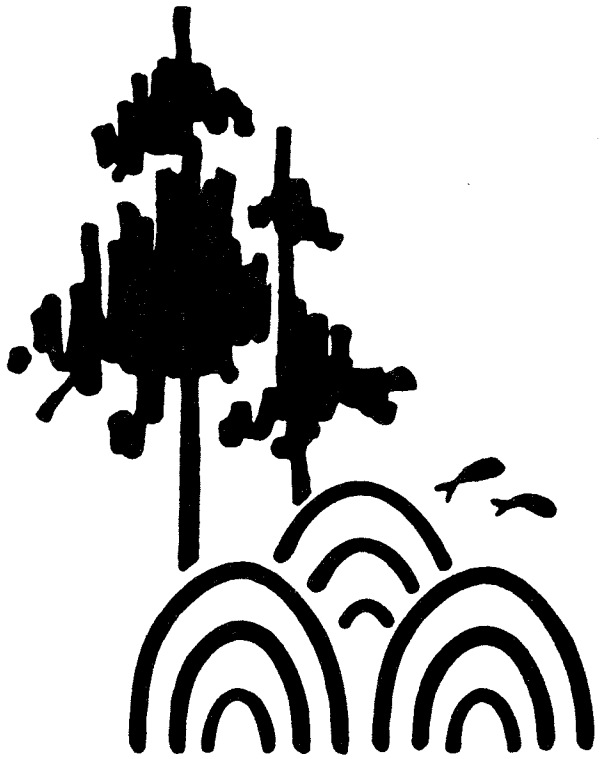
Growing and Marketing Christmas Trees in Virginia



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School of Forestry and Wildlife Resources
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

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GROWING AND MARKETING
CHRISTMAS TREES IN VIRGINIA

by

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and

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The authors were Extension Specialist, Forest Management; Associate Professor, Forest Management and Economics; and Research Associate in the Department of Forestry when the research was performed.

ADDITIONAL COPIES

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INTRODUCTION

The purpose of this report is to assist potential and existing Christmas tree growers in making investment decisions about small Christmas tree plantations by presenting cost and revenue data and analysis of financial returns. Potential growers should find the entire report of interest although existing growers may want to concentrate their attention on the sections containing cost and revenue data and the discussion of financial analyses. This report updates Leuschner and Sellers (1975).

Data in this report come from two questionnaires administered in the spring and summer of 1982. The Growers Questionnaire was mailed to all 272 members of the Virginia Christmas Tree Growers' Association (VCTGA) and requested information about cultural and marketing practices. Non-respondents were sent a reminder card two weeks later and another copy of the survey two weeks after that. One hundred and fifty-nine questionnaires were usable - a 58 percent response rate.

A Financial Questionnaire gathering detailed cost information was sent to the 60 growers who met the study definition of a grower. A grower was a person who had either sold one or more crops of over 100 Christmas trees or had three or more acres of plantations that were sheared at least once. It was felt that these growers would be most likely to be practicing sound, business-like management, and therefore, would supply the best cost and return information. Seventy percent, or 42 of the 60 growers returned questionnaires.

Some respondents did not answer all the questions on the questionnaire. This could happen because some growers did not perform the particular practice for which the information was sought. Alternatively, the grower might not have known the requested cost or price information. Therefore, the number of observations for any one question may be considerably less than the 159 or 42 usable questionnaires. The number of responses on which an entry in a table is based is shown in the table. The reader can then judge how much confidence he or she wishes to place on that estimate.

Most Virginia growers operate small plantations. Consequently, data gathered reflect practices and costs found in small operations. Practices and equipment used on large operations are not included. This report also does not include recommendations about many important biological aspects of Christmas tree production, such as choice of site, matching species to site, and control of insect and pathological enemies. That information can

be obtained from numerous publications and by consulting your local extension agent.

Some results reported in this study differ from those reported by Leuschner and Sellers (1975). This report does not compare or explain these differences, which could have occurred for many reasons, such as: increased grower experience and knowledge, more assistance available, technological and cultural improvements, real price changes, inflation, improved recordkeeping, number of responses per question, and interviewing versus mail-back survey methodology.

General Financial Prospects

Christmas tree production in Virginia can be a worthwhile enterprise in many cases. The financial return from well-managed plantations can be significantly higher than from other investments usually available to small investors. Further, Christmas trees can be grown on land that is marginal for farming and is therefore a potentially high return alternative for farmers and small landowners.

The interest rate earned on Virginia Christmas tree investments may range between 21 and 56 percent after inflating revenues and costs, for well-managed plantations and depending on individual circumstances. This return is much better than the 8 to 10 percent currently available from certificates of deposit or the 12 percent available on some corporate bonds.

However, growers must manage their plantations in a serious and business-like manner to earn this return. Further, cultural operations require much work during certain times of the year. Trees cannot simply be planted, left untended for eight to ten years and then harvested. Anyone expecting to operate in such a manner will not succeed and endangers all or part of the investment.

The Virginia Christmas Tree Industry

The 159 study respondents are currently managing approximately 2,342 acres of plantations - an average of 14.7 acres per grower. These growers reported selling about 55,355 trees in 1981, about one-third of the number of trees (176,100) reported sold in Virginia in 1981 (National Christmas Tree Growers' Association). This, as well as other factors discussed below, indicates a good potential market in Virginia for locally grown trees.

The Virginia grower has a competitive advantage because of lower transportation costs than importers. Virginia has ten cities exceeding 100,000 persons in population (eight in the coastal area and two in the northern piedmont), fifty-five cities with populations between 10,000 and 50,000 and fifty cities with populations between 5,000 and 10,000 scattered throughout the state. This population distribution gives a potential grower flexibility in choosing a market and a marketing method.

Despite the seemingly favorable situation for Virginia growers, however, forecasts for the national market predict an over-supply of Christmas trees within the next three to five years. Competition from trees imported into Virginia probably will increase. Thus, growers should concentrate their efforts on producing quality trees and potential growers should carefully evaluate this factor before deciding to become growers.

Other risks exist. Producing Christmas trees takes six to fifteen years. The grower must spend money for labor, supplies, equipment, fuel and many other items before receiving any income. Insect attacks or pathological outbreaks may occur and destroy or substantially reduce the plantation's value or income received. And, there is always the risk of being unable to find a buyer if it is necessary to liquidate the investment before the final harvest. The decision to invest should therefore be made carefully.

In summary, small Christmas tree plantations are currently a good potential investment for Virginia's small landowners. The potential return is high, trees are well suited to poorer quality land, there appears to be a strong Virginia market, and Virginia's population distribution allows wide latitude in choosing markets and marketing practices. This investment opportunity is balanced by a need for hard work to grow quality trees, business-like plantation management, a long investment period, and realization that national markets may be over-supplied in the next three to five years.

CULTURAL PRACTICES

The production cycle begins with preparing the plantation site and planting the trees. Most growers perform some type of vegetation control during each year of the plantation's life and shear trees annually from the second or third year after planting until the year before harvest. In addition, trees may be pruned several times during the rotation, insect control may be needed, fertilization may be required periodically, and artificial coloring may be applied just prior to harvest. Finally, the grower must choose a marketing method, and, depending on this choice, harvest the trees and transport them to a buyer.

Site Preparation

The plantation site must be prepared once it has been chosen for two reasons. First, the site may be wooded or brush-covered making it impossible to use mechanized equipment. Second, existing plants such as sod, weeds, or trees may take soil moisture and nutrients needed by the Christmas trees and thereby slow growth. Slower growth can decrease the financial return by increasing the time until revenues are received and also by spoiling the tree's shape.

There are several site preparation methods. The method chosen depends on both the vegetation currently on the site and the method's cost. One half of the surveyed growers site prepared in the last two years. They reported four primary types of preparation--clearing, cultivating, mowing, and applying herbicide.

Clearing

Clearing must be used when the site is covered with brush or trees. Additional preparation is often required. Forty percent of the respondents reported clearing land in the last three years. Most used 30 to 40 horsepower farm-tractors, although front-end loaders and light to heavy crawler tractors from 75 to 300 horsepower were also used. Clearing is usually contracted.[1] While land is usually cleared during the summer before

planting, some growers reported clearing in winter.

Cultivation

Cultivation is generally used after clearing to further prepare the site or instead of mowing or applying herbicides. Virginia growers usually plow and disk one month before planting to cultivate soil. The decision to cultivate depends on the existing cover type and the available equipment. For example, some growers may plow and disk rather than mow if they already own a plow and disk harrow but not a mower.

Mowing

Mowing is the cutting down of all grasses and weeds on the plantation site. Large equipment, such as 30 to 40 horsepower farm tractors with 4 to 7 foot bush hogs, is usually used. However, growers also reported using 7 to 16 horsepower mowers or tractor-mowers.

Mowing is the most common type of site preparation on old field sites and growers usually mow either in the fall or immediately before spring planting. They report no advantage to either time.

Herbicides

Another site preparation method reported was the application of herbicides. Most growers applied herbicide in either small circular spots or in long bands or strips, although some used a broadcast application. Circular spots are better adapted to hand-planting and strips to machine planting. Herbicides are often combined with mowing.

Application method depends on the herbicide formulation. Most Virginia growers use liquid formulations, followed by wettable powders and a very few use granulars. Virginia growers were almost equally divided between manually operated backpack sprayers and 25 to 40 horsepower tractors with 12 to 55 gallon pressure sprayers.

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[1]A list of contractors who perform site preparation is available from the Virginia Division of Forestry, Box 3758, Charlottesville, VA 22903 or from a local Virginia Division of Forestry office.

Application time depends on the chemical used and the vegetation being controlled. Late summer or early fall treatment is usually recommended for perennial grasses or low-growing shrubs, such as blackberries or dewberries. Other types of vegetation are controlled either in the fall or the spring before planting.

