.22
Fraser fir	650	11	2.10
Eastern redcedar	155	8	2.00
White pine	5,080	8	2.34
Over-all			$2.16
Standard deviation			0.224

Table 9. Number of trees, average age, and price of trees sold balled at the roadside in 1972

Species	Number of trees sold	Average age	Average price
Fraser fir	150	7	$2.50
White pine	75	8	7.60
Scotch pine	99	6	7.50
Spruces	10	6	7.50
Over-all			$6.28
Standard deviation			2.50

Table 10. Number of trees, average age, and price of trees sold choose and cut in 1972.

Species	Number of trees sold	Average age	Average price
Fraser fir	100	11	$2.50
Douglas-fir	150	6	5.00
Scotch pine	2,689	8	5.46
White pine	861	8	4.32
Austrian pine	100	11	5.50
Over-all			$4.56
Standard deviation			1.22

Table 11. Number of trees, average age, and price of trees sold at the roadside in 1972

Species	Number of trees sold	Average age	Average price
Fraser fir	1,050	11	$2.60
Scotch pine	7,596	8	4.29
White pine	2,869	8	4.35
Norway spruce	538	9	3.03
Over-all			$3.56
Standard deviation			0.92

Table 12. Number of trees, average age, and price of trees sold at a retail lot by Virginia Christmas tree producers in 1972

Species	Number of trees sold	Average age	Average price
Balsam fir	400	9	$7.00
Scotch pine	650	8	3.70
White pine	3,312	8	4.14
Red pine	45	8	7.00
Spruces	275	10	3.60
Over-all			$5.09
Standard deviation			1.75

found in this study that sales to a retail lot will generate the higher profit, since the grower is more than adequately compensated for assuming the increased marketing costs. However, a limited supply of labor, which would tend to increase the cost of marketing, or a nearness to a large consumer market, which would tend to increase the price of trees sold at the roadside, may in specific cases make sales at the roadside the more attractive.

Two marketing alternatives, sales on the stump and choose and cut sales, are also available to growers who have the buyer harvest their trees. Although choose and cut sales would always be expected to generate more profit than sales on the stump, the fact that twice as many trees were sold on the stump in 1972 than were sold choose and cut should indicate that considerations other than costs and revenues are involved in choosing a marketing alternative. This thought permeates this report. Although it is appropriate and meaningful to discuss the financial aspects of the various harvesting and marketing alternatives, it should be recognized that the choice of one option over another is often based more on individual grower-preference than it is on economic soundness. It is hoped that the analytical program developed in the next chapter will provide growers with more complete knowledge in evaluating their preferences.

ECONOMIC ASPECTS OF PRODUCTION AND MARKETING

The results of the economic analysis of Christmas tree production and marketing are in the form of a computer printout, which for a given set of input data calculates the present net worth, internal rate of return, and break-even price per tree of the investment. In addition to this, the printout includes a cost summary, which shows for each year of the production period the operations performed, the equipment used, the number of trees or acres treated, and the cost of the operation; an income summary, showing the number and species of trees sold, the marketing system used, the price received, and the revenues for each year trees are sold; and finally, a listing of the basic cost assumptions used in making the analysis.

Table 12 provides a sample computer printout generated from the analysis of a hypothetical Christmas tree plantation. The cost and income summaries give a thorough listing of the five-acre plantation's management for the nine year production period, and therefore no attempt will be made to further explain the operations and marketing methods implemented. It will be noted that for the most part, the operations included in this illustration are those recommended in the previous two chapters. Therefore, although the 69 percent survival rate is much lower than the average, this example provides insight as to the economic potential of Christmas tree investments with sound plantation management.

Table 13. Sample computer printout for a hypothetical Christmas tree plantation.

COST SUMMARY

YEAR 1					
5.000	ACRES PURCHASED FOR $	200.00 PER ACRE		$ 1000.00	
5.000	ACRES	SITE PREPARE	WITH TRACTOR/MOWER	$ 53.74	
5.000	ACRES	SITE PREPARE	WITH TRACTOR/SPRAYER	$ 125.45	
7.200	M TREES	PLANTED	WITH BY HAND	$ 617.94	
TOTAL COST IN YEAR 1 IS					$ 1947.13
YEAR 2					
1.080	M TREES	REPLANTED	WITH HAND TOOLS	$ 88.40	
15.000	ACRES	MOWED	WITH TRACTOR/BUSH HOG	$ 203.44	
TOTAL COST IN YEAR 2 IS					$ 291.84
YEAR 3					
6.480	M TREES	SHEARED	WITH PRUNING UNDER 3'	$ 379.08	
15.000	ACRES	MOWED	WITH 12 HP MOWER	$ 117.85	
1.620	M TREES	INSECTICIDE	WITH HAND SPRAYER	$ 26.86	
TOTAL COST IN YEAR 3 IS					$ 523.79
YEAR 4					
6.318	M TREES	SHEARED	WITH PRUNING UNDER 3'	$ 369.60	
10.000	ACRES	MOWED	WITH 12 HP MOWER	$ 78.57	
6.318	M TREES	HERBICIDE	WITH 12 HP TRACTOR	$ 46.09	
TOTAL COST IN YEAR 4 IS					$ 494.26
YEAR 5					
6.128	M TREES	SHEARED	WITH KNIVES 3' TO 5'	$ 317.89	
15.000	ACRES	MOWED	WITH 12 HP MOWER	$ 117.85	
TOTAL COST IN YEAR 5 IS					$ 435.74
YEAR 6					
6.005	M TREES	SHEARED	WITH KNIVES 3' TO 5'	$ 311.51	
15.000	ACRES	MOWED	WITH 12 HP MOWER	$ 117.85	
1.501	M TREES	INSECTICIDE	WITH HAND SPRAYER	$ 24.89	
TOTAL COST IN YEAR 6 IS					$ 454.25

Table 13. Sample computer printout for a hypothetical Christmas tree plantation (continued).

YEAR 7					
5.885	M TREES	SHEARED	WITH KNIVES OVER 5'	$ 348.24	
15.000	ACRES	MOWED	WITH 12 HP MOWER	$ 117.85	
5.885	M TREES	FERTILIZED	WITH HAND APPLICATOR	$ 56.47	
TOTAL COST IN YEAR 7 IS					$ 522.56
YEAR 8					
5.797	M TREES	SHEARED	WITH KNIVES OVER 5'	$ 343.04	
15.000	ACRES	MOWED	WITH 12 HP MOWER	$ 117.85	
0.500	M TREES	MARKED	WITH FLAGGING	$ 23.61	
0.500	M TREES	HARVESTED	WITH BY HANDSAW C & C	$ 629.77	
TOTAL COST IN YEAR 8 IS					$ 1114.27
YEAR 9					
5.214	M TREES	SHEARED	WITH KNIVES OVER 5'	$ 308.54	
15.000	ACRES	MOWED	WITH 12 HP MOWER	$ 117.85	
5.214	M TREES	COLORED	WITH 12 HP TRACTOR	$ 881.76	
5.214	M TREES	HARVESTED	WITH CLEAR CUT	$ 74.50	
5.214	M TREES	TRANSPORTED	WITH LOADING AT ROAD	$ 437.14	
5.214	M TREES	TRANSPORTED	WITH TRUCK TO BUYER	$ 1316.44	
5.214	M TREES	TRANSPORTED	WITH HAND TO ROADSIDE	$ 475.25	
TOTAL COST IN YEAR 9 IS					$ 3611.49
TOTAL COSTS, ALL YEARS, IS					$ 9395.33

Table 13. Sample computer printout for a hypothetical Christmas tree plantation (continued).

INCOME SUMMARY

250 SCOTCH PINE	SOLD CHOOSE AND CUT	AT $ 2.50 PER TREE	$ 625.00
250 WHITE PINE	SOLD CHOOSE AND CUT	AT $ 7.60 PER TREE	$ 1900.00
TOTAL INCOME IN YEAR 8 IS			$ 2525.00

YEAR 9

2607 SCOTCH PINE	SOLD AT RETAIL LOT	AT $ 2.60 PER TREE	$ 6778.20
5.00 ACRES SOLD AT $ 200.00 PER ACRE			$ 1000.00
2607 WHITE PINE	SOLD AT RETAIL LOT	AT $ 4.35 PER TREE	$11340.45
5.00 ACRES SOLD AT $ 200.00 PER ACRE			$ 1000.00
TOTAL INCOME IN YEAR 9 IS			$ 20118.65

TOTAL INCOME, ALL YEARS IS $ 22643.65

Table 13. Sample computer printout for a hypothetical Christmas tree plantation.

CASH FLOW-FINANCIAL SUMMARY

YEAR	TOTAL COST	TOTAL REVENUE	YEARLY NET CASH FLOW	ACCUMULATED NET CASH FLOW	PRESENT NET WORTH AT 12.000 %	INTERNAL RATE OF RETURN	BREAK-EVEN PRICE PER TREE
1	$ 1947.	$ 0.	$-1947.	$-1947.			
2	$ 292.	$ 0.	$ -292.	$-2239.			
3	$ 524.	$ 0.	$ -524.	$-2763.			
4	$ 494.	$ 0.	$ -494.	$-3257.			
5	$ 436.	$ 0.	$ -436.	$-3693.			
6	$ 454.	$ 0.	$ -454.	$-4147.			
7	$ 523.	$ 0.	$ -523.	$-4670.			
8	$ 1114.	$ 2525.	$ 1411.	$-3259.			$ 1.66
9	$ 3611.	$20119.	$16507.	$13248.	$ 3150.55	24.087%	$ 2.55

Table 13. Sample computer printout for a hypothetical Christmas tree plantation.

