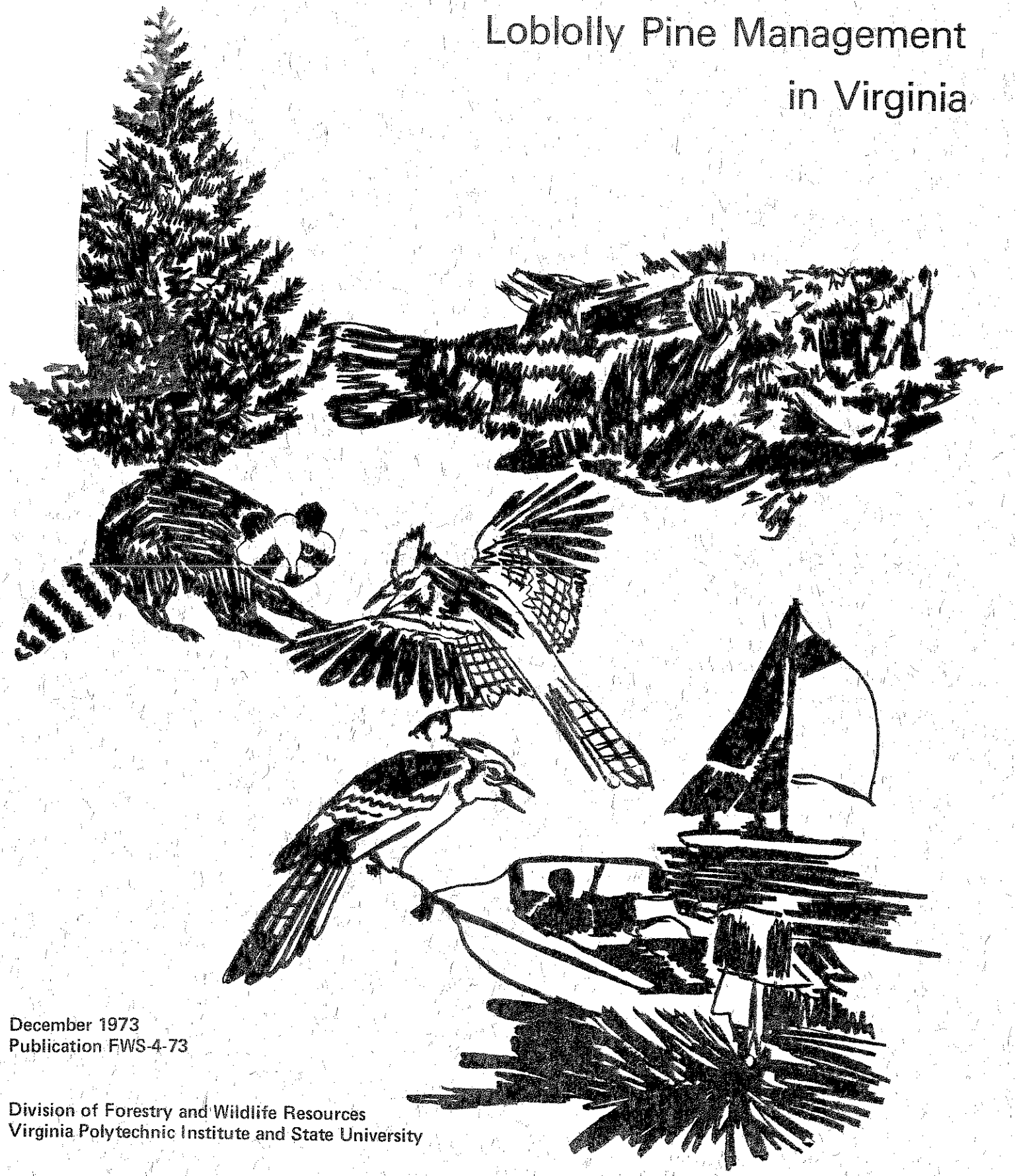
Economic Guidelines for Loblolly Pine Management in Virginia



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PREFACE

The study, upon which this publication is based, was undertaken to make pertinent economic information regarding loblolly pine production available to Virginia's farm and other private, non-industrial forest landowners. The research was made possible by a grant from the Virginia Agricultural Foundation. The authors wish to express their gratitude to the Foundation for providing funding.