The most commonly used herbicides were Roundup (glyphosate), Princep (simazine), and Aatrex (atrazine), although the final choice depends on the vegetation being controlled and time of application.[2] Growers are urged to contact their local extension agent if they are in doubt about the appropriate chemical. Instructions on the label should, of course, be followed.

Planting

Planting follows site preparation and is one of the more critical steps in the whole production cycle. Several key decisions must be made at this point: the species to plant, the source of the planting stock, the spacing between the trees, and the method and timing of planting.

Virginia growers usually plant in March and April. The choice of tree species depends on the plantation's site characteristics, an assessment of which species will be the most marketable at harvest, and several other factors. Recommendations on species selection can be obtained from the local extension agent, the Virginia Christmas Tree Growers' Association, or any one of several publications such as Vodak (1982) and Chapman and Wray (1979).

The importance of seedling source is often overlooked by the new grower. A nursery supplying healthy seedlings with good root systems must be found. The speed of delivery after the seedlings are removed from the nursery bed and the care taken in preparation for shipment are also important because seedlings which are dry or are otherwise damaged will have greater mortality after planting or take longer to begin growing. The seed source of white and Scotch pine is particularly important. One-third of Virginia growers purchase their seedlings from the Virginia Division of Forestry (VDF). About half buy seedlings from both the VDF and private nurseries. Most growers buying from private nurseries used those in Pennsylvania. White and Scotch pine are the two most popular species.

Most growers space trees 6' x 6' or 6' x 7' (1,000 and 1,200 trees per acre). Dense planting is important when land prices are high and the grower desires a minimum investment. However, spacing closer than 5' x 5'

[2]The use of a brand name in this report does not imply special approval or recommendation of that brand.

for pine and 4' x 4' for spruce and fir is not recommended because the trees will not have room to grow into a desirable shape.

The type of equipment the grower will use also affects spacing. The final spacing choice depends on the individual case and is a balance between land cost, machinery operating cost, labor availability and the tree's biological requirements.

The small grower must choose between machine or hand planting. A crawler tractor or 30 horsepower farm tractor is used to pull the planter for machine planting. This typically requires a tractor operator, a laborer riding the planter to place the seedlings, and another worker (often the grower) following the planter to reset and straighten the seedlings. This same person, or another person, supplies the planter with seedlings. About half the growers hand plant with a planting bar, while one quarter machine plant and the remaining quarter use a combination of both.

Replanting

Replanting is used either following planting to replace dead seedlings or following a partial harvest. Replacing dead seedlings is important because it will increase the number of harvestable trees. Eighty-five percent of the growers reported replanting to replace mortality the first year after planting, while 65 percent also replanted two years after the initial planting. Replanting beyond the first two years after planting is not usually practiced.

Replanting after a partial harvest can be important because it immediately returns land to production. However, this production gain must be balanced against possible increased costs of site preparation and planting because of working around mature trees. Only a few growers replant after a partial harvest. All replanting was done by hand.

Vegetation Control

Vegetation control is the most important cultural practice during the first three years of a plantation's life. There are several reasons. Weeds and other vegetation compete for sunlight, moisture and nutrients thereby hindering tree growth. They may also choke young trees, causing poor shape and decreased value and they can slow a worker's movement through the plantation, thereby increasing costs. Finally, they make the plantation less attractive to consumers if the grower retails trees at the

plantation. Vegetation control's importance is reflected by almost 90 percent of respondents practicing it.

Mowing and herbicide application are the two control methods. Mowing is most common followed by joint mowing and herbicide application. Mowing is generally effective for controlling weeds and grasses in the rows between the trees. Herbicides are combined with mowing to kill vines and briars, or to kill vegetation immediately around the tree.

Mowing

Equipment used ranged from a 2 horsepower lawnmower through a 30 horsepower tractor but a 10 to 20 horsepower horticultural tractor with a mounted rotary blade was used most often. The size of the mower chosen depends on the cost, the time required to mow, and the space between the rows. Larger mowers have greater purchase and operating costs but require less time per acre. Growers may therefore choose a larger, more expensive mower if they plan to do the mowing themselves and want to minimize the time they spend doing it.

However, larger mowers are less maneuverable and may cause significant tree damage as the plantation grows. The grower can compensate for this by planting his trees farther apart and receiving less gross revenue per acre, by buying a smaller mower which will fit between the trees, or by purchasing both a large and a small mower. This is a decision each grower must make on the merits of his particular case.

Herbicides

Growers applied herbicides either manually with backpack sprayers, or mechanically with a pressure sprayer pulled by a tractor. The most common herbicides used were Roundup, Aatrex and Princep in that order. Application time varied with the vegetation controlled and the chemical used. Growers should seek the advice of their local extension agent before applying herbicides. This is necessary to match the herbicide to the vegetation, to assure correct application time, and because of the material's toxicity.

Shearing

Shearing is the cutting of the ends of branches and terminal leaders to shape trees and increase branch density. This is perhaps the single most important cultural operation for producing quality, high-valued, marketable trees.

Shearing begins the second or third year after planting when the tree begins rapid lateral and terminal growth. The tree will look sparse and spindly if this growth is not cut back to 10 to 12 inches a year. Shearing also stimulates new buds on the remaining branches thereby producing a denser, fuller tree. Most growers shear annually--some stopping the year before harvest while others include the year of harvest. The former feel shearing in the year of harvest causes unsightly cut-off branches which reduce tree value.

Pines are sheared in the late spring or early summer after the new growth has stopped but before it hardens into woody tissue. There is a period of about 10 to 14 days, during June or July in Virginia, depending on the region, which is ideal for shearing. But, because of operation size and labor requirements, some growers begin just before and end just after this optimal period. Other species may be sheared throughout the year, with the exception of spring. Most spruce and fir growers in Virginia prefer to shear these species in late July and August. However, good results can also be obtained from shearing these species during the dormant season.

Shearing pines is one of the major constraints to large Virginia plantations. It is labor intensive, requiring 10 to 16 manhours per acre during a 10 to 20 day period. Growers report great difficulty in finding suitable labor. The work is physically demanding, it only lasts for a few weeks, it can be physically dangerous when shearing with knives, and skilled labor is needed to obtain proper shearing. These difficulties usually result in the grower and his family performing most of the shearing and serves as a real constraint on the total number of trees one person can grow.

Thirty-four percent of the growers use only hedge shears, 22 percent use only knives, 31 percent used both knives and shears, and 7 percent used some other method including gas- and electric-powered machines. Shearing knives are much faster than shears, but the safety hazard is higher. Gas and electric machines are fast and perhaps less fatiguing, but are much more expensive.

Pruning

Pruning is the complete removal of a branch. The first few branches at the butt of the tree may be removed to form a "handle" to facilitate placing the tree in a stand. Deformed branches, upper branches, and multiple leaders may be removed to improve vigor and shape.

Combining pruning and shearing into one operation results in a considerable saving of time. Hence, 44 percent of the growers combined butt-pruning with shearing. While butt-pruning was reported every year from the first year after planting through the seventh, the majority performed this operation the third year after planting. All other pruning was performed usually "as needed."

Fertilization

Only one quarter of the growers reported fertilizing, but apparently do so through the rotation. These growers fertilized in April and March. A 10-10-10 fertilizer was applied by the majority, and 50 percent of these applied two to three ounces per tree.

Fertilization may increase tree growth and improve vigor and color. Growers usually apply fertilizer for the last two reasons because growth must be removed by shearing. However, some tree species, particularly the spruces and firs, require good sites and may need fertilizer to improve growth.

Most growers fertilized in April and March, followed by February and January. Midsummer application, particularly of nitrogen, may also improve color. Broadcast fertilization either before or after planting is not recommended because it is more expensive and will aid competing vegetation.

Insect Control

Insects can be a major threat because they can radically decrease plantation value in any year of the production cycle. The threat is compounded because neither the time of year nor the year of attack can be predicted in advance, hence preparation for an outbreak is difficult. Timely insect control will lessen loss because fewer trees have to be sprayed and less income lost through reduced tree quality.

Growers can most effectively control insects by becoming familiar with the insects most likely to attack, the control measures needed, the sources of insecticides, and by having the necessary equipment ready. Determining the need for control is difficult because judgment must be made about whether the insect will become epidemic. The decision requires balancing chemical and application costs against the net revenues lost from trees wich would have been killed or damaged.

The risk of a large financial loss makes the cost of control, about $20 per thousand trees, appear relatively low and usually results in early control. It is suspected that lack of control usually results from a grower's lack of knowledge rather than a conscious decision not to control. Insects may be controlled before attack by propagating their natural enemies or by timing shearing or pruning to remove insects before their emergence.

Two-thirds of the respondents practiced some sort of insect control in the last two years and 38 percent claimed "appreciable" damage. About three-quarters of the respondents reported 150 or less trees damaged, although the maximum was 4,000 trees damaged.

Aphids, white pine weevil, sawflies, and tip moths were the four insects most often attacking plantations. Proper treatment varies with the insect and species. Lindane, malathion, Cygon and Sevin were the most common insecticides used. Growers should, as with herbicides, consult their local extension agent before applying insecticides.

Disease Control

Problems of disease control closely parallel those of insect control. Occurrence is impossible to predict, plantations may be heavily damaged or lost, determining the need for control is difficult, and control can be best accomplished by adequate familiarization and preparation.

There are a few differences however. Some diseases can be controlled by physically removing an infected branch or tree from the plantation. Infected branches can be removed during pruning at little added cost but this requires that field workers be familiar with the various diseases.