COST ASSUMPTIONS FOR THIS OPERATION

OPERATION/EQUIPMENT	EQUIPMENT COST PER HOUR	EQUIPMENT HOURS PER UNIT	LABOR COST PER HOUR	LABOR HOURS PER UNIT	MATERIAL COST PER GAL/LB	MATERIAL GALS/LBS PER UNIT
SITE PREPARATION						
TRACTOR/MOWER	$ 7.85	0.91	$ 3.50	1.03	$ 0.00	[illegible]
TRACTOR/SPRAYER	$ 6.38	0.92	$ 3.50	0.92	$ 16.00	1.0[illegible]
PLANTING						
BY HAND	$ 0.00	21.49	$ 2.50	21.49	$ 32.10	1.00
REPLANTING						
HAND TOOLS	$ 0.00	19.90	$ 2.50	19.90	$ 32.10	1.00
SHEARING						
KNIVES 3' TO 5'	$ 0.00	20.75	$ 2.50	20.75	$ 0.00	0.00
KNIVES OVER 5'	$ 0.00	23.67	$ 2.50	23.67	$ 0.00	0.00
PRUNING UNDER 3'	$ 0.00	23.40	$ 2.50	23.40	$ 0.00	0.00
MOWING						
TRACTOR/BUSH HOG	$ 7.85	1.25	$ 3.00	1.25	$ 0.00	0.00
12 HP MOWER	$ 1.27	1.84	$ 3.00	1.84	$ 0.00	0.00
INSECT CONTROL						
HAND SPRAYER	$ 0.00	3.11	$ 3.00	3.11	$ 7.25	1.00
HERBICIDE						
12 HP TRACTOR	$ 2.55	0.81	$ 3.00	0.81	$ 2.80	1.00
COLORING						
12 HP TRACTOR	$ 2.55	10.99	$ 3.00	10.99	$ 6.00	1.00
FERTILIZATION						
HAND APPLICATOR	$ 0.00	2.73	$ 3.00	2.73	$ 5.62	1.00
MARKING						
FLAGGING	$ 0.00	4.55	$ 2.62	4.55	$ 35.30	1.00
BUNDLING						
HARVESTING						
CLEAR CUT	$ 1.71	3.30	$ 2.62	3.30	$ 0.00	0.00
BY HANDSAW C & C	$ 0.00	503.82	$ 2.50	503.82	$ 0.00	0.00
TRANSPORTING						
HAND TO ROADSIDE	$ 0.00	34.75	$ 2.62	34.75	$ 0.00	0.00
TRUCK TO BUYER	$ 3.00	32.66	$ 2.62	58.77	$ 0.00	0.00
LOADING AT ROAD	$ 0.00	32.00	$ 2.62	32.00	$ 0.00	0.00

The economic analysis is provided in the cash flow-financial summary which shows the total yearly costs, revenues, and cash flows, the accumulated net cash flows, and the values of PNW, IRR, and BPT. The present net worth of $3150.55 indicates that this investment is earning a substantial profit above the minimum needed for it to be financially justified. The internal rate of return shows that capital invested in the operation has grown at an average compound interest rate of 24.089 percent. The present net worth is greater than zero, and the internal rate of return is greater than 12 percent, because the required break-even price for trees sold in the eighth and ninth years is $1.66 and $2.55, respectively, while the average price received for trees was $5.05 in year eight and $3.48 for those sold in year nine. This difference between the actual price and the break-even price represents the future value of the net profit per tree sold. All indications from this hypothetical example show that investment in Christmas trees can be very financially rewarding. The primary disadvantage to Christmas tree investments is reflected in the accumulated net cash flow column which shows the large cash outlay which must be made before any income is realized.

To provide further insight into the economic potential of Christmas tree investment, the hypothetical plantation analyzed in Table 12 was analyzed assuming various production costs and land values. In an average cost operation, shown in the third column of Table 13, it was assumed that the labor- and equipment-hours required to perform each treatment were the same as the average hourly requirements calculated

from responses to the Financial Questionnaire and shown throughout this report. In a low cost operation, shown in the second column of Table 13, it is assumed that the labor- and equipment-hour requirements were two standard deviations lower than the average requirements. Similarly, in the high cost operation it is assumed that the hours required to perform each treatment are two standard deviations higher than the average labor- and equipment-hours required. Since costs vary from the average by two standard deviations, Table 13 shows the range of IRR that can be expected 95 percent of the time if a landowner implements the operations recommended in this study and has land valued from $100.00 to $1000.00 per acre.

This range of IRR is fairly impressive, and indicates that only with the most expensive land and highest costs of production would the landowner be expected to earn less than the 12 percent alternative rate of interest assumed in this study. Recalling that the survival rate for this operation was 69 percent, even with this high cost production combination and a survival rate closer to the 79 percent experienced by the typical grower interviewed, the landower may earn a IRR above 12 percent.

Table 14. Internal rates of return from hypothetical Christmas tree investments with varying production costs and land values.

Land Price	Low Cost Operation[a] (Percent)	Average Cost Operation[b] (Percent)	High Cost Operation[c] (Percent)
$100 per acre	39.781	26.388	18.392
$200 per acre	35.283	24.089	16.993
$500 per acre	26.688	18.992	13.495
$1000 per acre	18.892	13.395	9.397

[a] All treatment costs in this operation are taken as the average cost minus two standard deviations.

[b] All treatment costs in this investment are taken as the average cost based on responses to the Financial Questionnaire.

[c] All treatment costs in this investment are taken as the average cost plus two standard deviations.

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Appendix I

Cover letters

Christmas Tree Growers Questionnaire

Follow-up letters

Financial Questionnaire

COLLEGE OF AGRICULTURE AND LIFE SCIENCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DIVISION OF FORESTRY AND WILDLIFE SCIENCES (703) 552-6346

January 2, 1973

Dear Christmas Tree Grower:

The Department of Forestry and Forest Products is conducting a study on the production and marketing of Christmas trees in Virginia. This study is sanctioned by the Virginia Christmas Tree Growers Association and partially funded by a grant from the Virginia Agricultural Foundation.

The objectives of the study are to assist Virginia's farm and other small landowners in determining if investment in Christmas tree plantations is likely to be economically successful in their particular case and to provide data and analysis systems to improve production management decisions. The results should therefore assist you in managing your plantations and in making them more profitable.

The information requested on the enclosed questionnaire is essential to the study. The results of the study depend on your answering each question as accurately as possible. A response from every person sent a questionnaire is important and individual answers will be held in strictest confidence.

A pre-addressed, stamped envelope is included for your convenience in returning the questionnaire. No postage is necessary.

Thank you for your help.

Sincerely,

William A. Leuschner

William A. Leuschner
Project Leader

mln

Enclosures

114 COLLEGE OF AGRICULTURE AND LIFE SCIENCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DIVISION OF FORESTRY AND WILDLIFE RESOURCES (703) 951-5481

CHRISTMAS TREE GROWERS QUESTIONNAIRE

Dear Christmas Tree Grower:

This questionnaire should be completed by a person familiar with your operation. We hope you will answer each item carefully and completely. The success of this study depends on the completeness and accuracy of your answers.

First, we would like to ask you a few general questions.

1 - Please answer both parts a and b.

a. Have you sold one or more crops of over 100 Christmas trees?

Circle one: YES NO

b. Do you have 3 or more acres of Christmas tree plantations which have been sheared at least once? (Shearing is cutting off the ends of branches)

Circle one: YES NO

If the answer to BOTH PART a and PART b was "NO" do not complete the questionnaire. Please place it in the enclosed envelope and return it. Thank you for your cooperation.

2 - a. In what county(ies) of Virginia do you grow your Christmas trees?

_____

County(ies)

b. Which town or city is nearest to your plantation?

_____

City(ies)

Next we would like to ask you about the practices you use to grow your trees.

3 - How did you plant your trees in 1972 (or the last year you planted)?

/__/ By hand using a planting bar.

/__/ By hand using another tool _____
(specify tool)

/__/ By machine.

4 - a. Do you do anything to control undesirable vegetation such as weeds or grass.

Circle one: YES NO

If "NO" skip to question 5. If "YES" complete question 4.

b. Write the year or years after planting during which you control vegetation, for example, "1,2" if you control the 1st and 2nd years after planting or "before planting" if you control only the years before planting.

_____
(years after planting during which you control vegetation)

c. Write in the method you use to control vegetation, for example, "herbicide" or "mowing".

_____
(method(s) used to control vegetation)

5 - a. Do you shear your trees? (Shearing is cutting off the ends of the branches)

Circle one: YES NO

"If "NO" skip to question 6. If "YES" complete question 5.

b. Please list the year(s) after planting during which you generally shear your trees, their species, and the month(s) in which you

shear them. For example, write "white pine June 2-8" if you shear your white pine during June every year from the second through eighth years after planting.

	Species	Month(s) when you shear	Year(s) after planting when you shear
(1)	_____	_____	_____
(2)	_____	_____	_____
(3)	_____	_____	_____
(4)	_____	_____	_____
(5)	_____	_____	_____

c. What method did you use in 1972? (check one)

/__/ knives only

/__/ electric shears only

/__/ hand shears only

/__/ a combination of the above

/__/ other (specify) _____

6 - a. Do you prune either the butt end of your trees to form a "handle" or the upper branches to improve their shape? (Pruning is removing a branch)

Circle one: YES NO

If "NO" skip to question 7. If "YES" complete question 6.

b. Write in the year(s) after planting during which you prune and the type of pruning you do. For example, write "1,2 butt prune" if you butt prune during the 1st and 2nd years after planting or "all seasons - upper branches" if you prune the upper branches

through the life of the tree as needed and do not butt prune.

_____

(type of pruning and years after planting during which you prune)

7 - a. Do you use any other method such as spraying or coloring to improve the quality of your trees?

Circle one: YES NO

If "NO" skip to question 8. If "YES" complete question 7.

b. Please specify the additional methods you use to improve your trees' quality, for example, "spray insecticide as needed" or "spray color on trees".