Virginia landowners wishing assistance in using the study results to develop economic data for their specific situations, should contact the Extension Forestry Project Leader, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

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ECONOMIC GUIDELINES FOR LOBLOLLY PINE MANAGEMENT IN VIRGINIA

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INTRODUCTION

Recent studies (e.g. Southern Forest Resource Analysis Committee, 1969; U. S. Forest Service, 1972) indicate that wood requirements may exceed available supplies by the end of this century. The latest forest survey of Virginia (Knight and McClure, 1967) indicated a 15 per cent excess of pine cut over pine growth. As a result of this latter finding, Virginia's General Assembly passed a 1970 Reforestation of Timberlands Act. This Act provides financial assistance to private landowners to restore former pine growing lands to pine production.

Virginia has clearly established a state policy of encouraging investment in forest production. However, individual landowners may have alternative uses for their land and/or capital, or they may not be fully aware of their land's potential for timber. The specific objective of this study was to develop a means for making economic data on using their land for loblolly pine production available to Virginia's individual forest landowners. The study was limited to loblolly pine for several reasons. Loblolly pine is perhaps the most important of the timber species currently grown in Virginia, and it is expected to increase in importance. Of the 67.5 million tree seedlings planted in Virginia in 1972, 62.0 million were loblolly pine and 36.5 million of these were planted by farmers and other individuals (Virginia Forests, 1972). Loblolly pine accounts for over 90 per cent of the approximately 85 thousand acres artificially regenerated in Virginia each year (Shores, 1970). In addition, new information on the physical yields of natural stands of loblolly pine and loblolly pine plantations in Virginia has recently become available (Burkhart, et al., 1972a; Burkhart, et al., 1972b).

MODEL DEVELOPMENT

The number of variables which must be considered in economic analyses of timber production suggests that a computer-based means of analysis could be beneficial to landowners. The combined characteristics of speed, data storage capacity, and accuracy make modern day computers extremely helpful in providing pertinent decision-making

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information. Thus, it was considered appropriate to develop an investment model capable of being analyzed on a computer. This would provide a model with sufficient flexibility to handle many landowner situations.

The procedure used, then, was to develop a computer-based system to assist in determining the conditions under which loblolly pine production is economically justified in Virginia. The variety of objectives and physical and economic situations faced by different landowners required a program flexible enough to handle many different situations. The program was written in the FORTRAN IV language for an IBM 370/155 computer. Appendix E is a listing of the program. Appendices A, B, and C contain detailed descriptions of the card input order and data deck preparation for the program.

To maintain landowner flexibility, four separate, economic decision-making criteria are available: present net worth, internal rate of return, equivalent annual income, and capitalized value of annual incomes. The following discussions of these criteria are not intended to be exhaustive. For a more thorough treatment, as well as a source of additional references, see Gregory (1972: Ch. 14 and 15).

Present Net Worth

Present net worth (PNW) or discounted cash flow is defined as the difference between the present value of all future relevant incomes and the present value of all future relevant costs at a given interest rate. Present net worth is a measure of the contribution of an investment to the investor's capital stock. It represents the amount by which the investment either fails to reach or surpasses the selected interest rate. That is, the present net worth figure ranks an investment in relation to the financial return an investor could expect to receive from an alternative investment opportunity earning the given interest rate.

The interpretation of the present net worth criterion is straightforward. A positive PNW indicates that the investment will offer a higher return than the selected rate. A zero PNW reflects an investment that is just equaling the selected rate. A negative PNW indicates that the alternate investment is preferable to the one under consideration.