Another difference is that only nine percent of the growers reported "appreciable" disease problems in the last two years. Half of these lost 250 or less trees although the maximum loss was 2,500 trees. White pine root decline and gall rust were the two main diseases with needle cast also cited. Growers are again urged to contact their local extension agent or county forester for disease information and identification.

Animal Damage

Animals may damage plantations; particularly deer, mice, rabbits, birds, and cattle. Fifty-six percent of the respondents reported animal damage within the last two years. Deer and mouse damage, either singly or combined, accounted for almost 90 percent of the cases. Two hundred trees or less were damaged in about three-fourths of the cases with maximum damage of 1,500 trees. Control usually consisted of improved vegetation control or chemical repellants.

Artificial Coloring

It is also difficult to identify the need to apply artificial coloring because, to be most effective, the color must be applied in the early fall before temperatures drop below 45 or 50 degrees farenheit and before trees begin to turn yellow. Therefore, a grower must decide to apply artificial color based on prior years' observations of needle fade.

In the past, growers were concerned about the quality of artificial color. However, it has been reported that improved coloring materials, applied using procedures recommended on the label, make artificial color

difficult to detect. The emphasis consumers place on color and the improved quality of artificial color make coloring a realistic emergency measure. However, only eight percent of the growers indicated that they had colored any trees in the last two years. These growers, though, were happy with the results and planned to color again. Scotch pine was the primary species colored, with white pine a distant second.

COSTS OF CULTURAL PRACTICES

Estimated costs of cultural practices are based on responses to the Financial Questionnaire, the second survey. The reader should exercise caution in using them for several reasons. First, they are responses to questionnaires and therefore only as accurate as those responses.

Second, there are varying numbers of observations for each practice because every grower did not use each practice. Generally, averages are more representative the greater the number of observations, although there can still be a large variation between growers. The number of growers contributing cost data is indicated to assist the reader in judging how much faith to put in the results. Further, dollar costs are for 1981-1982 and may be considerably higher in the future due to inflation. Finally, readers should remember that these are averages and that their costs may vary from them.

Consequently, for all these reasons, these results should be considered indicative of what can be expected, but individual growers are encouraged to make their own estimates where possible. Equipment and labor hour estimates are shown separately so that growers may substitute their costs if they are known.

Site Preparation Costs

No usable land clearing costs were reported. Lands needing clearing are undesirable because they are difficult and costly to prepare. Land clearing costs are often $100 to $175 per acre. A grower can save these costs, or afford to pay that much more per acre, by planting or purchasing land that does not require clearing.

Cultivation costs ranged from $27 to $139 per acre, (Table 1). These costs are difficult to compare for several reasons. First there is only one observation for each type of cultivation. Second, the difficulty of the terrain in each observation is unknown. Finally, cultivation requirements might also be avoided or decreased by purchasing an alternative site.

Table 1. Reported site preparation costs per acre - 1981

Type of Site Preparation	Nmbr. Obs.	Hours Required Equipment	Hours Required Labor	Cost Per Hour Equipment	Cost Per Hour Labor	Total Cost
Cultivation						
52 HP Tractor and Plow	1	5.00	5.00	$22.81	$5.00	$139.05
35 HP Tractor and Plow	1	2.50	2.50	18.72	5.00	59.38
35 HP Tractor and Disk	1	1.25	1.25	17.04	5.00	27.55
Mowing						
30-40 HP Tractor and Mower	4	1.10	1.10	21.56	5.00	29.22
20-29 HP Tractor and Mower	1	1.00	1.00	10.66	5.00	15.66
10-19 HP Ride On Mower	9	2.68	2.68	9.61	5.00	39.15
5-10 HP Hand Self-Propelled	3	3.75	3.75	4.69	5.00	36.34
Herbicide						
Hand Applicator	11	--	3.30	--	5.00	21.50
Tractor & Sprayer	9	1.12	1.12	31.43	5.00	45.80

Mowing, or mowing combined with herbicide application, is an alternative site preparation method. Mowing with a 20-29 horsepower tract may be the lowest cost ($15.66 per acre) but only one observation is available. The 30-40 horsepower tractor is the next lowest cost.

Herbicides combined with mowing are costly and can approach or exceed other methods. For example, a 30-40 horsepower tractor-mower ($29.22 per acre) plus hand applying herbicide ($21.50 per acre) costs $50.72 per acre.

However, our data contain no observations of large equipment; for example, a 30 horsepower tractor with a 30 foot sprayer boom, or equipment which combines spraying and mowing in one operation. This equipment might provide lower costs.

In summary, based on the data gathered, mowing seems the least cost method of site preparation. The cost of combined mowing and herbicides approaches or exceeds that of disking, so disking might be considered if both are needed. The final site preparation decision will be based not only on the costs, but also on the biological requirements of the particular plantation site and the availability of equipment to do the job.

Planting Costs

The costs for hand planting and machine planting, including seedlings, are $113 and $72.37 per thousand trees, respectively (Table 2). The cost of planting bars ($22 each) for hand planting is not included because bars are used almost indefinitely.

Machine planting appears most desirable because of lower costs and labor requirements but many growers prefer hand planting because they feel seedling mortality is less. Available information is inconclusive. Proper seedling handling before planting is critical, regardless of the planting method. Mortality should not differ significantly if seedlings are handled correctly.

Hand replanting with a planting bar costs $124.20 per thousand trees the first and second years after planting. Replanting costs are probably higher than initial planting because it takes more time to locate, remove, and replace dead seedlings. The cost of hand replanting after a partial harvest is even higher -- $128.50 per thousand trees.

Shearing and Pruning Costs

Shearing cost increases as the height of the tree increases regardless of whether knives or hedge shears are used (Table 3). The cost for shearing a thousand trees with knives ranges from $28.75 to $113.65 and is less than the cost using hedge shears except for the tallest trees. Pruning costs from $77 to $250 per thousand trees (but note these values are single observations). Costs are slightly understated because the cost of shears, knives, and pruning tools, about $8 to $25 each, is not included.

High labor requirements for shearing and pruning are well demonstrated in Table 3. Prospective growers are urged to use these labor estimates to

Table 2. Reported planting costs per thousand trees, 1981.

Type of Planting	Nmbr. Obs.	Hours Required Equip.	Hours Required Labor	Cost per Hour Equip.	Cost per Hour Labor	Total Cost[1]
Hand Planting						
Dibble	19	--	13.72	--	$5.00	$113.60
Shovel	1	--	55.56	--	5.00	322.80
Mechanical	15	1.23	2.46	12.25	5.00	72.37
Hand Replanting First or Second Year						
Dibble	14	--	15.84	--	5.00	124.20
Shovel	3	--	26.32	--	5.00	176.60
Hand Replanting After Partial Harvest	12	--	16.70	--	5.00	128.60

[1]Includes 1,000 seedlings at $45.00/M.

calculate the manhours needed to shear and to make estimates of labor availability. These estimates, and the number of days during which shearing is biologically possible, should be used to determine the maximum plantation size which can be adequately maintained.

Shearing with knives is desirable because it is least costly, but the safety hazard may make higher cost hedge shears more attractive. Powered equipment cost is comparable to shearing with knives for taller trees and requires less labor. Individual growers must again decide for themselves which shearing method to use based on their individual circumstances.

Table 3. Reported shearing and pruning cost per thousand trees, 1981.

Type of Shearing or Pruning	Nmbr. Obs.	Hour Required Equip.	Hour Required Labor	Cost per Hour Equip.	Cost per Hour Labor	Total Cost
Shearing-Knives						
Trees under 3 ft.	10	--	5.76	--	$5.00	$ 28.75
Trees 3 to 5 ft.	13	--	9.86	--	5.00	49.30
Trees 5 to 6 ft.	9	--	16.07	--	5.00	80.35
Trees over 6 ft.	8	--	22.73	--	5.00	113.65
Shearing-Hedge Shears						
Trees under 3 ft.	6	--	10.71	--	$5.00	$ 53.55
Trees 3 to 5 ft.	5	--	14.62	--	5.00	73.10
Trees 5 to 6 ft.	6	--	21.74	--	5.00	108.70
Trees over 6 ft.	5	--	22.52	--	5.00	112.60
Shearing-Both Knives and Shears						
Trees under 3 ft.	7	--	12.39	--	$5.00	61.95
Trees 3 to 5 ft.	7	--	15.23	--	5.00	76.15
Trees 5 to 6 ft.	6	--	17.65	--	5.00	88.25
Trees over 6 ft.	9	--	23.08	--	5.00	115.40

Table 3. continued.

Type of Shearing or Pruning	Nmbr. Obs.	Hour Required Equip.	Hour Required Labor	Cost per Hour Equip.	Cost per Hour Labor	Total Cost
Shearing-Electric Shears						
Trees under 3 ft.	1	0	6.67	0	$5.00	33.35
Trees 3 to 5 ft.	1	--	8.00	--	5.00	40.00
Trees 5 to 6 ft.	1	--	10.00	--	5.00	50.00
Trees over 6 ft.	1	--	16.67	--	5.00	83.35
Shearing-Beneke plus Hand Tools						
Trees under 3 ft.	5	7.58	7.58	2.00	$5.00	53.06
Trees 3 to 5 ft.	5	9.80	9.80	2.00	5.00	68.60
Trees 5 to 6 ft.	5	12.12	12.12	2.00	5.00	84.84
Trees over 6 ft.	5	15.87	15.87	2.00	5.00	111.09
Pruning Only						
Hedge Shears	4	--	29.00	--	$5.00	148.00
Pruning Snips	3	--	16.30	--	5.00	81.50
Pruning Saw	1	--	50.00	--	5.00	250.00
Brush Hook	1	--	15.40	--	5.00	77.00

Vegetation Control Costs

Mowing costs varied between $20 and $46.51 an acre depending on the equipment (Table 4). The major differences occur in the labor and capital

investment needed. Consequently, growers will probably choose equipment based on labor and capital availability, equipment versatility in other uses, and the tree spacing considerations previously discussed.