_____

_____

_____

8 - a. Do you fertilize your trees?

Circle one: YES NO

If "NO" skip to question 9. If "YES" complete question 8.

b. Write in the year(s) after planting in which you fertilize, for example, "1,2" if you fertilize the 1st and 2nd years after planting or "all seasons" if you fertilize throughout the life of the tree as needed.

_____

(years after planting during which you fertilize)

c. Write in the chemical composition of the fertilizer you use, for example, "10-10-10" or "amonium nitrate 20%".

_____

(chemical composition of fertilizer)

d. On the average, how many pounds per acre or per tree do you apply a year?

_____
(pounds per acre or per tree)

The following questions concern your harvesting and selling practices.

9 - Please list your trees' species and their usual age at time of harvest.

	Species	Age at Harvest
a.	_____	_____
b.	_____	_____
c.	_____	_____
d.	_____	_____
e.	_____	_____

10 - On what dates do you generally begin and end your harvesting?

a. _____ (beginning date) b. _____ (ending date)

11 - a. In general, what percent of your trees remain uncut in your plantation and must be removed before another crop is planted?

_____
(percent)

b. What are the major reasons they were uncut. Indicate as many reasons as were important by entering the number "1" beside the most important reason, "2" beside the second most important reason, and so on.

_____ Lack of buyers for trees

_____ Poor color of tree

_____ Poor shape due to insect or disease damage

_____ Poor shape due to lack of time or labor to shear

_____ Poor shape due to fire damage

_____ Other (specify) _____

12 - a. Do you use any grading procedure to set prices on your different quality trees?

Circle one: YES NO

If "NO" skip to question 13. If "YES" complete question 12.

b. Do you use the U.S. Department of Agriculture grading system.

Circle one: YES NO

c. If "YES" skip to question 13. If "NO", what are your reasons for not using it?

_____

_____

_____

d. Please explain your grading system briefly.

_____

_____

_____

13 - Please estimate for the 1972 season, by species, the number of trees you sold, their grade (if used), and the average price per tree.

	Species	No. of Trees Sold	Grade (if used)	Avg. Price Per Tree
a.	_____	_____	_____	_____
b.	_____	_____	_____	_____
c.	_____	_____	_____	_____
d.	_____	_____	_____	_____
e.	_____	_____	_____	_____
f.	_____	_____	_____	_____

14 - Please list any customer services, such as placing individual trees in nets, which you used during 1972 AND found effective in improving your sales.

_____

_____

15 - a. Please estimate the number of trees and their average price sold by you in the 1972 Christmas season which were marketed in the following manner.

	No. of Trees Sold in 1972	Avg. Price Per Tree
Sold on stump to wholesaler	_____	_____
Cut and sold bundled or unbundled to retailer or wholesaler at roadside	_____	_____
Cut and sold bundled or unbundled to retailer or wholesaler at his lot	_____	_____
Sold "Cut and Choose" to public at plantations	_____	_____
Cut and retailed by you	_____	_____
Balled stock (live trees with roots wrapped in burlap) sold at retail	_____	_____
Other (specify)	_____	_____

b. Please write in the estimated number of by-products such as wreaths, roping, or boughs, which you sold in 1972 and their average price. For example, "none" if you did not sell any or "200 feet of roping at 50¢ a foot". _____

Our final questions concern the number of trees you are now growing and which you plan to grow.

16 - How many trees and what species do you plan to plant in the future?

	SPECIES			
Year				
1973				
1974				
1975				

17 - Please fill in the number of trees and acres in your plantations by their species and the number of years since they were planted.

	1972		1971		1970		1969		1968		1967	
	1		2		3		4		5		6 and Over	
Species	No. Trees	No. Acres	No. Trees	No. Acres	No. Trees	No. Acres	No. Trees	No. Acres	No. Trees	No. Acres	No. Trees	No. Acres

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE. PLEASE CHECK BACK TO SEE THAT YOU HAVE ANSWERED EVERY QUESTION. IF SO, PLEASE RETURN THE QUESTIONNAIRE IN THE STAMPED, ADDRESSED ENVELOPE TO:

Dr. William A. Leuschner
Department of Forestry and Forest Products
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

123 COLLEGE OF AGRICULTURE AND LIFE SCIENCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DIVISION OF FORESTRY AND WILDLIFE RESOURCES · (703) 951-5481

January 25, 1973

Dear Christmas Tree Grower:

Several weeks ago you received a questionnaire requesting information to be used in determining the economic aspects of Christmas tree production and marketing in Virginia.

As of yet, we have not received your questionnaire, which is needed to complete the study. If you still have your copy of the questionnaire we sent you, we request that you complete and return it to us as soon as possible. If you do not have a copy of the questionnaire, please notify us, and we will send you another one.

It is very important that we receive as much information as possible in order to make the results of this study meaningful. When this project is completed we will be able to determine the key factors essential to a successful Christmas tree operation. These results will aid you in becoming even a better manager.

Thank you very much for your vital help.

Sincerely,

William A. Leuschner

William A. Leuschner
Project Leader

mln

124 COLLEGE OF AGRICULTURE AND LIFE SCIENCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DIVISION OF FORESTRY AND WILDLIFE RESOURCES (703) 951-5481

February 16, 1973

Dear Christmas Tree Grower:

On January 2 and 25 we wrote you requesting certain information about your Christmas tree growing activities. Our records indicate that as of this date we still have not received your reply and we were wondering if the questionnaire had been misplaced or forgotten.

It is extremely important that we have your completed questionnaire, even if the answers to the first question are both "NO", and I would like to urge you to take the time this evening to complete it and return it to us. Enclosed is another questionnaire and stamped, addressed envelope in case you have misplaced the first.

Thank you.

Sincerely,

William A. Leuschner

William A. Leuschner
Project Leader

mln

Enclosures

COST DATA -- CHRISTMAS TREE GROWERS' QUESTIONNAIRE

Date: _____

Plantation Owner: _____

Owners Address: _____

_____

Plantation Location: _____

_____

_____

You were selected in a sub-sample from which we will get detailed information on the costs of growing Christmas trees. This sub-sample includes people who have at least several years experience of successfully managing an intensive Christmas tree operation and who, we feel, will be able to give us the kind and quality of information we need to complete this study.

Before we start I'd like to assure you that your answers are strictly confidential. This information we receive on costs will be coupled with the information from the first questionnaire we sent out in January so that we can make a financial analysis of Christmas tree production in Virginia. The final results will contain no information that can be identified as coming from any particular individual.

We'll begin with a few general questions, then I'd like to ask the questions in the order in which the costs would normally occur; that is, planting, stand improvement, harvesting, and finally marketing.

1. Do you have any insurance coverage which protects you against loss or death of your trees?

   _____ yes

   _____ no

   If "no", go to 2.

   a. What does this protect you against, as, fire, theft, disease, etc. _____

   b. How many acres are covered by this insurance? _____

   c. What is the annual cost of this insurance? _____

2. Now we will move into the general area of planting, which includes site preparation, planting, replanting following mortality and replanting following harvest.

   a. Prior to your last planting, did you do anything to control undesirable vegetation or to otherwise improve the site for your seedlings?

      _____ yes

      _____ no If "no" go to 3.

   b. Is this a standard part of your planting operation?

      _____ yes

      _____ no

      1) Before your last planting how did you prepare the site, for example, by using heavy equipment such as a tractor and disc, or by the use of herbicides, or by removing stumps?

         _____ Heavy machinery (go to 2c)

         _____ Chemical (go to 2d)

         _____ both (go to c and d)

_____ stump removal (go to 2e)

c. Questions for the site preparation done using heavy machinery.

1) How many years before planting did you prepare the site?

_____

2) What equipment did you use for this? We will need both the size and type. _____

_____

3) On the average, how many hours did it take for one unit of this equipment to complete work on 1 acre? _____

4) How many men were needed to operate 1 unit of this machinery?

_____

5) Did you have any workers other than those operating this equipment?

_____ yes

_____ no

6) If yes, on the average, how many hours were needed for each of these workers to complete 1 acre? _____

7) What was the wage rate for each type of worker? _____

_____

8) Did you or any of your family do any of this work which hasn't been included above? _____

9) If yes, on the average, how many hours did it take you to complete work on 1 acre? _____

d. Questions for site preparation using chemicals

1) How many years before planting did you apply the chemical?

_____

2) What types of equipment did you use to apply the chemical?

_____

3) On the average, how many hours were needed for one unit of this equipment to complete work on 1 acre? _____

4) How many men were needed to operate one unit of this equipment? _____

5) Did you have any workers other than those operating this equipment?

_____ yes

_____ no

6) If yes, on the average, how many hours were needed for each of these workers to complete 1 acre? _____

7) What was the wage rate for each type of worker? _____

_____

8) What were the chemicals used? _____

_____

9) On the average, how many pounds of each chemical were applied per acre? _____

10) Did you or any of your family do any work which hasn't been included above? _____

11) If yes, on the average, how many hours did it take you to complete work on 1 acre? _____

e. Stump Removal

1) How many years before planting were the stumps removed?

_____

2) On the average, how many stumps per acre were removed?

_____

3) What equipment was used for this? _____

4) How many stumps could one unit of this equipment remove in an hour? _____

5) How many men were needed to operate this equipment?

_____

6) Did you have any other workers, not operating equipment, but whose time was spent helping to remove stumps? _____

7) What was the wage rate for your workers? _____

8) Did you or any of your family do any of this work which hasn't been included in the above labor?

_____ yes

_____ no

9) If yes, how many hours were required for you to complete work on one acre? _____

Now, I'd like to move to your planting operation. Here we'll only be concerned with the planting you do following the clear-cutting of a stand, or planting done following complete mortality of the previous stand.