Internal Rate of Return

Internal rate of return (IRR) is the compound interest rate that equates the present value of all future incomes with the present value of all future costs. Internal rate of return is the average growth rate of an investment. It is a relative measure showing the rate at which the investment increases in value over time with respect to the outlays required to produce that flow of income.

The IRR criterion is based on several assumptions. Perhaps the most important is that all incomes, intermediate and final, can be reinvested at the internal rate of return. If this is not the case, difficulties will arise. Marty (1970) has suggested a composite rate of return to avoid the difficulties.

Equivalent Annual Income

When alternative investment opportunities have unequal lives, they cannot be compared solely on their present net worths. The lives must somehow be equalized. If it can be assumed that each alternative will perpetually duplicate itself, infinity becomes the common life. The present net worth of any cash flow can be converted to an equivalent annual income (EAI). The EAI, then, can be used as the criterion to compare unequal life investments.

Soil rent, a concept familiar to most foresters, is a special case of equivalent annual income for comparing unequal length timber rotations.

Capitalized Value of Annual Income

The capitalized value (CV) of an annual income is determined by dividing the annual income, or equivalent annual income, by the appropriate interest rate. This figure represents the present value of a perpetual series of annual, or equivalent annual, net incomes and implies the amount will remain constant over time.

Since the capitalized value is based upon future net returns, it approximates the worth of the particular investment alternative. If the investment is in land, capitalized value can be interpreted as the maximum one could pay for land and still realize the desired rate of interest. When used in this manner, the calculated CV is the same as soil expectation value, which is also a familiar concept to most foresters.

Choosing the Appropriate Criterion

The appropriate investment criterion for a given situation depends upon the investor's objectives and economic situation. Each of the above criteria has certain advantages which make it especially suited to specific situations. But, when used out of context, each of the criteria can lead to poor decisions.

Present net worth is a flexible criterion in that any cost/return schedule and investment length is easily considered. PNW can be used to analyze either an established or a prospective timber stand. By considering the value of the current stand and estimating future value, growth, and costs, the stand's optimum economic harvest age can be determined. When considering a new stand, PNW can also be used to evaluate the desirability of the investment.

If the investor is interested in the rate of value growth, or yield, of an investment, the internal rate of return is the proper criterion. The IRR is probably most useful for deciding between alternative projects in terms of capital efficiency.

Equivalent annual income is useful for comparing alternatives of unequal lives, when it can be assumed that the investment opportunities will repeat themselves indefinitely. This restriction does become less important as the length of the investment period increases.

The capitalized value of an annual income is most useful in determining the value of an annual, or equivalent annual, net income stream. In forestry this criterion is useful in determining the value of bare forest land for producing successive timber crops. This criterion assumes an infinite planning horizon, but, like equivalent annual income, the assumption becomes less important as the length of the individual investment period increases.

Because the various criteria may lead to different decisions, it is important that the investor match his objectives and economic situation to the criteria. Unless the investor is certain that one of the other criteria is best suited to his situation, it may be best to stick with present net worth. In general, if the investor expects a complex pattern of costs and returns, has doubt about his reinvestment opportunities, or if the decision is between mutually exclusive opportunities, it is better to rely on present net worth than to risk an incorrect decision because the assumptions underlying the other criteria were not satisfied.

USING THE MODEL

The model consists of a computer program which calculates present net worth, internal rate of return, equivalent annual income, and/or capitalized value of annual income for specified loblolly pine investment opportunities. Physical yield equations for both old-field loblolly pine plantations (Burkhart, et al. 1972a) and natural loblolly pine stands (Burkhart, et al. 1972b) are incorporated in the program. These equations were used because they represent the most recent research data available on loblolly pine yield in Virginia and they allow volume to be expressed in a number of units of measure.

Descriptions of the program options available and the information necessary to employ the program are discussed below.