On the average, growers mowed their plantations three times a year. The actual number of mowings will depend on site fertility, the amount of rain, and other edaphic and climatic variables. The costs in the table are for one mowing; consequently, they should be multiplied by three or four to estimate annual costs and labor requirements.

Sixty-seven percent of the responding growers controlled vegetation with herbicides in addition to mowing. Therefore, this cost should also be included in estimates.

Table 4. Reported vegetation control costs per acre, 1981.

Type of Vegetation Control	Nmbr. Obs.	Hours Required Equip.	Hours Required Labor	Cost per Hour Equip.	Cost per Hour Labor	Total Cost
Mowing 20-29 HP Tractor and Mower	6	1.29	1.29	$10.66	$5.00	$20.20
10-19 HP Ride-On Mower	18	2.68	2.68	9.61	$5.00	39.15
5-10 HP Hand Self Propelled	5	4.80	4.80	4.69	5.00	46.51
2-3 HP Hand Mower	1	3.00	3.00	2.66	5.00	22.98
Herbicide Hand Application	15	--	2.70	--	$5.00	17.25[1]
Tractor and Sprayer	7	0.90	0.90	31.43	5.00	32.79

[1]Includes 1/4 gallon of Princep 4L at $15.00/gal.

Miscellaneous Costs

Even though some type of insect control was practiced during the last two years by 65 percent of the responding growers, insect control, artificial coloring, fertilization, and disease control costs will not be incurred by many growers. For example, only nine growers used artificial coloring and only five reported applying fertilizer (Table 5). Insect control was more common and should probably be included in cost estimates although the year it will occur is usually unpredictable.

Insect control costs were $19.79 per thousand trees for hand application. Hand spraying is likely to be the most economical for individual trees but mechanical spraying should prove best when the entire plantation must be treated.

Table 5. Reported miscellaneous cultural costs per thousand trees, 1981.

Type of Cost	Nmbr. Obs.	Hours Required Equip.	Hours Required Labor	Cost per Hour Equip.	Cost per Hour Labor	Total Cost
Insect Control Hand Application	13	--	3.24	$ --	$5.00	$19.79[1]
Tractor & Sprayer	4	0.90	0.90	31.43	5.00	36.38[1]
Artificial Color Hand Application	9	--	15.63	--	5.00	157.33[2]
Fertilization Hand Application	5	--	2.38	--	5.00	29.90[3]

[1]Includes 20 oz. of Sevin at $23/gal.
[2]Source: Vodak, 1983. Includes 4.4 gallons colorant at $18/gal.
[3]Includes 200 lbs. of 10-10-10 at $9/cwt.

HARVESTING AND MARKETING

Harvesting is the way trees are removed from the plantation and brought to the place of sale. Marketing is the way trees are sold. A grower may harvest all trees in one year (clearcutting) or some trees each year for several years (partial cutting). The grower may market trees by selling them on the stump (selling stumpage), cut and stacked "at the roadside," delivered f.o.b. to a retail lot, at the grower's own retail lot, by running a "choose and cut" operation, or by a combination of these.

The marketing method will determine the harvesting operations. For example, selling clearcut stumpage only requires indicating the trees to cut, but retailing requires cutting and transporting trees to the retail lot, manning the lot and making sales to the consumer. Revenues increase as the marketing system approaches the consumer, but so do the costs. The final choice of harvesting and marketing method must balance these increasing costs and revenues, the availability of growers' time or other labor, the degree of risk associated with the method, and proximity to population centers.

Harvesting

A great deal of risk is assumed when trees are cut. The product will deteriorate physically and will also become obsolete if not sold before December 25. Risk is minimized if the trees are sold before they are cut. Growers should insist on a written contract and a 25 to 35 percent down payment before cutting as further market assurance. Of course, the grower assumes all of the risk when selling trees at his or her own retail lot.

The size and shape of the trees rather than their physical age determine the year of harvest. The trees should be about six or seven feet tall and well-shaped. Some trees are commonly held an extra year or two to improve either height and/or shape. Further, the price per tree is often dependent on height. Therefore, harvest age varies between plantations, although eight years is common in Virginia.

Clearcutting

Clearcutting is the least expensive and most efficient cutting method. The crew can cut all trees and not lose time searching for crop trees. They are also unhindered by the residual plantation.

Partial Cutting

Partial cuts are used because trees become marketable in different years. Further, some trees may be grown to ten or twelve foot heights for sale to commercial establishments. In practice, most growers use a partial cut and remove all remaining trees in the second year.

The primary advantage of partial cutting is increasing the total revenues by increasing the number of merchantable trees or the selling price per tree. This is accomplished by harvesting the best trees during the first year and using the growth between the harvests to improve the height and shape of the remaining trees. The extra year can turn a nonmerchantable tree into a merchantable tree or increase the price per tree. In addition, the cash flow is improved by harvesting trees as soon as they become merchantable.

There are several disadvantages. First, trees cut in the first year might increase in value if left until the second year. Trees should be left if their increased value is greater than the return which can be obtained by cutting them and reinvesting the revenues.

A second disadvantage is that plantations are usually not regenerated until all trees are cut, although some growers replant after a partial cut, as discussed above. This means the harvested part of the plantation is not growing trees and the production cycle is delayed for the number of years between the first and final cut.

A final disadvantage is that partial cut costs are somewhat higher than clearcut costs. This, of course, is inconsequential when selling stumpage and may be insignificant in most cases.

The choice between a partial cut or a clearcut depends on the individual case. The total revenue expected from a partial cut must be compared to that expected from a clearcut. This requires estimating for each method the number of trees sold and the price per tree as well as lost production and differential harvesting cost. These estimates can then be analyzed using present net worth, which is discussed below. Usually, a partial cut is preferable if it causes an appreciable increase in total revenue and does not extend beyond two or three years.

Harvesting of Balled-and-Burlapped (B&B) Trees

Balled-and-burlapped trees are dug from the ground with part of their roots, wrapped in burlap, and sold to the consumer for indoor use during Christmas and subsequent outdoor planting. B&B trees can be marketed at roadside, at the retail lot, or directly to the consumer.

Only 30 percent of the growers responding to the Financial Survey reported harvesting and selling B&B trees. Most did so because of higher prices and to meet perceived demand. Fifty percent dug the tree for the consumer, while 33 percent had the customer dig the tree.

There are at least two disadvantages to harvesting B&B trees. First, holes remain in plantations where trees were removed. If not filled, these can hamper future mechanized management practices and possibly lower soil productivity. Second, the majority of growers surveyed did not use mechanical diggers and hand digging is labor intensive. The grower is thus faced with the difficulty of finding labor and added harvesting costs.

As always, adoption of the practice depends on the individual case. Each grower must balance estimated increases in costs and revenues to make the decision.

Marketing

The marketing method chosen determines many of the harvesting operations which the grower must perform (Table 6). The choice of marketing method must be based not only on price differentials but also on the availability of labor, harvesting equipment, and the grower's time to supervise or perform these operations. There are additional advantages and disadvantages to each of the marketing methods.

Sales on the Stump

The grower sells the right to enter his plantation and to cut and remove trees when marketing on the stump. The grower needs only to designate the trees to cut and does not have to organize and execute any of the other harvesting operations. Despite this simplicity, only 8 percent of the responding growers used this as their sole marketing method in 1981. An additional 23 percent, however, used this method in combination with one of the other methods.

Table 6. Harvesting operations required for marketing method.

Harvesting Operations Grower May Perform	Marketing Method				
	Sell on the stump (Stumpage)	Sell at Roadside	Sell to Retail Lot	Retail	Choose and Cut
Tag Trees to Cut	X	X	X	X	
Cut Trees		X	X	X	X
Transport to Roadside		X	X	X	X
Load on Truck		X	X	X	
Transport to Lot			X	X	
Unload Truck			X	X	

There are, however, several disadvantages. First, the price per tree is lowest and it must be assured that only crop trees are cut and damage to the residual plantation must be prevented if a partial cut is used. The grower should designate the crop trees beforehand and then be present during the harvest to see that only crop trees are taken and that the remaining trees are not damaged.

Sales at the Roadside

This marketing method requires the grower to cut and transport the trees to the plantation roadside or some central location adjacent to an all-weather road. Twenty-one percent of the growers responding to the Financial Survey indicated that they sold at least a portion of their trees in this manner. This method usually requires that the grower load the trees on the buyer's truck. Just over half the growers marketing their trees at the roadside also loaded the trees.

Sales at the roadside, on the average, bring a higher price per tree than stumpage sales. Also, harvesting is done by the grower thereby allowing better control over the trees cut and the damage to the residual plantation. This may be offset by the costs of cutting, transporting, and loading the trees.

Sales to a Retail Lot

Sales to a retail lot require growers to perform the additional operations of transporting and unloading trees at the lot. However, only five respondents to the Financial Survey reported that they had sold trees to a retail lot; thus, cost data were insufficient. Average price will be higher than the preceding marketing methods.

Transportation costs to the lot vary with the distance traveled and equipment used. The average time for a one-way trip was reported to be 2.2 hours, although 67 percent of those hauling their own trees reported trip time to be 1 hour or less. Transportation cost is easy to estimate once the destination is known. All that is needed is an estimate of the number of miles, the machine rate for the truck, the number of hours per trip, and the number of trees carried per trip.

All growers unloaded the trees at the retail lot. This cost is negligible or non-existent because the truck driver would have to wait while the truck was unloaded and hence the grower would incur the cost of the driver's time anyway.