3. Planting

a. In what year did you last plant? _____

b. What equipment did you use last time you planted?

_____ hand tools (go to 3c)

_____ machinery (go to 3d)

_____ both (do both c & d)

c. Questions for planting done using hand tools.

1) What was the cost per thousand of your seedlings for each

species you planted by hand?

2) What spacing, or how many seedlings per acre, did you use for each species?

3) What was the survival rate for each species planted by hand?

Species	Cost/M	Spacing	Survival Rate

4) What hand tools were used in planting? _____

_____

5) On the average, how many trees did 1 man plant in an hour?

_____

6) Did you have any workers other than those planting trees?

_____ yes

_____ no

7) If yes, on the average, how many hours were needed for each of these workers to complete 1 acre? _____

8) What was the wage rate for each worker? _____

9) Did you or any of your family do any planting work which hasn't been considered?

_____ yes

_____ no

10) If yes, on the average, how many hours were needed for you to complete work on 1 acre? _____

d. Questions for planting done using machinery

1) What was the cost per thousand of your seedlings for each species you planted by machinery?

2) What spacing, how many seedlings per acre, did you use for each species?

Species	Cost/M	Spacing	Survival Rate
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

3) What machinery was used for planting? We will need both the size and type. _____

_____

4) On the average, how many trees were planted in 1 hour using this type of machinery? _____

5) How many men were required to operate 1 unit of this machinery? _____

6) Did you have any workers other than those operating the planting equipment?

_____ yes

_____ no

7) If yes, on the average, how many hours were needed for each of these workers to complete 1 acre? _____

8) What was the wage rate for each type of worker? _____

_____

9) Did you or any of your family do any of this work which hasn't been considered? _____

10) If yes, how many hours did it take you to complete work on 1 acre? _____

Now lets consider any replanting you do to compensate for any trees which died within a year or 2 after planting?

4. Replanting following mortality

a. Have you done any of this type of replanting in the last two years?

_____ yes

_____ no If "no" go to 5.

1) How many replantings were required for each species before you achieved adequate stocking?

Species	# of replanting
_____	_____
_____	_____
_____	_____

If more than 1 replanting was needed for a particular species, repeat 4b as many times as needed.

4. b. For each species, with your first (2nd or 3rd) replanting, how many seedlings per acre did you replant.

Species	1st Replanting trees/acre	2nd Replanting trees/acre	3rd Replanting trees/acre

1) How many years after planting did your 1st (2nd or 3rd) replanting occur? _____

2) What equipment was used for this replanting? _____

_____

3) How many trees could 1 man replant in an hour? _____

4) What was the wage rate for each type of worker? _____

_____

5) Did you or any of your family do any replanting work which hasn't been considered?

_____ yes

_____ no

6) If yes, how many trees did you plant in an hour? _____

7) If respondent has insurance: did your insurance reimburse you for any of these costs?

_____ yes

_____ no

8) If yes, how much did you receive per acre? _____

The next several questions will apply to replanting you do to replace trees which were harvested in a selective or "choose and cut" harvest.

5. Replanting following a harvest

a. Have you done any replanting immediately following a selective harvest in the last two years?

_____ yes

_____ no If "no" go to 6

1) For each species you replanted in this way, how many seedlings per acre did you plant?

Species	Seedlings/Acre	Survival Rate

2) What was the survival rate for each species replanted?

3) How many years after harvest did the replanting occur?

_____

4) What equipment was used for replanting? _____

_____

5) On the average, how many trees were planted in an hour by 1 man or 1 unit of machinery? _____

6) What was the wage rate for each type of worker? _____

_____

7) Did you have any other workers other than those planting the trees? _____

8) If yes, how many hours did it take for 1 man to finish work on 1 acre? _____

9) Did you or any of your family do any replanting not included above?

_____ yes

_____ no

10) If yes, how many hours did you spend working on 1 acre?

_____

That should complete all of the costs associated with your planting operation. Now we will go to stand improvement costs. Here we will be interested in pruning, shearing, fertilization, weed and insect control, as well as anything else you might do to improve the quality or survival of your trees.

We will start with pruning and shearing.

In this study we have defined pruning as the complete removal of branches, while shearing is the trimming of the ends of the branches.

6. Pruning

a. Have you done any pruning in the last two years?

_____ yes

_____ no If "no", go to 7

1) What equipment do you use to prune your trees? _____

_____

2) How many trees can 1 man prune in an hour? _____

3) What was the wage rate for your workers? _____

4) On the average, how many trees per acre do you prune?

_____

5) Did you have any other workers who were not actually pruning, but whose time was used in this operation?

_____ yes

_____ no

6) If yes, how many hours did they spend working on 1 acre?

_____

7) Did you or any of your family do any pruning which hasn't been considered?

_____ yes

_____ no

8) If yes, how many hours did you spend working on 1 acre?

_____

7. Shearing

a. Have you done any shearing in the last two years?

_____ yes

_____ no If "no" go to 8

1) What size trees have you sheared in the last two years?

_____ under 3 feet

_____ 3 ft. to 5 ft.

_____ over 5 feet

2) What equipment do you use to shear? _____

_____

3) For each of these sizes, how many trees can 1 man shear in an hour? _____

4) On the average, how many trees per acre do you shear?

_____

5) What was the wage rate for each type of worker? _____

_____

6) Did you have any other workers who were not actually shearing but whose time was used in this operation?

_____ yes

_____ no

7) If yes, how many hours did they spend working on 1 acre?

_____

8) Did you or any of your family do any shearing which hasn't been considered?

_____ yes

_____ no

9) If yes, how many hours did you spend working on 1 acre?

_____

8. Fertilization

a. Have you fertilized or limed any of your stands in the last two years?

_____ yes

_____ no If "no" go to 9

1) What types of fertilizers do you use?

2) What type of applicator is used for each fertilizer?

3) How much of each fertilizer is applied per acre? or per tree?

4) How many trees can one man fertilize in an hour?

Fertilizer Type	Applicator	lbs/acre	trees/hour
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

5) What is the wage rate for your workers? _____

6) Do you or any of your family do any of this work which hasn't been considered?

_____ yes

_____ no

7) If yes, how many hours an acre do you work at this? _____

9. Weed Control

a. After planting the stand, have you done anything to control undesirable vegetation in last two years?

_____ yes

_____ no

1) What type of weed control do you practice?

_____ mowing go to 9b

_____ herbicide go to 9c

_____ both go to 9b & c

b. Questions for weed control using mowing

1) What size and type of mower do you use? _____

2) How many hours does it take for 1 mower to complete 1 acre?

_____

3) How many men are needed to operate each mower? _____

4) What is the wage rate for these workers? _____

5) Did you or any of your family do any of this work which hasn't been considered?

_____ yes

_____ no

6) If yes, how many hours did it take you to complete work on 1 acre? _____

c. Questions for weed control using herbicide.

1) What type of chemical do you use? _____

2) How much of each chemical do you apply per acre? _____

3) Do you apply the chemical in strips, or treat the whole area?

_____

4) What type of applicator do you use? _____

5) How many hours does it take for one applicator to apply the chemical on 1 acre? _____

6) What is the wage rate for your workers? _____

7) Did you or any of your family do any of this work which hasn't been considered?

_____ yes

_____ no

8) If yes, how many hours did it take you to complete work on 1 acre? _____

10. Insect Control

a. Did you do anything to control insects in the last 2 years?

_____ yes

_____ no If "no", go to 11

1) How many years after planting is the insecticide used?

_____

2) What chemicals do you use for this? _____

3) How much of the chemical is applied per acre? _____

4) What type of applicator do you use? _____

_____

5) How many hours does it take to apply the insecticide on 1 acre? _____

6) What was the wage rate for your workers? _____

7) Did you or any of your family do any of this work which hasn't been considered?

_____ yes

_____ no

8) If yes, how many hours did it take you to complete work on 1 acre? _____

11. Additional Stand Improvement

a. Do you do anything else to improve the quality of your trees?

_____ yes

_____ no If "no" go to 12

1) What additionally is done? _____

_____

2) What equipment is used for this? _____

_____

3) If chemical is used, how much chemical is applied per acre (or per tree)? _____

4) How many hours are required to complete work on one acre; or, how many trees can be treated in an hour? _____

5) What is the wage rate for your workers? _____

6) Did you or any of your family do any of this work which hasn't been included above?

_____ yes

_____ no

7) If yes, how many hours are required for you to complete work on 1 acre? _____

12. Preparing for harvest

a. During 1972, did you have to spend any time marking or identifying those trees that would be harvested either in a selective cut or a choose and cut operation?

_____ yes

_____ no (go to 13)

1) On the average, how many hours were needed per acre to determine and mark those trees that would be cut? _____

2) On the average, how many trees per acre were marked? _____

3) What was the cost/100 trees of your flagging material?

_____

4) What was the wage rate for the workers who marked these trees?

_____

5) Did you or any of your family do any of this work which hasn't been considered?

_____ yes

_____ no

6) If yes, how many trees per hour did you mark? _____

13. Harvesting

a. Did you sell any balled stock in 1972? Balled stock is live trees sold with their roots wrapped in burlap.

_____ yes

_____ no (go to 13b)

1) Did the customer dig his own tree or did you dig it for him?

_____ customer digs (go to 13a-4)

_____ grower digs

2) How many men worked together to dig a particular tree? ___

3) How many hours were required to dig one tree? _____

13. a. 4) What equipment was used to place the burlap on the roots?

_____

5) How many men worked at wrapping the roots? _____

6) How many hours were required to wrap the roots of one tree?

_____

7) How were the trees transported to the roadside or customers' car? _____

8) How much time was needed to carry a tree to the roadside?