Options Available

Three options or program classifications are used to distinguish alternative investment opportunities. The first two are very similar, differing only by the number of rotations considered. The third represents a totally different situation.

Option I deals with the pre-investment question of whether or not a landowner should plant loblolly pine. Because this is a pre-investment decision, all expected future costs and revenues are included. The format followed was to first discount costs and revenues using

the appropriate discounting formulas at an increasing interest rate starting from zero and working up by increments of 0.5 per cent. The present net worth for the interest rate is then calculated by finding the difference between the present value of incomes and the present value of costs. If costs prove to be greater than incomes at a zero per cent interest rate, the total cost, total revenue, and net worth figures are printed along with a statement indicating what has happened. If incomes exceed costs at zero per cent, the discounting process continues until present net worth becomes zero. A bisection method is then used to more accurately approximate the internal rate of return (Chappelle, 1969).

The equivalent annual income is calculated and printed for each interest rate used in the discounting process. The capitalized values of these annual incomes are calculated only if no value is given to land in the input data.

The first option deals with only one rotation age thus there will be only one set of calculations produced. Option II allows for up to 25 different rotation ages to be investigated with all other input factors remaining constant. Because costs and revenues will change as different rotation lengths are considered, there is a set of calculated values (present net worth, rate of return, etc.) printed for each rotation age tried.

Option III is designed to handle existing natural stands and plantations. In this case the relevant question is whether or not a stand should be cut now or sometime in the future. Past costs and incomes are irrelevant and have no bearing on what is to be done in the future. Instead, the decision to cut should be based on the growth in value that can be expected by allowing the stand to continue to grow.

The relevant costs in this case include the value of the present stand plus any costs that may occur before the stand is cut. The value of the present stand is equal to its volume times the current stumpage price. The future revenue is equal to the future volume cut times the expected stumpage price.

Option III will only calculate the values of present net worth and internal rate of return. Equivalent annual income is irrelevant in this situation because EAI assumes that the cash flows will be duplicated over time. This duplication is impossible without establishing a new stand, thus future costs will be different from those experienced in growing the current stand. The capitalized value of the equivalent annual income is not included for the same reason.

Basis for Calculating Physical Yields

A detailed description of the derivation of the loblolly pine yield equations used in this study is given in Burkhart, et al. (1972a)

and Burkhart, et al. (1972b). Only the information needed for the correct application of these equations will be presented here.

It is important to note that all physical yields and costs and returns are on a per acre basis. Total tract values can be calculated by multiplying the number of relevant acres by these per acre values.

The yield equations should perform adequately in predicting yields for the geographical areas sampled and for the range of observed data. Data for plantation yields were collected from sample plots located in loblolly pine plantations of the Virginia Piedmont and Coastal Plain and the Coastal Plain of Maryland, Delaware, and North Carolina. Data for natural stands were collected from sample plots located in the Virginia Piedmont and Coastal Plain and the Coastal Plain of North Carolina.

The 189 sample plots for plantations ranged in age from 9 to 35 years, in site index (base age 50) from 62 to 110 and in number of trees per acre from 300 to 2,900 (Burkhart et al., 1972a:3). The sample plots for natural stands ranged in age from 13 to 77 years, in site index (base age 50) from 53 to 92, and in basal area from 35 to 217 square feet per acre (Burkhart, et al., 1972b:3).

If the yield equations are used for stands having physical characteristics falling outside the range of observed data, the user must be aware that the yield estimates may be unreasonable and care should be taken to first evaluate the yield estimates for their validity before using them to estimate future income from timber harvest.

Yield estimates can be expressed in the following units of measure (Burkhart, et al., 1972a).

1. Total cubic-foot volume (inside and outside bark) per acre for all stems in the 1-inch dbh class and above.

2. Merchantable cubic-foot volumes (inside and outside bark) per acre to 3- and 4-inch top diameters (outside bark) for stems in the 5-inch dbh class and above.