Sales to the Consumer at a Retail Lot

Because of insufficient responses and data, the costs and returns of this marketing option were not investigated. However, tree prices should be highest, and cost should be easy to estimate. Rental costs for the lot, and perhaps incidental costs such as electricity and advertising should be included. An article by Leuschner and Bell (1973) may be helpful in estimating potential revenues.

Choose and Cut

In a choose-and-cut operation the consumer comes to the plantation, walks through a designated area, and chooses the tree desired. The consumer may either be given a bow saw to cut the tree or the grower may cut the tree. The grower may help the consumer transport the tree to the parking lot and load it into or on the buyer's vehicle.

The major advantage of choose-and-cut is a higher price per tree. The major disadvantage is that the grower must have someone on the plantation during those hours when customers are likely to arrive. Leuschner and Sellers (1975) estimated that over 500 manhours were required to sell 1,000 trees. As shown in Table 7, just over 370 manhours were required to sell 1,000 trees according to this study.

Labor for choose-and-cut operations is a fixed cost because the grower must be on the plantation throughout the advertised hours of business. The cost per tree (in dollars or manhours) can be decreased by increasing the number of trees sold per hour. This, of course, reaches an absolute maximum because one man can only serve a limited number of customers in an hour.

A variation which shows promise is to combine choose-and-cut with clearcutting, possibly for wholesale. The first year a plantation could be opened for choose-and-cut in order to obtain higher prices. The second year the plantation could be clearcut to avoid the opportunity cost of idle acreage and to facilitate planting. Seventy-three percent of the growers responding to the Financial Survey indicated that they marketed at least some of their trees by this method. Thirty-nine percent used it solely.

Baling

Christmas trees may be baled individually in plastic nets to prevent excessive drying, to protect them from damage in transport, and to make them easier to handle. Various machines are available for baling.

This process usually requires two to four workers on a production basis in addition to the cost of netting. All four of the growers reporting baling required three workers for the job. The average cost for the three growers supplying data was $0.53 per tree. The average price per tree should be raised by this amount due to baling. Again, the decision to adopt this practice must be made on an individual basis balancing the additional costs and revenues.

Costs and Revenues

Harvesting operation costs and revenues are based on responses to the Financial Questionnaire. The reader is again cautioned to use data carefully because they are responses to questionnaires, have varying numbers of observations, and are averages which may differ from actual costs and revenues individual growers will experience. All labor figures are total labor requirements; for example, harvesting B&B trees required on the average a three-man crew and this is reflected in the total hours required. Also, each harvesting operation was treated as totally separate and independent.

Harvesting Costs

All costs associated with harvesting and marketing are included in this category for convenience even though some might be categorized as marketing rather than harvesting costs. The first step in harvesting, which is needed only for a partial harvest, is to tag or otherwise mark trees for cutting. Six growers reported an average cost of $19.10 per thousand trees for this operation (Table 7). This cost is understated because time spent supervising and inspecting cutting on a stumpage sale is not included. Tagging costs would not be incurred for clearcut harvests or for a final partial cut.

The next step in harvesting is to cut the trees. Responding growers reported using either bow saws or chainsaws for cutting the trees. Table 7 shows cutting with a bow saw is less expensive but is only one observation and the hours of labor are lower than previously reported (Leuschner and Sellers 1975). Thus, we suspect cutting with a chainsaw is preferable.

The trees must next be transported to the roadside and loaded on trucks. While three basic methods were reported for transporting to roadside - dragging them by hand, loading them on a trailer pulled by a tractor, and loading them on a truck - hourly data were again insufficient so labor and machine hours from Leuschner and Sellers (1975) were used to project costs of $173.75, $282.56, and $282.90 per thousand trees, respectively. Average loads per trip were 44 trees for the tractor-trailer and 48 trees for the truck (Leuschner and Sellers, 1975).

Direct comparison of transport costs is impossible because the distance traveled for each method was not available and probably differed. However, hand transportation is probably the least expensive alternative if the distance is short because it avoids the fixed cost of loading and unloading trees. The tractor-trailer alternative is probably best for longer hauls because the tractor will travel faster.

Loading trucks at roadside and unloading them at the retail lot are the next costs encountered. Loading at roadside took an average of 32 manhours per thousand trees and unloading at retail lots an average of 17 manhours (Leuschner and Sellers, 1975). This differential probably exists because it is easier to unload than load and because the retailer may assist with the unloading.

The cost of transporting trees to the retail lot depends on the distance traveled. Again, data received were not sufficient to project these costs and therefore not included in the table. In 1975, however, the average cost of transporting trees to the retail lot was $259 per thousand trees (Leuschner and Sellers, 1975).

Generally, trees were baled when shipped long distances or when customers specifically requested it. The operation usually took three

Table 7. Reported harvesting and marketing costs per thousand trees, 1981.

Harvesting Operation	Numbr. Obs.	Hours Required Equip	Hours Required Labor	Cost per Hour Equip	Cost per Hour Labor	Total Cost
Tag trees for harvest	6	--	2.62	6.00[1]	5.00	$19.10
Cutting trees[2]						
Bow saw	1	--	6.67	--	5.00	33.35
Chain saw	5	11.68	11.68	1.37	5.00	74.40
Transport to Road						
Hand	--	--	34.75[3]	--	5.00	173.75
30 HP tractor & trailer	--	10.24	35.52[3]	10.25	5.00	282.56
Truck	--	87.50	153.33[3]	5.90	5.00	1282.90
Loading on trucks						
Roadside	--	--	32.00[3]	--	5.00	160.00
Retail lot (unloading)	--	--	17.08[3]	--	5.00	85.40
Baling	3	--	37.50	340.00[4]	5.00	527.50
Choose & cut by grower or customer	14	--	371.00	--	5.00	1855.00
B & B trees						
Digging by hand	7	--	217.00[5]	--	5.00	1085.00
Wrapping	8	--	131.80	--	5.00	659.00
Transporting to roadside	5	--	83.3	--	5.00	416.50
Total B & B Harvesting cost:						2160.50

[1] Cost includes 4 rolls of flagging at $1.50/roll.
[2] Clearcut and partial cut combined
[3] Insufficient observations received. Hours required taken from Sellers and Leuschner (1975).
[4] Material cost per thousand trees (primarily Vexar netting)
[5] Only 3 observations available for machine digging: 120.5 hours per 1000 trees.

persons, one bringing trees to the baling machine, another guiding the butt-end into the machine and a third pulling the tree through the baler. Data from only three of the four responding growers were used to project costs. The fairly high cost of $0.53 per tree indicates this practice should be used judiciously. These costs are understated because the cost of the baler is not included.

Revenues

The average price per tree for sales on the stump was $7.60 (Table 8), with a fairly wide range from the lowest to the highest. The $8.20 average for sales at roadside had a much narrower range. The average prices for the other marketing methods showed a great deal of variability.

Price variations can occur for several reasons. First, tree quality may vary. Data were not available to analyze price-quality differences although Leuschner and Bell (1973) found they existed at the retail level. Tree height is a second factor unaccounted for because of insufficient information. Ordinarily, a higher price is paid for taller trees.

Finally the greater price variability may indicate the growers' ability to find lucrative outlets. Most stumpage and roadside sales probably are to wholesalers who have access to a larger supply of trees and also have a more rigid price structure. However, as growers deal with smaller buyers there is a greater chance of finding someone willing to pay a higher price or willing to pay for some added service.

There are too few observations to make conclusive statements about price differences between spruces and firs. Price differences between white and Scotch pine are relatively small when trees are sold as stumpage or at the roadside and neither species is consistently higher priced than the other.

The price per foot of Scotch pine was greater than that for white pine when sold C&C or at retail. However, different average tree heights make the price trend per tree inconsistent. Spruces and firs are consistently higher priced, but note the relatively few observations and number of trees sold. These observations may indicate that there is no real price difference between the two pines and that the grower can base planting decisions on other factors.

However, price differences by marketing methods appear significant. Sales on the stump and at roadside are much lower than sales at retail lots and choose-and-cut operations, assuming six- or seven-foot trees. Prices of B&B trees are much higher than those for other marketing methods.

Table 8. Reported prices and number of trees sold by species and marketing, 1981[1].

Marketing Method	White Pine	Scotch Pine	Fraser Fir	Norway Spruce	Blue Spruce	Other	Total
	Price in Dollars per Tree[2]						
Sales on the stump							
Average	$7.49	$8.27	--	--	--	--	$7.60
Lowest	4.50	5.50	--	--	--	--	--
Highest	10.35	14.00	--	--	--	--	--
Number of trees	8,920	1,400	--	--	--	--	10,320
Number of observations	15	11	--	--	--	--	26
Sold at Roadside							
Average	8.24	8.05	--	9.00	--	8.00	8.20
Lowest	6.50	6.50	--	--	--	--	
Highest	10.00	8.75	--	--	--	--	
Number of trees	18,515	5,500	--	50	--	60	24,125
Number of observations	9	6	--	1	--	1	17
B & B							
Average	18.62	12.95	17.00	21.47	22.67	18.33	19.18
Lowest	8.00	9.00	7.00	12.00	12.00	15.00	--
Highest	30.00	15.80	25.00	30.00	40.00	25.00	--
Number of trees	1,209	127	214	574	187	39	2,350
Number of observations	14	4	3	7	4	4	36
	Price in Dollars per foot[3]						
Choose & cut							
Average	1.98	2.22	2.50	2.42	4.36	2.08	2.23
Lowest	1.00	1.50	2.00	1.80	2.20	1.00	--
Highest	5.00	5.00	3.00	3.00	10.00	3.00	--
Number of trees	5,223	7,522	437	626	573	298	14,679
Number of observations	26	18	2	6	4	7	63
Sold at Retail							
Average	2.13	2.42	3.25	2.67	--	2.00	2.25
Lowest	1.50	1.50	3.00	2.00	--	--	--
Highest	3.75	4.00	3.50	3.00	--	--	--
Number of trees	4,236	1,991	70	230		2	6,529
Number of observations	9	6	2	3	--	1	21
Total number of trees	38,103	16 540	721	1,480	760	71	57,675

[1] Data from Grower's Survey Part I.
[2] Average heights reported for sales on stump: Scotch pine 5', white pine 7'; at roadside: white pine, Scotch pine and Norway spruce -6'.
[3]Average heights reported C&C: white pine, Norway spruce and other -6'; other species -5'; for retail: white pine, Scotch pine and Norway spruce -6'; Fraser fir and other -6'; for B&B all species averaged 5' except blue spruce which was 3 1/2'.