_____

9) What was the wage rate for your workers? _____

13. b. Did you sell any trees during 1972 that were cut:

Yes	No	
___	___	1) by a wholesaler without your labor?
___	___	2) by customers in a "choose and cut"? (go to 13c)

Yes No

___ ___ 3) In a clear-cut by you? That is, a harvest in which your labor cut essentially all trees in a particular stand? (go to 13d)

___ ___ 4) In a selective harvest by you? That is, a harvest in which your labor cut only those trees that met certain requirements? (go to 13c)

NOTE: If part 1 is the only question answered "yes", go to Question 19.

13. c. Selective Harvest

1) What equipment was used to cut the trees in a selective harvest? _____

2) How many trees could 1 of your workers harvest in an hour?

_____

3) What was the wage rate for your workers? _____

4) Did you or any of your family do any of this harvesting work?

_____ yes

_____ no

5) If yes, how many trees did you harvest in an hour? _____

Return to 13b

13. d. Clear-cut Harvest

1) What equipment was used to clear-cut your trees? _____

_____

2) How many trees could 1 man harvest in an hour? _____

3) What was the wage rate for your workers? _____

4) Did you, or any of your family, do any of the harvesting work?

_____ yes

_____ no

5) If yes, how many trees did you harvest in an hour? _____

Return to 13b

13. e. Choose and Cut

1) Does the customer cut his own tree, or do you cut it for him?

_____ customer cuts

_____ grower cuts

2) What equipment do you furnish either for cutting the tree or for hauling it to the customers' car? _____

_____

3) How many days during the Christmas season are your trees available for sale? _____

4) During what hours of the day can trees be purchased?

_____

14. Roadsiding

a. Following your 1972 harvest, did you haul any trees from the plantations to the roadside?

_____ yes

_____ no (go to 19)

1) What equipment did you use to haul these trees to the roadside? _____

2) How many trees were taken each trip to the roadside?_____

3) How many hauls were made from the plantation to the road in an hour? _____

4) How many men did you use in transporting these trees to the roadside? _____

5) What was the wage rate for your workers? _____

6) Did you, or any of your family, do any of this work which hasn't been considered?

_____ yes

_____ no

15. Bundling

a. Did you handle any trees that were harvested in 1972?

_____ yes

_____ no (go to 16)

1) What kind of bundling material did you use? _____

_____

2) What was the cost of the bundling material per tree or per 100 trees? _____

3) What equipment was used to put the bundling on the trees?

_____

4) How many men were used to put this material on the trees?

_____

5) How many trees were bundled? _____

6) How many trees could be bundled in an hour? _____

7) What was the wage rate for your workers? _____

8) Did you, or any of your family, do any of this work which hasn't been considered?

_____ yes

_____ no

9) If yes, how many trees did you help bundle in an hour?

_____

16. Loading

a. After you brought the trees to the roadside, was it necessary to load them onto other vehicles?

_____ yes

_____ no (go to 17)

1) What type of vehicles were the trees loaded onto? _____

_____

2) How many trees were loaded in an hour? _____

3) How many men were used to load the trees? _____

4) What was the wage rate for your workers? _____

5) Did you or any of your family do any loading work which hasn't been considered?

_____ yes

_____ no

6) If yes, how many trees did you load in an hour? _____

17. Transporting

a. Did you transport any trees from your roadside to a buyer's lot?

_____ yes

_____ no (go to 19)

1) What type of equipment was used to transport these trees?

_____

2) How many trees were taken in 1 trip to the buyer's lot?

_____

3) How many hours were needed to make a one-way trip? _____

4) What was the wage rate for the workers you had transporting these trees? _____

18. Unloading

a. After transporting the trees to the buyer's lot, did you have to furnish the labor for unloading the trees?

_____ yes

_____ no (go to 19)

1) How many trees were unloaded in an hour? _____

2) How many men were used to unload the trees? _____

3) What was the wage rate for your workers? _____

4) Did you, or any of your family do any unloading work which hasn't been considered?

_____ yes

_____ no

5) If yes, how many trees an hour did you help unload? _____

19. As a final question, how many hours do you spend planning and organizing your management in an average week of the year? _____

How many weeks during the year are you occupied with this kind of work? _____

Appendix II: Standardized costs used in the discussion and analysis of Christmas tree production

The following tables in this appendix list the unit costs of purchasing and operating the various types of equipment and materials in common use by Virginia Christmas tree producers. These costs have been used in analyzing the economic aspects of Christmas tree production in the state as a whole, and will be used to analyze the individual grower's plantation unless he specifically supplies other input data.

Table I gives a detailed listing of the total cost and assumed hours of annual use of mechanized Christmas tree production equipment, taken for the most part from Smith and Oliver (1972). The ownership costs include allowance for capital recovery, insurance, taxes, and housing. These costs must be paid regardless of the level of use, although the hourly ownership costs depend directly on the hours of annual use. For example, if the ownership cost of some piece of equipment is $500.00, the ownership cost per hour will be $5.00 if the machine is used 100 hours per year, but only $2.00 per hour if used 250 hours per year. Thus, a machine's cost per hour declines as its use per year increases. The operating cost of equipment includes items such as fuel, lubricants, maintenance, and repairs, and this cost will remain constant regardless of the hours of use. The total cost of using equipment is, therefore, the sum of the hourly ownership and hourly operating costs.

The estimates of hours of annual use, which have a significant effect on the standardized costs chosen, are taken from responses made to the Financial Questionnaire. For example, it was found that the average annual

use of a 12 horsepower tractor was 250 hours, while an 8 horsepower tractor was used 100 hours per year. Thus, the hourly ownership cost of the 8 horsepower tractor is substantially higher than that of a 12 horsepower tractor, making its total hourly cost higher, even though an 8 horsepower tractor has a lower operating cost. Because of the responsiveness of the hourly equipment cost to hours of annual use, the grower should provide his own estimates of equipment cost if his hours of use significantly differ from those assumed in this study.

The costs of materials, shown in Appendix Table II, the costs of hand tools, in Appendix III, and the costs of labor, in Appendix Table IV, are self-explanatory. Although these are realistic cost estimates, the grower should again supply his own unit costs if greatly different from those assumed. Appendix Table V presents a summary of the labor- and equipment-hours required, amount of material used, and total cost of each treatment involved in Christmas tree production.

Appendix Table I. Operating costs of mechanized Christmas tree production equipment

Type and Size of Equipment	Hours of Annual Use	Owner's Cost per Hour (dollars)	Operating Cost per Hour (dollars)	Total Cost per Hour (dollars)
Crawler Tractor[a]	-			
68 Horsepower	-	-	-	14.00
125 Horsepower	-	-	-	18.00
Wheel-type Tractor				
30 Horsepower	150	4.26	0.84	5.10
12 Horsepower	250	0.83	0.44	1.27
8 Horsepower	100	1.41	0.30	1.71
Cultivator				
7 ft. chisel plow	50	2.07	0.63	2.70
8 ft. lift-type disk	50	2.30	0.67	2.87
2 bottom mounted plow	50	2.89	0.55	2.34
Miscellaneous				
55 gal. power sprayer	50	1.01	0.27	1.28
single row transplanter	25	2.07	0.27	2.34
5 ft. mounted mower	25	2.51	0.24	2.75
wheeled trailer	25	1.32	0.08	1.40
pickup truck	250	2.48	0.72	3.20
chainsaw	100	0.80	0.40	1.20
lawnmower	100	0.75	0.50	1.25

[a]Rates for crawler tractors are from Commomwealth of Virginia, 1971.

All other rates are from E. S. Smith and J. D. Oliver, 1972.

Appendix Table II. Cost assumptions for chemicals used in the production of Christmas trees.

Chemical type and Name	Units of Measure	Cost per Unit (Dollars)
Herbicides		
Simazine	pounds	2.80
2,4,5-T	gallons	16.00
2,4-D	gallons	5.50
Insecticides		
Malathion	gallons	7.25
Cygon	gallons	15.50
Sevin	gallons	8.50
Chlordane	gallons	8.25
Fertilizers		
10-10-10	pounds	0.045
Lime	pounds	0.012
Coloring		
Greenzit	gallons	6.00

Source: Higgs and Young Co., Roanoke, Virginia.

Appendix Table III. Cost assumptions for manually operated Christmas tree production equipment

Equipment Type and Size	Purchase Price (Dollars)
Shearing knife	9.00
Hand shears	8.25
Planting bar	6.95
Bow saw	4.75
3.5 gal. tank sprayer	19.00

Source: Forestry Suppliers, Inc., 1973 General Catalog No. 22, Jackson, Mississippi.

Appendix Table IV. Standardized labor costs assumed in the production of Christmas trees

Type of worker	Labor Cost Dollars[a]	Size of crew	Average Labor Cost (Dollars)
Common laborer	2.25	one man	300
Foreman or landowner	3.00	two men	2.62
		three men	2.50
Equipment operator	3.50	four men	2.44

[a] Source: Virginia Division of Forestry. "Rates suggested as guidelines for work completed by private contractors and/or landowners for reforestation of timberlands projects", 1971.

Appendix Table V. Labor- and equipment-hours required, amount of material used, and total cost per unit in implementing the production, harvesting, and marketing treatments involved in Christmas tree production.