3. Standard cords of wood and bark per acre to 3- and 4-inch top diameters (outside bark).

4. Green weight with and without bark in 1,000 pounds per acre for the total stem and to 3- and 4-inch top diameters (outside bark).

5. Dry weight of wood only in 1,000 pounds per acre for the total stem and to 3- and 4-inch top diameters (outside bark).

6. Board foot volume per acre, International 1/4 inch log rule, for all stems in the 8-inch dbh class and above that qualify (i.e., contain at least one 16-foot sawlog to a 6-inch top diameter, inside bark).

7. Pulpwood volume in addition to board foot volume is defined to include trees less than the threshold diameter for sawtimber (8-inch dbh class) but greater than a minimum size for pulpwood (5-inch dbh class), plus the trees above the threshold diameter for sawtimber but not qualifying due to form or quality, plus the pulpwood volume in the tops of those trees utilized for sawtimber.

Proper use of the yield equations requires knowing the assumptions upon which they are based and their input data requirements. For best results, the yield estimates for plantations should be used for stands that are unthinned, contain no interplanting, are free of severe insect or disease damage, are unburned and unpruned, and are relatively free of wildlings. The equations estimate yield per acre under a clear-cut harvesting method. Thus they cannot be used to estimate growth response to thinnings or to estimate yields from partial cuts. The site index figure required is based on an index age of 50 years. However, site indexes for eastern softwoods are often based on an index age of 25 years. The following conversion factor can be used to make the change:

$$SI_{50} = 1.31(SI_{25})$$

Yields of natural stands pertain to stands that are unthinned, even-aged, unaffected by severe insect and disease damages, and are unburned and unpruned. Although the equations are capable of considering natural stands having 75 per cent or more of their total basal area in loblolly pine, this study assumed that all stands are stocked only with loblolly pine.

Site index, current age, and current basal area per acre are needed to estimate yields from natural stands. If necessary, site index can be converted to a base age of 50 years by the same method previously described. Basal area projections for determining future yields from natural stands are made using the prediction equation developed by Clutter (1963).

Where for some reason it is believed that an acre of loblolly pine will produce more or less volume than that calculated by the yield equations, it is possible to change the calculated volumes by means of a volume change factor. That is, the calculated yields can be increased or decreased by a specific percentage of the original yield calculated. This makes it possible to take into account differences in growth rate due to such factors as fertilization or the use of genetically improved stock.

Calculation and Description of Incomes

The primary source of income from forested property is derived from wood products. Other sources of revenue such as leasing land to hunting clubs may be substantial but they are relevant to only a limited number of landowners. Annual and periodic incomes from these complementary uses of the forest can be handled by the computer program.

Gross income from the final harvest is defined as the product of physical yield and stumpage price. The yield refers to the complete removal of all merchantable timber from an unthinned stand. Adjustments for the volume left as seed trees in compliance with the Virginia Seed Tree Law is not explicitly considered in the yields but they may be incorporated by using the volume change factor.

Estimation of future stumpage prices is essentially a value judgment involving many interrelated factors. It could probably be safely concluded that stumpage prices will increase but to what extent, when, and for whom is a question which the individual landowner will have to satisfactorily answer for himself.

Calculation and Description of Costs

The cost side of any economic analysis is extremely important for it is the basis upon which the worth of an investment is measured. Although some costs cannot be foreseen (such as a natural disaster), it is possible to identify many of the costs that an investor in a forest enterprise can expect to incur. These can generally be classified according to time and frequency of occurrence. The most common categories are one-time, periodic, and annual costs.

The real difficulty lies in the estimation of the values and exact timing of these costs. They are subject to all the uncertainities of the future and considerable knowledge and foresight is required of the forest investor before he can intelligently analyze an investment opportunity.