Analysis of Marketing Methods

Average costs and revenues can indicate which marketing method may be more profitable. This assumes, of course, that the average will be encountered by the individual grower. However, this may not be the case; therefore individuals should satisfy themselves that the data are representative and substitute their own estimates if they are not.

Where full costs are known, marketing by choose-and-cut (C&C) appears to be the most desirable marketing method, followed by sales at roadside, and sales on the stump (Table 9). Sales on the stump may be preferable to sales at roadside (if the choice is restricted to these two methods) because the average net revenues are only about $190 less per thousand trees and stumpage sales require much less organization.

Margins, rather than net revenues, are calculated for sales at a retail lot and B&B trees because some costs are unknown. The margin per thousand trees for sales at a retail lot is only about $220 ($11,730-$11,509) greater than net revenues for sales by choose-and-cut, assuming the lot is run by one person for two weeks. However, this $220 must cover lot rental and other costs, including the risk of not selling the trees. Retailing therefore may not be worth the added effort of loading and transporting trees and managing a lot.

The margin per thousand trees for marketing B&B trees is $5,511 ($17,020 - 11,509) above net revenues for sales by choose-and-cut. However, this margin is calculated assuming the trees are only transported to roadside. Costs of loading, transporting, and unloading must be added to this estimate if it is unlikely that customers will purchase trees at roadside. This may well make the margin unattractive considering the weight and cumbersome nature of B&B stock.

In summary, from a strictly financial view, sales by choose-and cut and possibly B&B stock are the most attractive marketing methods, followed by sales at a retail lot. Sales on the stump and sales at roadside are the two least attractive methods.

Individual growers may rank the marketing systems differently for several reasons. First, costs, revenues, and/or the harvesting operations may differ from those used in the analysis. Second, the analysis does not

Table 9. Average net revenues per thousand trees by marketing method, 1981.

Sales on Stump			
Revenue $7.60 x 1,000		$7,600	
Costs			
Tag Trees		19	
Net Revenue			$7,581
Sales at Roadside			
Revenue $8.20 x 1,000		$8,200	
Costs			
Cost from "Sales on Stump"	$19		
Cut with Chain Saw	74		
Transport to Road-Hand	174		
Load on Truck	160		
Total Cost		$427	
Net Revenue			$7,773
Sales at Retail Lot[1]			
Revenue $13.50 x 1,000		$13,500	
Costs			
Costs from "Sales At Roadside"	$427		
Transport to lot[2]	518		
Unload	85		
Estimated Labor[3]	740		
Other Unknown Costs (e.g., lot rental, advertising costs)	?		
Partial Cost		$1,770	
Margin			$11,730
Choose and Cut[1]			
Revenue $13.38 x 1,000		$13,380	
Costs			
Manhours on Plantation	$1,855		
Chain Saw Equip. Cost	16		
Total Cost[4]		$ 1,871	
Net Revenue			$11,509

B & B Trees			
Revenue $19.18 x 1,000		$19,180	
Costs			
Digging (by hand)	$1,085		
Wrapping	659		
Transport to Roadside	416		
Other unknown costs	?		
Partial Cost		$2,160	
Margin			$17,020

[1] Assumes average tree height of 6'
[2] Estimate based on Leuschner and Sellers (1975).
[3] Assumes lot is open for two weeks from 10:00 a.m. to 10:00 p.m. on weekends, 12:00 noon to 10:00 p.m. on weekdays and that only one person is on the lot at a time. Wage rate assumed was $5.00/hr.
[4] Assumes hand transportation to parking lot. Labor for cutting included in manhours on Plantation.

include time spent in organizing harvesting and marketing operations although time spent in performing the operations is included. More organizational time must be spent as the marketing system comes closer to the consumer. Consequently, a grower having other time demands may choose a less demanding marketing system, such as stumpage sales.

Finally, the grower may have difficulty obtaining labor for harvesting operations. Labor requirements generally increase as the net revenues increase (Table 10). All methods, except stumpage and roadside sales, require more than four man-weeks labor per thousand trees. Labor with the necessary skills may not be available for large harvests, particularly when it is only employed for a few weeks. These considerations again show the necessity of each grower determining the marketing method best for him or her.

Table 10. Estimated labor requirements (manhours per thousand trees) by marketing method.

Harvesting Operation	Sales On Stump	Sales at Roadside	Sales at a Retail Lot	Choose and cut	B&B Trees
Tag Trees	2.62	2.62	2.62	--	--
Cutting with Chain Saw	--	11.68	11.68	--	--
Dig and Burlap Trees	--	--	--	--	348.80
Transport to Road--Hand	--	34.75[1]	34.75[1]	--	83.30
Load on Truck	--	32.00[1]	32.00[1]	--	?
Transport to Retail Lot	--	--	58.97[1]	--	?
Unload at Retail Lot	--	--	17.08[1]	--	?
Man Retail Lot	--	--	148.00[2]	--	--
Manhours on Plantation	--	--	--	371.00[3]	--
Total Manhours	2.62	81.05	305.10	371.00	432.10
Total 8 hour Mandays	.33	10.13	38.14	46.38	54.01

[1] Insufficient observation received. Hours required taken from Leuschner and Sellers (1975).
[2] Values assumed because no data available (see t. 9, fn. 1 & 3)
[3] Cutting and transporting to parking lot included.

FINANCIAL ANALYSES OF CHRISTMAS TREE INVESTMENT

The basic financial criterion for investing in a project is to invest if the project's returns are higher than those from any other investment alternative. This means, for example, that it is better to put your savings in a bank which pays five percent rather than four percent interest.

There are, however, other factors to consider. One of the most important is the amount of risk. Most savings accounts are insured to a stated maximum; therefore, this investment is relatively risk free. The Christmas tree grower, on the other hand, bears a greater risk because of the danger of insect attack, changing market demand, and other items previously discussed. People usually expect to be compensated for greater risk and so the grower may want an extra five percent return on his investment, or a total of 10 percent.

Another consideration is the ability of the investor to withdraw from the investment. Investors usually expect to be compensated for the inability to withdraw. It is easy to withdraw money from a bank account but a grower must either wait until the trees mature or find a buyer for the immature plantation. Thus, the grower may want an extra three percent return to compensate for this factor or a total of 13 percent.

Finally, some people may simply enjoy working with plants and prefer growing Christmas trees rather than other employment. In this case, the grower may prefer to give up some income, perhaps one percent return, just to grow trees. In that case, he would require a return of 12 percent on his investment.

Other factors can affect the rate of return individuals require to invest, but are too numerous to discuss. However, each individual can decide what his return should be by starting with his best alternative, such as a savings or cashfund account.

Investment Criteria

It is important to use compound interest when the costs and revenues occur over a period of years. Compound interest accounts for expenses incurred in future years costing less because the investor can use the money during the intervening years, and for revenues received in future years being worth less because the investor does not have the money to use in the intervening years. There are several widely used investment criteria based upon these principles. Two are Present Net Worth (PNW) and the Internal Rate of Return (IRR).

Present Net Worth

Present Net Worth (PNW) is the algebraic sum of the discounted costs and revenues from a particular investment.[3] The resulting figure is the gain or loss from an investment in today's dollars over and above the interest rate used for discounting.

For example, a Christmas tree plantation with a PNW of $5,000 at 12 percent interest means that the investor could expect to earn 12 percent on his investment and still have $5,000 left over. This also means that the investment is earning over 12 percent because there is a $5,000 surplus.

PNW's are sometimes negative. For example, a -$5,000 PNW at 12 percent would mean the grower needs $5,000 more revenue in today's dollars in order to earn a 12 percent return. It would also mean that the rate of return on the investment is less than 12 percent because an additional $5,000 is needed to raise the return to 12 percent.

Internal Rate of Return

The PNW will decrease as the interest rate used for discounting is increased, and vice versa. It is possible to find a negative PNW for any investment simply by making the interest rate large enough. There will be some interest rate where the PNW is zero as long as there was a positive PNW at some lower, positive interest rate. The interest rate where the PNW is equal to zero is called the Internal Rate of Return (IRR).

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[3]The formula is: $PNW = (R_t - C_t)(1/(1 + i)^t)$ where: R = the revenues which occur in the t th. year; C = the costs which occur in the t th. year; i = the interest rate used for discounting; t = the year in which the cost or revenue occurs, where t = 0, 1, 2, . . . n.

IRR is the annual compound percent return which an investment earns. It is comparable to the interest rate which a grower could earn by putting his money in a bank. For example, an IRR of 12 percent on a plantation could be compared to a five percent savings account. It means the grower earns an extra seven percent on his investment to recompense him for added risk, having his money unavailable, and the other factors discussed.

This brief discussion is not sufficient to fully familiarize an uninitiated person with PNW and IRR. For example, the effects of inflation are not discussed. However, it is hoped that it will suffice to interpret the results of the following financial analysis program. Those interested in learning more about PNW or IRR should consult books in the fields of corporate finance, investment and capital theory, or engineering economy.