Operation/Treatment	Number of Observations	Unit[a] Basis	Equipment[b] Hours Per Unit	Labor[b] Hours Per Unit	Material[b] Amount Per Unit	Total Cost[c] Per Unit (Dollars)
Site Preparation						
Clearing						
D-6 Catepillar	3	acre	6.03	6.03	0	108.54
D-4 Catepillar	3	acre	10.00	10.00	0	140.00
Cultivation						
30 HP Tractor and plough	5	acre	3.84	3.84	0	43.39
30 HP Tractor and Disk	5	acre	3.24	3.24	0	37.16
30 HP Tractor and Drag	3	acre	1.55	1.55	0	17.78
30 HP Tractor and Subsoiler	3	acre	4.50	4.50	0	49.23

Appendix Table V. Labor- and equipment-hours required, amount of material used, and total cost per unit in implementing the production, harvesting, and marketing treatments involved in Christmas tree production. (continued)

Operation/Treatment	Number of Observations	Unit[a] Basis	Equipment[b] Hours Per Unit	Labor[b] Hours Per Unit	Material[b] Amount Per Unit	Total Cost[c] Per Unit (Dollars)
Site Preparation						
Mowing						
30 HP Tractor and Mower	8	acre	0.91	1.03	0	10.23
12 HP Tractor and Mower	5	acre	5.50	7.10	0	28.28
Herbicide						
Hand Applicator	5	acre	0	5.50	3.00 lbs	24.90
12 HP Tractor and 50 gal sprayer	3	acre	0.92	0.92	0.75 gals	20.63
Planting						
Hand Tools	20	M tr.	0	19.90	1000 trees	85.82
30 HP Tractor and Machine Planter	6	M tr.	3	7.14	1000 trees	73.12

Appendix Table V. Labor- and equipment-hours required, amount of material used, and total cost per unit in implementing the production, harvesting, and marketing treatments involved in Christmas tree production (continued)

Operation/Treatment	Number of Observations	Unit[a] Basis	Equipment[b] Hours Per Unit	Labor[b] Hours Per Unit	Material[b] Amount Per Unit	Total Cost[c] Per Unit (Dollars)
Replanting						
Hand tools						
First year after planting	21	M tr.	0	19.90	1000 trees	81.85
Second year after planting	14	M tr.	0	12.10	1000 trees	62.35
Following a partial harvest	5	M tr.	0	29.98	1000 trees	107.50
Shearing						
Knives						
Trees under 3 ft	9	M tr.	0	18.48	0	46.20
Trees 3 to 5 ft	9	M tr.	0	20.75	0	51.18
Trees over 5 ft	9	M tr.	0	23.67	0	59.18

Appendix Table V. Labor- and equipment-hours required, amount of material used, and total cost per unit in implementing the production, harvesting, and marketing treatments involved in Christmas tree production (continued).

Operation/Treatment	Number of Observations	Unit[a] Basis	Equipment[b] Hours Per Unit	Labor[b] Hours Per Unit	Material[b] Amount Per Unit	Total Cost[c] Per Unit (Dollars)
Shearing						
Hand Shears						
Trees under 3 ft	21	M tr.	0	16.43	0	41.08
Trees 3 to 5 ft	21	M tr.	0	25.69	0	64.22
Trees over 5 ft	21	M tr.	0	33.15	0	82.88
Joint with Pruning						
Trees under 3 ft	9	M tr.	0	23.40	0	58.50
Trees 3 to 5 ft	9	M tr.	0	29.07	0	72.68
Trees over 5 ft	9	M tr.	0	33.59	0	83.98

Appendix Table V. Labor- and equipment-hours required, amount of material used, and total cost per unit in implementing the production, harvesting, and marketing treatments involved in Christmas tree production (continued).

Operation/Treatment	Number of Observations	Unit[a] Basis	Equipment[b] Hours Per Unit	Labor[b] Hours Per Unit	Material[b] Amount Per Unit	Total Cost[c] Per Unit (Dollars)
Pruning						
Hand shears	15	M tr.	0	15.73	0	39.32
Vegetation Control						
Mowing						
30 HP tractor and mower	4	acre	1.25	1.25	0	11.60
12 HP tractor and mower	15	acre	1.84	1.84	0	7.86
6 HP tractor and mower	12	acre	2.33	2.33	0	11.03
2 HP lawnmower	6	acre	3.22	3.22	0	13.68
Herbicide						
Hand applicator	8	M tr.	0	2.31	3.3 lbs	16.17

Appendix Table V. Labor- and equipment-hours required, amount of material used, and total cost per unit in implementing the production, harvesting, and marketing treatments involved in Christmas tree production (continued).

Operation/Treatment	Number of Observations	Unit[a] Basis	Equipment[b] Hours Per Unit	Labor[b] Hours Per Unit	Material[b] Amount Per Unit	Total Cost[c] Per Unit (Dollars)
Vegetation Control						
Herbicide						
12 HP Tractor and 50 gal Sprayer	3	M tr.	0.81	0.81	3.5 lbs	12.23
30 HP Tractor and 100 gal Sprayer	4	M tr.	0.74	0.74	3.2 lbs	11.18
Insect Control						
Hand sprayer	12	M tr.	0	3.11	1.25 gal	18.81
12 HP Tractor and 50 gal Sprayer	8	M tr.	2.02	2.02	1.25 gal	21.82
Artificial Coloring						
12 HP Tractor and 50 gal Sprayer	3	M tr.	10.99	10.99	18.00 gal	169.11

Appendix Table V. Labor - and equipment-hours required, amount of material used, and total cost per unit in implementing the production, harvesting, and marketing treatments involved in Christmas tree production (continued).

Operation/Treatment	Number of Observations	Unit[a] Basis	Equipment[b] Hours per Unit	Labor[b] Hours Per Unit	Material[b] Amount Per Unit	Total Cost[c] Per Unit (Dollars)
Fertilization						
hand applicator	8	M tr.	0	2.73	149 lb	14.04
12 HP Tractor and Spreader	2	M tr.	0.58	0.58	343 lb	41.34
Inventory						
tagging trees for harvest	12	M tr.	0	4.55	0	11.92
Bundling						
Vexar and hand funnel	5	M tr.	20.89	62.66	0	334.15
Harvesting						
Partial harvest						
hand saw	2	M tr.	0	40.00	0	120.00
chain saw	11	M tr.	19.47	19.47	0	81.77

Appendix Table V. Labor- and equipment-hours required, amount of material used, and total cost per unit in implementing the production, harvesting, and marketing treatments involved in Christmas tree production (continued).

Operation/Treatment	Number of Observations	Unit[a] Basis	Equipment[b] Hours Per Unit	Labor[b] Hours Per Unit	Material Amount Per Unit	Total Cost[c] Per Unit (Dollars)
Harvesting						
Partial harvest						
12 HP Tractor Mounted saw	2	M tr.	7.77	7.77	0	36.60
Clearcut Harvest						
12 HP Tractor Mounted saw	1	M tr.	0	240.50	0	630.11
Choose and Cut						
Cut by grower or consumer	17	M tr.	0	503.82	0	1259.55
Transporting						
To roadside						
Hand	7	M tr.	0	34.75	0	91.15
30 HP Tractor and Trailer	4	M tr.	10.24	35.52	0	159.62

Appendix Table V. Labor- and equipment-hours required, amount of material used, and total cost per unit in implementing the production, harvesting, and marketing treatments involved in Christmas tree production (continued).

Operation/Treatment	Number of Observations	Unit[a] Basis	Equipment[b] Hours Per Unit	Labor[b] Hours Per Unit	Material Amount Per Unit	Total Cost[c] Per Unit (Dollars)
Transporting						
To Roadside						
Truck	4	M tr.	87.50	153.33	0	664.22
To Retail Lot						
Truck	7	M tr.	32.66	58.97	0	259.01
Loading						
Onto Trucks at Roadside	10	M tr.	0	32.00	0	83.84
Off of trucks at Retail Lot	7	M tr.	0	17.08	0	44.75

[a] The abbreviation M tr. denotes costs are on a per 1000 tree basis.

[b] These figures are the weighted averages of growers' responses to the Financial Questionnaire.

[c] The figures are obtained by multiplying the appropriate unit costs from tables I, II, and IV, by the equipment, labor, and material requirements and summing the products.

Appendix III. Two-way analysis of variance of the prices received for Christmas trees sold in 1972 by Virginia producers

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An analysis of variance procedure was used to analyze species and marketing system effects on the selling price of Christmas trees. Since not all species were sold in each of the five marketing systems, sufficient data were available only for Scotch pine and eastern white pine. Price observations were classified according to the species and the marketing method used. The price received by a grower for each species sold using each of the five marketing systems was treated as one observation. This produced a two-way classification with an unequal number of replications in each cell.

The Statistical Analysis System, designed by Barr and Goodnight (1972), was used to evaluate the data. The results, shown in Table IV, indicate that the price differential between Scotch and white pine is nonsignificant at the 95 percent level, while there is a very significant difference, at the 99.9 percent level, in the price received for trees sold using different marketing systems. The interaction between species and marketing system is also nonsignificant, indicating that the marginal price received for white pine between any two marketing systems is not significantly different than the marginal price received for Scotch pine between the same two systems.

Appendix Table VI. Analysis of variance for variable price

Source of Variation	Degrees of freedom	Sum of Squares	Mean Square	F Value
Marketing System Used	4	154.587	38.647	11.581***
Species Being Sold	1	7.976	7.976	2.390 n.s.
Interaction	4	0.909	0.227	0.068 n.s.
Residual	67	223.579	3.337	
Total	76	387.052	5.093	

Appendix Table VII. Number of acres planted in Christmas trees and number of growers in the Virginia industry by years.

Species	Year of Planting 1972	1971	1970	1969	1968	1967 or before	Total All Years
White pine	46.33	48.32	54.81	51.00	127.50	114.66	442.62
Scotch pine	50.20	36.40	46.30	53.60	28.70	115.80	331.00
Douglas-fir	3.3	0	3.50	0.50	0.50	6.50	14.30
Fraser fir	1.50	6.00	0.50	6.00	6.00	17.50	32.00
Spruces	3.62	7.50	2.40	2.58	2.58	39.44	65.57
Other pine[a]	0.	1.00	1.50	2.00	2.00	11.00	17.10
Other species[b]	1.00	0.50	0.50	1.95	1.95	2.60	6.55
Total All Species	106.55	99.72	109.51	116.63	169.23	307.50	909.14
Number of Growers in Industry	67	65	65	59	52	48	

[a]Other pine include red, 1 blolly, and Austrian pines.