Federal Income Taxation

If a forest landowner satisfies the requirements, he is eligible to receive long-term capital gains treatment on his income from timber sales. Procedures for determining taxable income from timber sales are explained in Agriculture Handbook 274 "The Timber Owner and his Federal Income Tax" (U. S. Forest Service, 1971). The procedures outlined in this reference were used in developing the taxation aspects of the model.

Initial Cost

Stand establishment will in many cases be the largest cost incurred in forest investments. It is an important consideration

for not only is it a large expense but the economic and biological success of the subsequent stand is closely related to how and when the stand was reproduced.

Different site preparation and reproduction techniques affect future yields through the influence of stocking, plant competition, and mortality. The benefits of these various methods must be carefully weighed before one method is chosen. Since the additional benefit from a more intensive site preparation method won't be realized until harvest, it is the present value of that benefit that must be compared with the additional cost of site preparation. If this additional benefit is not enough to cover the added expenditure, then increased site preparation intensity is not economically worthwhile.

Periodic Costs

The small private landowner is unlikely to incur large or frequent periodic costs. Whenever they are incurred, however, they must be classified as to whether or not they are to be expensed or capitalized for federal income tax purposes. Most costs experienced by the small private landowner can be expensed, and it is to his advantage to do so.

The computer program can handle both types of periodic costs. The capitalized costs are used in their absolute form, while the expensed costs are reduced to effective costs before being discounted. Calculations involving annual and periodic incomes and annual costs are also reduced to their effective values before being used in the discounting procedure.

Actual cost must be converted to effective cost because expenditures reduce the amount of income tax to be paid. Therefore, the effective amount of the expenditure is somewhat less than the absolute amount. For example, assume that a landowner's taxable income is 1000 dollars. With an ordinary income tax rate of 20 per cent, his income tax would be 200 dollars. If he were to incur a cost of 200 dollars that could be charged against his income, his taxable income would only be 800 dollars and the subsequent tax 160 dollars. In effect, the landowner has "saved" 40 dollars. The effective cost incurred is thus 200 dollars minus 40 dollars, or 160 dollars.

Annual Costs

For convenience, annual costs may be broken into two main categories: management costs and property taxes. Management costs are those annual costs incurred in producing a forest crop. They include such costs as interest, maintenance, and salaries of woods workers. Management costs for the small private landowner are generally not great. Property taxes usually constitute the largest part of a small forest landowner's annual expense.

Value of Land

Land, as well as all other resources, derives its value from potential use. It has an imputed value given to it by its present use but it also has a value derived from other potential uses. The use of land for one alternative prevents it from being used for another, thus there exists a loss in potential revenue which can be referred to as an opportunity cost.

The amount of this opportunity cost depends upon the alternative available to the owner. The land could be sold in which case the opportunity cost could be based upon its fair market value. The landowner may be able to lease his land or he may have several alternative crop type possibilities in which case the land value may be the present value of the future revenue streams.

For some landowners, an alternative use of land may not exist and there is no opportunity cost. If a landowner refuses to consider selling his land and would prefer to grow trees as opposed to other alternatives, he has no lost opportunities in using the land for timber production. To some it may seem inconceivable that land could be regarded as having no alternative uses, but for those landowners who have very close ties to their land and have a very rigid idea as to its uses, such an approach is not entirely irrational.

The opportunity cost of land can be expressed as the loss of annual revenue that could have been received had the land been put to another use. This annual return can be determined either by estimating the potential annual returns from an alternate use such as an agricultural crop or by calculating the interest charges of holding the land that could have otherwise been sold. In either case, the capitalized value of that annual income stream will equal the imputed value of the land for that use.

If the annual income from an alternative use were to be realized then it would be subject to federal income taxation. This makes the real or effective opportunity cost somewhat less than first anticipated.

The present value of the opportunity cost of using land can be expressed as:

$$OC = \frac{(VL)(1 - FTR)((1 + i)^r - 1)}{(1 + i)^r}$$

where

OC = Present value of the opportunity cost
VL = Total value of land
FTR = Federal ordinary income tax rate
r = Length of planning horizon or rotation
i = Annual compound interest rate

The interpretation of this formula is:

1. (1-FTR) This factor places the opportunity cost on an after tax basis.