Investment Analysis Programs

Calculating the PNW and IRR can be complicated and time consuming so it is usually best to use a computer program for the task. In the years since the last Christmas tree grower's survey, many investment programs have been written and are generally available. Thus, no effort has been made to update Sellers (1974) Christmas Tree Investment Analysis Program (CTIAP).

CTIAP has the advantage of having many survey results imbedded in the program. However, the user still must specify cultural operations, marketing method, and certain general information. CTIAP then automatically places survey costs and revenues into the analysis and calculates the PNW, IRR, and several other investment guidelines.

The major difference between CTIAP and the investment analysis programs now available is that the user must specify the costs and revenues rather than having the program automatically insert them. This has the advantage of forcing the user to more carefully consider the costs and revenues which are entered. These data should fit the individual case as closely as possible. Automatically using survey results might increase the probability that a user would use the cost and revenue estimates in the program without carefully considering their applicability. Survey results in this publication can still be used for the analysis. However, the user must now consciously decide which to use rather than having the program automatically do it.

The investment analysis program user must specify each and every cultural operation and harvesting step, the year in which each is planned, and the cost or revenue amount. Other miscellaneous costs, such as property taxes and hand tool costs, must also be specified. Finally, the

interest rate for calculating the PNW is specified, although most programs calculate PNW for multiple interest rates. An investment analysis can be made for any number of acres but it is customary to analyze one acre and then multiply results by the number of acres in the plantation. Note that a single rotation is analyzed; thus, additional calculations are needed for a sustained yield plantation having tree ages distributed between, for example, 1 and 9 years. The following example (Table 11) will help clarify investment analysis program requirements. These calculations are for a one acre plantation.

Suppose a person could buy land for $100.00 per acre and that one year later the land would be site prepared by mowing with a 10 to 19 horsepower mower and herbiciding with a tractor and sprayer. A 75/25 percent mixture of white and Scotch pine will then be hand planted with a dibble on a six by six foot spacing.[4]

Seedling mortality is replanted in the second and third years and vegetation in the plantation will be controlled from the second to seventh year by three mowings each year plus one herbicide application. The herbicide application will be omitted in the eighth and ninth year, but not the mowing. Insect control expenditures are assumed every other year between the third and seventh year and annual property taxes and hand tool costs of $7.00 per acre are included in every year. Other planned cultural activities are evident if the reader will study Table 11.

The projected marketing method is wholesale at the roadside. Thus, the harvesting costs for cutting, hauling to the road, and loading on the buyer's truck are included. One third of the trees are sold in year 8 and the remainder in year 9. The sales price is a weighted average (75/25) for white and Scotch pine. Mortality assumptions follow Leuschner and Sellers (1975).

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[4] 6' x 6' = 36.0 square feet per tree. (43,560 sq. ft./acre)/36 sq. ft./tree = 1,210 trees per acre.

Table 11. Example of information needed for investment analysis, per acre.

Year Occur.	Activity	Number of Units	Cost per Unit	Total
0	Purchase land	1.0a	$100.00	$100.00
1	Site preparation			
	Mow with 10-19 HP Mower	1.0a	39.15	39.15
	Herbicide with tractor-sprayer	1.0a	40.80	40.80
1	Plant with dibble	1.2M[1]	113.60	137.46
1	Property tax & hand tools	1.0a	7.00	7.00
2	Replant with dibble	0.181M	124.20	22.48
2	Vegetation control			
	Mow 3 times with 10-19 HP Mower	3.0a	39.15	117.45
	Herbicide-Hand Application	1.0a	17.25	17.25
2	Property tax & hand tools	1.0a	7.00	7.00
3	Replant with dibble	0.121M	124.20	15.03
3	Vegetation control			
	Mow 3 times with 10-19 HP Mower	3.0a	39.15	117.45
	Herbicide-hand application	1.0a	17.25	17.25
3	Insect control	0.300M	19.79	5.94
3	Property tax & hand tools	1.0	7.00	7.00
4	Vegetation control			
	Mow 3 times with 10-19 HP Mower	3.0a	39.15	117.45
	Herbicide-hand application	1.0a	17.25	17.25

Table 11. continued.

Year Occur.	Activity	Number of Units	Cost per Unit	Total
4	Prune with snips	1.133M	$81.50	92.34
4	Shear with knives-under 3'	1.133M	28.75	32.63
4	Property taxes & hand tools	1.0a	7.00	7.00
5	Vegetation control			
	Mow 3 times with 10-19 HP Mower	3.0a	39.15	117.45
	Herbicide-hand application	1.0a	17.25	17.25
5	Shear with knives 3'-5'	1.110M	49.30	54.72
5	Insect control	0.300M	19.79	5.94
5	Property tax & hand tools	1.0a	7.00	7.00
6	Vegetation control			
	Mow 3 times with 10-19 HP Mower	3.0a	39.15	117.45
	Herbicide-hand application	1.0a	17.25	17.25
6	Shear with knives 3'-5'	1.088M	49.30	53.64
6	Property tax & hand tools	1.0a	7.00	7.00
7	Vegetation control			
	Mow 3 times with 10-19 HP Mower	3.0a	39.15	117.45
	Herbicide hand application	1.0a	17.25	17.25
7	Shear with knives 5'-6'	1.071M	80.35	86.05
7	Insect control	0.30M	19.79	5.94
7	Property tax & hand tools	1.0a	7.00	7.00

Table 11. continued.

Year Occur.	Activity	Number of Units	Cost per Unit	Total
8	Vegetation control Mow 3 times with 10-19 HP Mower	3.0a	39.15	$117.45
8	Shear with knives 5'-6'	1.055M	80.35	84.77
8	Partial Harvest-wholesale roadside			
	Tag trees to cut	0.352M	19.10	6.72
	Cut with chain saw	0.352M	74.40	26.19
	Hand to road	0.352M	173.75	61.16
	Load truck	0.352M	160.00	56.32
8	Sell trees	352	8.19	2,882.88
8	Property tax & hand tools	1.0a	7.00	7.00
9	Vegetation Control Mow 3 times with 10-19 HP Mower	3.0	39.15	117.45
9	Shear with knives over 6'	0.703M	113.65	79.90
9	Final harvest-wholesale roadside			
	Cut with Chain Saw	0.661M	74.40	49.18
	Hand to road	0.661M	173.75	114.85
	Load truck	0.661M	160.00	105.76
9	Sell trees	0.661M	8.19	5,413.59
9	Sell land	1.0a	100.00	100.00
9	Property tax & hand tools	1.0a	7.00	7.00

[1]Spacing 6'x6'.

Year	Mortality Percent	Mortality Number	Trees/a After Replant
1	15	181	1210
2	10	121	1210
3	3 1/2	42	1168
4	3	35	1133
5	2	23	1110
6	1 1/2	22	1088
7	1 1/2	16	1071
8	1 1/2	16	1055

The plantation site is assumed sold at the end of the rotation. This may or may not occur but "selling" the land implicitly charges interest on the money invested in the land. Note also that all of the costs and revenues correspond with those previously presented in the discussion of cultural, harvesting, and marketing practices.

Cash Flow Analysis

Most investment analysis programs will include a cash flow analysis. The cash flow analysis shows in undiscounted dollars, and sometimes discounted dollars, the money being spent and received in each year of the investment. Table 12 is an example of such an analysis. It is derived from Table 11. The first column shows the year in the investment cycle and the second and third columns show the costs and revenues occurring in each year. The fourth column is the net amount of the cash flow for that year and the fifth column is the cumulative cash flow.

In the example, the land is purchased for $100 and the following year it is site prepared and planted at a total cost of $224.41 ($39.15 + $40.80 +$137.46 + $7.00). There is no revenue in either year. Table 12 shows these years, costs, and zero revenues in the first three columns. The net cash flow, in the fourth column, is negative in both years because only costs were incurred. There were no revenues to offset them. The fifth column shows the amount of money spent since the start of the investment. It is the algebraic sum of all the preceding Net Cash Flows. In year one, it is -$324.41 (-$100.00-$224.41).

The cumulative cash flow demonstrates one of the difficulties in forestry investments. A great deal of money must be invested for long time periods before any return is obtained. Christmas tree investments are better in this regard than most forestry investments because of the shorter rotations. However, even in this example, the first positive cash flow

Table 12. Undiscounted cash flow analysis per acre.

Year	Total Cost	Total Revenue	Net Cash Flow	Cumulative Cash Flow
0	100.00	0.00	- 100.00	- 100.00
1	224.41	0.00	- 224.41	- 324.41
2	164.18	0.00	- 164.18	- 488.59
3	162.67	0.00	- 162.67	- 651.26
4	266.67	0.00	- 266.67	- 917.93
5	202.36	0.00	- 202.36	-1,120.29
6	195.34	0.00	- 195.34	-1,315.63
7	233.69	0.00	- 233.69	-1,549.32
8	359.61	2,882.88	2,523.27	973.95
9	474.14	5,513.59	5,039.45	6,013.40

does not occur until year eight of the investment. The potential investor should be aware of these financial needs before beginning a Christmas tree investment. Christmas tree growing is not just a case of planting the trees, allowing them to grow, and then harvesting. A continual cash investment must be made in addition to the continual management of the plantation discussed before.

This point can be demonstrated even more forcefully. Assume a grower wished to grow trees for sale each year. Such a grower would probably want to arrange a plantation so that one acre, or a multiple number of acres, would be harvested each year. This would then generate a continuing income instead of income only in the eighth and ninth year as shown in Table 12.

One way to do this would be to plant one acre a year for nine years. Then, each year there would be the same cash flow as in Table 12 but it would be delayed by one year. A continuing income would then be generated beginning with year eight of the investments. The cash flows for this investment are shown in Table 13. These are simply the Net Cash Flow from

Table 12 delayed one year at a time as the "new" acres in the plantation are established. Note the increase in the investment as more and more acres are added (last column Table 13). Over $6,000 dollars are eventually invested in year seven and a positive return is not obtained until year eight. However, beyond that point a steady income of over $6,000 is obtained for each nine acre block in a plantation managed as shown in Table 11.