[b]Other species include balsam fir and eastern redcedar.

Appendix Table VIII. Listing of source deck for investment analysis computer program.

```
      DIMENSION PRICE(6,12),REVNUE(16),SYSREV(6,16),
     1SPPREV(12,16),EQPCST(13,10),EQPHRS(13,10),PRCST(13,10),
     2PRHPS(13,10),COST(14,16),ATCST(13,10),ATAMT(13,10),
     3TOTCOS(16),GETREV(16),DISREV(16),DISCOS(16),P(16),
     4BPTCOS(16),BPT(16),ACCREV(16),UNITS(2),SOLD(16),
     5SYSNAM(25),SPPNAM(44),OPNAME(104),ASUMLH(13,10),
     6EQNAME(13,40)
C
C      ESTABLISHMENT OF VARIABLES
C
      LENBOT = 0
      RATE = 1.12
      ACRES = 5.00
      ALAND = 200.
      ALAVAL = ACRES * ALAND
      LL = 0
      LLL = 0
      LLLL = 0
      DO 2 I = 1,14
      DO 1 K = 1,16
      BPT(K) = 0
      SOLD(K) = 0
      COST(I,K) = 0
      TOTCOS(K) = 0
    1 CONTINUE
    2 CONTINUE
      DO 5 I = 1,13
      DO 4 J = 1,10
      ASUMLH(I,J) = 0
    4 CONTINUE
    5 CONTINUE
      TOTCOS(1) = 150.00
      READ(5,  7)(OPNAME(J),J = 1,104)
    7 FORMAT(20A4,/,20A4,/,12A4,/,20A4,/,20A4,/,12A4)
      READ(5,  9) ((EQNAME(I,J),J=1,40),I=1,13)
    9 FORMAT(25(20A4,/),20A4)
      READ(5,8) ((EQPCST(I,J),J = 1,10),I = 1,13)
      READ(5,8) (( EQPHRS(I,J), J=1,10), I = 1,13)
      READ(5,8) (( PRCST(I,J), J = 1,10),I = 1,13)
      READ(5,8) (( PRHPS(I,J), J = 1,10),I = 1,13)
      READ(5,8) (( ATCST(I,J),J = 1,10), I = 1,13)
      READ(5,8) (( ATAMT(I,J), J = 1,10), I = 1,13)
    8 FORMAT(8(16F5.2,/),2F5.2)
      READ(5, 11)(SYSNAM(J),J=1,25)
   11 FORMAT(20A4,/,5A4)
      READ(5, 13)(SPPNAM(J),J=1,44)
   13 FORMAT(20A4,/,20A4,/,4A4)
C
C       ENTER BASIC COST DATA HERE IF DIFFERENT THAN THE UNIT
C       COSTS AND HOURS ASSUMED
```

Appendix Table VIII. Listing of source deck for investment analysis computer program (continued).

```
C
C
C       DETERMINATION OF COSTS
C
        WRITE(6,15)
   15 FORMAT('1',T20,'COST SUMMARY')
        WRITE(6,17)
   17 FORMAT('0',//1X,'YEAR 1')
        WRITE(6,18) ACRES,ALAND,ALAVAL
   18 FORMAT('0',T5,F6.3,' ACRES PURCHASED FOR $ ',F7.2,
     1' PER ACRE',T60,'$',F9.2)
   20 CONTINUE
        READ(5,21)IVAR,J,K,TRTNBR,I,UNITS(1),UNITS(2)
   21 FORMAT(T5,I2,T15,I2,T24,I2,T36,F5.3,T45,I2,T70,2A4)
        IF (IVAR .EQ. 0) GO TO 29
        IF (J .EQ. 0) GO TO 29
        ASUMLH(I,J) = BRHRS(I,J)
        COST(I,K)=COST(I,K)+EQPHRS(I,J)*EQPCST(I,J)*TRTNBR
        COST(I,K)=COST(I,K)+ BRHRS(I,J)* BRCST(I,J)*TRTNBR
        COST(I,K)=COST(I,K)+ ATCST(I,J)* ATAMT(I,J)*TRTNBR
        TOTCOS(K)=TOTCOS(K)+((EQPHRS(I,J)*EQPCST(I,J)+
     1BRCST(I,J)*BRHRS(I,J)+ATAMT(I,J)*ATCST(I,J)*TRTNBR)
        IF (IVAR .GT. 1) GO TO 22
        IF (K .EQ. 1) TOTCOS(1) = TOTCOS(1) + ALAVAL
   22 CONTINUE
        III = I + 26
        JJJ = J + 30
        WRITE(6,23)TRTNBR,UNITS(1),UNITS(2),(OPNAME(II),II=I,
     1III,13),(EQNAME(I,JJ),JJ=J,JJJ,10),COST(I,K)
   23 FORMAT(T5,F6.3,'  ',5A4,' WITH ',4A4,T60,'$ ',F8.2)
        IF (IVAR .EQ. 1) WRITE(6,25) K, TOTCOS(K)
   25 FORMAT('+',T60,10('_'),//1X,'TOTAL COST IN YEAR',I2,
     1' IS',T70,'$',F9.2)
        IF (K .EQ. LENROT) GO TO 26
        IF (IVAR .EQ. 1) K = K + 1
        IF (IVAR .EQ. 1) WRITE(6, 27) K
   26 CONTINUE
   27 FORMAT('0',//1X,'YEAR ',I2)
        COST(I,K) = 0
        GO TO 20
   29 CONTINUE
        DO 31 K = 1,15
        TOTCOS(16) = TOTCOS(16) +   TOTCOS(K)
   31 CONTINUE
        WRITE(6, 33)TOTCOS(16)
   33 FORMAT(' ',//1X,'TOTAL COSTS, ALL YEARS, IS',T70,'$',
     1F9.2)
C
C       DETERMINATION OF ANNUAL REVENUE
C
```

Appendix Table VIII. Listing of source deck for investment analysis computer program (continued).

```
      WRITE(6,37)
   37 FORMAT('1',T40,'INCOME SUMMARY',//)
C
C       REVNUE(K) = TOTAL REVENUE RECEIVED IN YEAR K.
C
C       SYSREV(I,K) = REVENUE RECEIVED IN YEAR K USING THE
C       ITH MARKETING SYSTEM.
C
C       SPPREV(J,K) = REVENUE RECEIVED IN YEAR K FROM THE
C       SALE OF SPECIES J.
C
      DO 43 I = 1,6
      DO 41 J = 1,12
      DO 39 K = 1,16
      REVNUE(K) = 0
      SYSREV(I,K) = 0
      SPPREV(J,K) = 0
   39 CONTINUE
   41 CONTINUE
   43 CONTINUE
      READ(5,45)((PRICE(I,J), J = 1,12), I = 1,6)
   45 FORMAT(4(16F5.2,/),10F5.2)
   47 CONTINUE
C
C       ENTER TREE PRICES HERE IF DIFFERENT THAN THOSE ASSUMED
C
      DO 49 K = 1,16
      BRTCOS(K) = 0
   49 CONTINUE
      DO 50 K = 1,16
      SOLD(K) = 0
   50 CONTINUE
C
C       ENTER THE NUMBER OF TREES SOLD IN EACH YEAR, AND THE
C       TOTAL NUMBER THAT WILL BE SOLD IN ALL YEARS FROM THIS
C       STAND.
C
      SOLD(8) = 500.
      SOLD(9) = 5214.
      SOLD(16) = 5714.
C
C
C       ENTER IVAR, J, K, NBRSLD, AND I, WHERE,
C
C       IVAR = THE NUMBER OF DIFFERENT VARIATIONS IN MARKETING
C       IN YEAR K.  THIS VARIATION MAY RESULT FROM SELLING MORE
C       THAN ONE SPECIES IN YEAR K, OR BY USING MORE THAN ONE
C       MARKETING SYSTEM IN YEAR K.
C
C       NBRSLD = THE NUMBER OF TREES OF SPECIES J SOLD IN YEAR
```

Appendix Table VIII. Listing of source deck for investment analysis computer program (continued).

```
C       K USING THE ITH MARKETING SYSTEM.
C
C       K = THE YEAR IN WHICH THIS VARIATION IS IMPLEMENTED
C
C       I = THE MARKETING SYSTEM USED IN THIS VARIATION
C
        READ(5,51) IVAR,J,K,NBRSLD,I
     51 FORMAT(T5,I2,T16,I2,T24,I2,T36,I5,T45,I2)
        IF (IVAR .EQ. 0) GO TO 69
        IF (J .EQ. 0) GO TO 47
        IF (J .EQ. 10) LL = 1
        IF (J .EQ. 11) LLL = 1
        IF (J .EQ. 5) LLLL = 1
        WOW = PRICE(I,J)
        IF (WOW .EQ. 0) WOW = PRICE(I,11)
        IF (WOW .EQ. 0) WOW = PRICE(6,J)
        IF (WOW .EQ. 0) WOW = PRICE(I,J)
        REVNUE(K) = REVNUE(K) + ( WOW * NBRSLD)
        SYSREV(I,K) = SYSREV(I,K) + ( WOW * NBRSLD)
        SPPREV(J,K) = SPPREV(J,K) + ( WOW * NBRSLD)
        REVSPP = WOW * NBRSLD
        III = I + 20
        JJJ = J + 33
        IF (IVAR .GT. 1) GO TO 52
     52 CONTINUE
        WRITE(6, 53)NBRSLD,(SPPNAM(JJ),JJ=J,JJJ,11),(SYSNAM(II),
       1II=I,III,5),WOW,REVSPP
     53 FORMAT('0',I5  ,' ',4A4,' SOLD ',5A4,' AT $',F5.2,
       1' PER TREE',T70,'$',F8.2)
        IF (K .EQ. LENROT) WRITE(6,54) ACRES,ALAND,ALAVAL
     54 FORMAT('0',F6.2,' ACRES SOLD AT $ ',F7.2,' PER ACRE',
       1T70,'$',F8.2)
        IF (K .EQ. LENROT) REVNUE(K) = REVNUE(K) + ALAVAL
        IF (IVAR .EQ. 1) WRITE(6, 55) K, REVNUE(K)
     55 FORMAT('+',T70,9('_'),//15X,'TOTAL INCOME IN YEAR ',I2,
       1' IS',T79,'$',F9.2)
C
C       BREAK-EVEN PRICE PER TREE CALCULATION
C
        BCOST = 0
        DUMB = NBRSLD
        P(1) = DUMB / SOLD(16)
        DO 56 KK = 2,K
        P(KK) = DUMB / (SOLD(16) - SOLD(KK - 1))
     56 CONTINUE
    577 CONTINUE
        DO 57 N = 1,K
        IYR = K - N
        BPTCOS(N) = (TOTCOS(N) * P(N)) * (RATE **IYR)
        BCOST =  BCOST + BPTCOS(N)
```