The grower must have these financial reserves available or else he will not be able to perform the planned management activities. He can make arrangements for these funds if he knows the amounts and the years in which they are needed. Alternatively, he can change his management plans to fit the funds available.

The investment decision criteria are printed following the cash flow analysis in most investment analysis programs. These criteria can vary from program to program but almost always include the PNW for several interest rates and IRR. Other criteria can include the Benefit-Cost Ratio, the Equivalent Annual Income, the Composite Rate of Return, and a Break-Even Price per Christmas tree, all at several different interest rates. These other criteria are not discussed in this publication. However, the analyst using an investment analysis program for an individual grower should be able to interpret them.

The PNW for the investment in Table 11 is $3,673 at 12 percent interest assuming all revenues and costs are inflated at 6.7 percent a year. This is the inflation rate of the Consumer's Price Index between 1967 and 1982. This PNW means the grower will earn 12 percent on the investment and still have $3,673 left over in today's dollars. The IRR is higher than 12 percent because the PNW is positive. The IRR equals 42 percent in this illustration. This can be compared to current market interest rates of around 12 percent and indicates that the investment will provide an extra 30 percent return to cover risk, illiquidity, and other considerations. Note, however, these statements are based on the assumption that the investment will have the revenues and costs shown in Table 11 and that the inflation rate will be 6.7 percent.

Table 13. Undiscounted cash flow analysis for a nine-acre sustained yield plantation.

Year	Acre Number 1	2	3	4	5	6	7	8	9	Net Cash Flow	Cumulative Cash Flow
0	-100	--	--	--	--	--	--	--	--	- 100	- 100
1	-224	-100	--	--	--	--	--	--	--	- 324	- 424
2	-164	-224	-100	--	--	--	--	--	--	- 651	- 912
3	-163	-164	-224	-100	--	--	--	--	--	-918	-1563
4	-267	-163	-164	-224	-100	--	--	--	--	-1120	-2481
5	-202	-267	-163	-164	-224	-100	--	--	--	-1316	-3601
6	-195	-202	-267	-163	-164	-224	-100	--	--	-1316	-4917
7	-234	-195	-202	-267	-163	-164	-224	-100	--	-1549	-6466
8	2523	-234	-195	-202	-267	-163	-164	-224	-100	974	-5492
9	4939[1]	2523	-234	-195	-202	-267	-163	-164	-224	6013	521
10	-224	4939	2523	-234	-195	-202	-267	-263	-164	6013	6534
11	-164	-224	4939	2523	-234	-195	-202	-267	-163	6013	12547
12	-163	-164	-224	4939	2523	-234	-195	-202	-267	6013	18560
13	-267	-163	-164	-224	4939	2523	-234	-195	-202	6013	24573
14	-202	-267	-163	-164	-224	4939	2523	-234	-195	6013	30586
15	-195	-202	-267	-163	-164	-224	4939	2523	-234	6013	36599
16	-234	-195	-202	-267	-163	-164	-224	4939	2523	6013	42612
17	2523	-234	-195	-202	-267	-163	-164	-224	4939	6013	48625
18	4939	2523	-234	-195	-202	-267	-163	-164	-224	6013	54638

[1]The figure $4,939 found on this diagonal is the net of the positive $5,039 from the final harvest and the negative $100 to "repurchase" the land.

Using Investment Analysis Programs

Investment analysis programs are flexible tools which can be used for the financial analysis of Christmas tree investments. The programs can provide many guidelines for choosing management systems. For example, the grower may first make a base-line computer run with planned or actual management regimes and marketing methods. Next, costs and revenues under alternative management regimes and/or marketing methods are projected. A second computer run is made with these projections using the same interest rate as before. The base-line and alternative PNW's are then compared and the system with the highest PNW is financially preferable.

Suppose a grower wanted to examine the feasibility of clearcutting and selling wholesale at the roadside for all of his trees in year 8 instead of the current two year harvest. He estimates that all trees could be sold at $7.00 per tree because average tree height will be less than if they were grown another year. The PNW at 12 percent of this marketing method is less than that for the Table 11 management regimes. The grower should not market his trees in year eight but should use the previously planned method. Similar changes can be made in the estimates until, by trial and error, the best method is found.

Other changes in management regimes can be similarly examined. These might include different methods of site preparation, shearing, or vegetation control as well as different marketing methods. The grower should make the program reflect his own particular advantages or disadvantages by including his own cost and revenue estimates.

Investment analysis programs can also help determine how long to let trees grow. To do this the price per tree and the number of trees that would be sold must be estimated for a range of years. A separate analysis is made for each year and the one with the largest PNW is financially most desirable.

Using financial analyses for planning is equally important. Projections of cash and manpower requirements can be developed by combining the information presented in reports. A manpower budget for plantations begun in any one year can be developed by identifying the cultural practices and the number of acres or trees they will be applied to from the investment analysis information. These are multiplied by the manhour requirements from the costs reported earlier (Tables 1 to 5) to find the annual manhour requirements (Table 14).

The labor budget in Table 14 shows the manhour requirements for a single acre in each year of the plantation's life. This estimate must be multiplied by the number of acres planted in a single year. Further, the analysis can be extended to cover the total number of acres planted in different years, as was demonstrated in the cash flow analysis for a

Table 14. Example of calculation of a labor budget.

Year	Practice	Number Units Treated	Manhours Per Unit	Total
1	Site prepare with tractor/mower	1.0 a.	2.68	2.7
	Site prepare with tractor/sprayer	1.0 a.	1.12	1.1
	Plant trees by hand	1.21 M Tr.	13.72	16.6
	Annual Total			20.4
2	Replant trees with dibble	0.181 M Tr.	15.84	2.9
	Mow with 10-19 HP mower	3.0 a.	2.68	8.0
	Herbicide-Hand Application	1.0 a.	2.70	2.7
	Annual Total			13.6
3	Replant Trees with Dibble	0.121 M Tr.	15.84	1.9
	Mow with 10-19 HP Mower	3.0 a.	2.68	8.0
	Herbicide-Hand Application	1.0	2.70	2.7
	Insecticide-Hand Application	0.300 M Tr.	3.24	1.0
	Annual Total			13.6
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9				

sustained yield plantation (Table 13). This type of analysis is desirable because plantations require different amounts of labor depending on their age and the total requirements can be quite large. Persons planning to provide most of the labor themselves or with their family members should be particularly certain to make this analysis because labor requirements have a tendency to explode. It has been reported that some growers have "overplanted" relative to their labor availability. That is, many acres of plantation have been established and, when they are older and require more labor, the grower has found that his family could not provide it all. A grower who is approaching his labor capacity might even want to make a labor budget by month because of the seasonality of the cultural operations.

A General Financial Analysis

It should be clear by now that the authors firmly recommend that each grower analyze his own case. Nonetheless, the public is interested in the general question of potential profitability because of curiosity and to ascertain whether more detailed analysis is worthwhile. This section is included to answer these needs.

The investment example in Table 11 was constructed using cultural and marketing practices which were both economically and practically feasible. The analysis indicates the returns a grower is most likely to receive if costs and revenues were average. This management regime will therefore be adopted as a standard case and used as the base of the general analysis.

Many growers will not have average costs. Some will be more or less experienced, or perhaps live in areas of higher or lower prices. Thus, financial analyses have been calculated with costs 50 percent above and below the standard case to provide a range of returns within which a grower is likely to fall. Note that only costs and not revenues have been increased 50 percent.

Land is one of the largest cash outlays and is made in the first year, thereby increasing its importance. It is also one of the more variable investment costs because it is closely related to local conditions. Therefore, we varied land price from $100 to $1,500 dollars per acre in the general analysis.

The grower's time spent performing cultural, harvesting and marketing operations was included at $5.00 per hour. His time for managerial functions such as bookkeeping, finding buyers, and other overhead items was not included because of the difficulty in quantifying it. The analysis was made on a before tax basis because of large differences in individual tax status and to maintain general comparability with alternative investments.

Finally, all costs and revenues were inflated at 6.7 percent. Thus, land within an assumed $100 purchase price was "sold" for $179 in year nine. This effect increases with land price; for example, the $1,000 land was "sold" for $1,793. Different inflation rates could be applied to each item in the cash flow if there is reason to believe they differ from the average. This is another reason for individual analyses.

The results of this analysis indicate that the IRR's from Christmas tree plantation investments may vary between 21 and 56 percent (Table 15). Similar analyses were made in constant dollars which removes the effects of inflation. These results varied between 12 and 41 percent for $100 to $1,000 an acre land cost. This appears to be a very satisfactory return on investment, even after adjusting for risk. Also, it should be borne in mind that many types of risk can be decreased by adequate preparation on the grower's part. We therefore conclude that investment in a Christmas tree plantation can be a good alternative for small investors who are willing to expend the time and effort to manage a plantation on a business-like basis.

Table 15. Internal rate of return for standardized Christmas tree investment, 1981[1].

Land Price per Acre	Low Cost[2] Operations	Average Cost Operations	High Cost[3] Operation
$100	56	42	33
250	48	38	30
500	41	34	27
750	36	30	25
1,000	33	28	24
1,500	28	25	21

[1]Calculated with Forestry Investment Analysis Program Version 1.1 written by J. M. Vasievich and R. Frebis, USDA Forest Service, Southeastern Center for Forest Economics Research, Research Triangle, NC.

[2]Equipment and labor costs decreased 50 percent.

[3]Equipment and labor costs increased 50 percent.

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