Appendix Table VIII. Listing of source deck for investment analysis computer program (continued).

```
   57 CONTINUE
      PPT(K) = BOOST / DUMB
C
C     RE-ENTER REVENUE CALCULATION
C
      IF (K .EQ. LENROT) GO TO 58
      IF (IVAR .EQ. 1) K = K + 1
      IF (IVAR .EQ. 1) WRITE(6, 59) K
   58 CONTINUE
   59 FORMAT('0',//56X,'YEAR ',I2)
      DO 63 K = 1,15
      DO 61 I = 1,6
      SYSREV(I,16) = SYSREV(I,16) + SYSREV(I,K)
   61 CONTINUE
   63 CONTINUE
      DO 67 J = 1,12
      DO 65 K = 1,15
      SPPREV(J,16) = SPPREV(J,15) + SPPREV(J,K)
   65 CONTINUE
   67 CONTINUE
      GO TO 47
   69 CONTINUE
      DO 71 K = 1,15
      REVNUE(16) = REVNUE(16) + REVNUE(K)
   71 CONTINUE
      WRITE(6, 73) REVNUE(16)
   73 FORMAT('0',/,T40,'TOTAL INCOME, ALL YEARS IS ',T78,'$',
     1F9.2,/////)
      IF (LL .EQ. 1) WRITE(6, 75)
   75 FORMAT('0','OTHER PINE INCLUDE,',/5X,'LOBLOLLY',/5X,
     1'AUSTRIAN')
      IF (LLL .EQ. 1) WRITE(6, 77)
   77 FORMAT('0','OTHER SPRUCE INCLUDE,',/5X,'BLUE SPRUCE')
      IF (LLL .EQ. 1) WRITE(6, 79)
   79 FORMAT('0','OTHER SPECIES INCLUDE,',/5X)
      DO 81 K = 1,16
      GETREV(K) = REVNUE(K) - TOTCOS(K)
   81 CONTINUE
      A = 0
      DO 83 K = 1,LENROT
      ACCREV(K) = GETREV(K) + A
      A = ACCREV(K)
   83 CONTINUE
C
C     INTERNAL RATE OF RETURN CALCULATION
C
      ROR = 1.045
   85 CONTINUE
      REVIRR = 0
      COSIRR = 0
```

Appendix Table VIII. Listing of source deck for investment analysis computer program (continued).

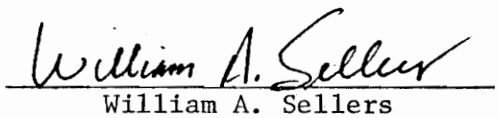
```
      ROR = ROR + .001
      DO 89 K = 1, LENROT
      REVIRR = REVIRR + REVNUE(K) /(ROR ** K)
      COSIRR = COSIRR + TOTCOS(K) / (ROR ** K)
   89 CONTINUE
      IF (COSIRR .LT. REVIRR) GO TO  85
      ROR = (ROR - 1) * 100
C
C     PRESENT NET WORTH CALCULATION
C
      PNW = 0
      DO 91 K = 1, LENROT
      PNW = PNW + GETREV(K) / (RATE ** K)
   91 CONTINUE
      R = (RATE - 1) * 100
      WRITE(6,92)
   92 FORMAT('1',T45,'CASH FLOW-FINANCIAL SUMMARY',/)
      WRITE(6, 93)R
   93 FORMAT('0',T10,'TOTAL',T21,'TOTAL',T32,'YEARLY NET',
     1T48,'ACCUMULATED',T65,'PRESENT NET WORTH',T87,'INTERNAL
     2'RATE',T107,'BREAK-EVEN',/1X,'YEAR',T11,'COST',T20,
     2'REVENUE',T33,'CASH FLOW',T47,'NET CASH FLOW',T68,
     3'AT ',F6.3,' %',T89,'OF RETURN',T105,'PRICE PER TREE')
      DO 101 NN = 1, LENROT
      WRITE(6, 95)NN,TOTCOS(NN),REVNUE(NN),GETREV(NN),
     1ACCREV(NN)
   95 FORMAT('0',T2,I2,T9,'$',F6.0,T20,'$',F6.0,T34,'$',F6.0,
     1T53,'$',F6.0)
      CHECK = RRT(NN)
      IF (CHECK .GT. 0.01) WRITE(6, 97) RRT(NN)
   97 FORMAT('+',T109,'$',F5.2)
      IF ( NN .EQ. LENROT) WRITE(6, 99)...,ICI
   99 FORMAT('+',T68,'I',F9.2,T89,F6.3,'%')
  101 CONTINUE
C
C      PRINTOUT OF COST ASSUMPTIONS
C
      WRITE(6,103)
  103 FORMAT('1',T42,'COST ASSUMPTIONS FOR THIS OPERATION',
     1///1X,T30,'EQUIPMENT',T46,'EQUIPMENT',T62,'LABOR',T78,
     2'LABOR',T91,'MATERIAL',T106,'MATERIAL',/29X,'COST PER',
     3T46,'HOURS PER',T62,'COST PER',T77,'HOURS PER',T91,
     4'COST PER',T106,'GALS/LBS',/1X,'OPERATION/EQUIPMENT',
     5T32,'HOUR',T48,'UNIT',T62,'HOUR',T78,'UNIT',T92,
     6'GAL/LB',T107,'PER UNIT')
      WRITE(6,105)
  105 FORMAT('+',20('_'),T30,9('_'),T46,9('_'),T62,8('_'),
     2T77,8('_'),T91,8('_'),T106,8('_'))
      DO 113 I = 1,13
      II = I + 52
```

Appendix Table VIII. Listing of source deck for investment analysis computer program (continued).

```
      III = I + 91
      WRITE(6,107)(OPNAME(IV),IV = II,III,13)
  107 FORMAT('0',4A4)
      DO 111 J = 1,10
      JJ = J + 30
      XYZ = 10 * ASUMLH(I,J)
      KCK = XYZ
      IF (KCK .GT. 0) WRITE(6,109)(EQNAME(I,JV),JV=J,JJ,10),
     1EQPCST(I,J),EQPHRS(I,J),BRCST(I,J),BRHRS(I,J),
     2ATCST(I,J),ATAMT(I,J)
  109 FORMAT(' ',T5,4A4,T31,'$',F6.2,T48,F6.2,T62,'$',F6.2,
     1T77,F6.2,T91,'$',F6.2,T107,F6.2)
  111 CONTINUE
  113 CONTINUE
      WRITE(6,115)
  115 FORMAT(' ',////////////)
      STOP
      END
```

VITA

The author was born in Muskogee, Oklahoma on July 30, 1950. After beginning school in Tulsa, Oklahoma, he attended the public schools in Eufaula, Oklahoma, graduating from Eufaula High School in 1968. He attended Oklahoma State University from 1968 to 1972, receiving his Bachelor of Science degree in forestry, in December, 1972. He began graduate work at Virginia Polytechnic Institute and State University in January, 1973. His work experience includes one summer with the U. S. Forest Service in Arkansas, and two summers with private forest industries in Oklahoma. He is a member of Gamma Sigma Delta Honorary Agriculture Fraternity, Xi Sigma Pi Honorary Forestry Fraternity, the Oklahoma Forestry Association, and the Society of American Foresters.



William A. Sellers

ECONOMIC ASPECTS OF CHRISTMAS TREE PRODUCTION AND MARKETING IN VIRGINIA

by

William A. Sellers

(ABSTRACT)

An economic description and analysis of Christmas tree production was made for the benefit of Virginia's farm and other landowners. The purpose of the study was to aid in determining if investment in Christmas trees was likely to be economically successful, and to improve plantation management on existing plantations.

Basic production and marketing data was collected from the state's growers, and used to describe and recommend certain operations commonly involved in the production process. Evaluation of the operations was based primarily upon financial considerations, with emphasis on cultural effectiveness whenever possible or appropriate. A computer analysis program was also developed which, given a set of input data, calculates the present net worth of the investment and break-even price per tree using a discount rate of 12 percent. In addition, the internal rate of return, and yearly and accumulated cash flows are presented.

It was found that if the operations recommended in the study were carried out on a five-acre plantation over a production cycle of nine years that the internal rate of return could be expected to range from 9.4 percent for a high-cost operation and $1000 per acre land cost, to 39.8 percent for a low-cost operation and a $100 per acre land value.

The primary financial disadvantage of Christmas tree production was found to be the large negative cash flow incurred up to the last year of the cycle.

The computer program developed in this study has been stored on the VPI & SU Extension Division's Computerized Management Network so that it will be readily accessible to prospective and current Christmas tree growers.