2. $((1 + i)^r - 1)$ Opportunity cost represents the "charge" for using the land. "$(1+i)^r$" is used to calculate the future value of the land which includes both land value and accumulated interest. The "-1" is necessary to remove the value of the land leaving only the interest charged. This part of the formula rests upon the assumption that the value of the land will remain constant over time.

3. The $(1 + i)^r$ Expression in the denominator brings the value of the opportunity cost back to the present.

Input Variables

Each investment situation is unique in certain respects but many of the input variables specified by the landowner are required by all three options. Variables common to all the options include:

Physical Variables

Site index (base age 50 years)
Desired units of measure for physical yields
Rotation lengths to be evaluated
Volume change factor

Costs (dollars per acre)

Annual cost
Intermediate costs to be expensed for federal income tax purposes
Intermediate costs to be capitalized for federal income tax purposes
Federal ordinary income tax rate (per cent)
Sale expenses
Land value

Incomes

Stumpage price (dollars per cord and per MBF)
Annual income (dollars per acre)
Intermediate incomes (dollars per acre)

Variables pertinent to specific situations include:

Prospective Plantations

Establishment cost (dollars per acre)
Initial stocking (number of trees per acre)

Existing Plantations

Establishment cost or other basis for federal tax purposes (dollars per acre)
Current age of stand
Current stocking (number of trees per acre)

Existing Natural Stands

Federal tax basis, if any (dollars per acre)
Current age of stand
Current stocking (basal area per acre)

RESULTS AVAILABLE FOR LANDOWNERS

The results of this study will enable an analyst to investigate various forest investment opportunities available to individual private forest landowners. By using input information pertinent to his particular physical and economic situation, a forest landowner will also be able to determine the relative economic importance of any foreseeable changes in his physical or economic situation by varying the value of individual inputs.

The economic model is designed to be flexible enough to accommodate most common forest investment situations. The program itself is easy to use and the output information is straight-forward and easily interpreted.

Output Information Provided by the Program

A description of the physical characteristics of the stand is given for each rotation age requested. This description includes the type of stand being considered, the initial or current stocking, and the projected stocking at time of harvest.

The physical yield of a stand can be expressed in up to three different groups of units of measure. These groups and the corresponding code numbers are listed in Appendix D. The first desired unit of measure must be in terms of cords only or board feet and additional cords, for the income from the timber harvest is based upon these values. The two remaining groups of units of measure may be in any other desired units.

If a landowner feels that the expected physical yield will be different from that calculated by the yield equations, he can alter the yield with the volume change factor. This factor either increases or decreases the yield by a constant percentage. If a change in the yield is made, the program first prints the unaltered yield. This is immediately followed by the modified yield. Such a format allows both yields to be compared directly. All subsequent incomes and economic analyses are based on the modified yields.

The relevant yield in the analysis of an existing stand is the increase in volume over and above the volume of the present stand.

Thus, for all existing stands, the yields printed by the program include first the volume of the current stand and then the amount of increase in volume at each desired rotation age. All incomes from timber harvests are based on these modified stand volumes.

To aid in the interpretation of the decision-making criteria, all economic input information relevant to the specific rotation in question are printed directly after the physical yield information. This information includes stumpage prices, gross income from harvest, and the anticipated income and cost streams. The information and procedures used for calculating federal income tax are also included in this section of the print out.

The decision-making criteria available for use depend upon the forest stand situation the landowner desires to explore. Net income at the time of harvest, present net worth, and the internal rate of return are calculated for all situations. The interest rates used in these calculations start at 0 per cent and increase by increments of one half of one per cent. Discounted incomes, discounted costs, and present net worth are calculated and printed for each interest rate. The internal rate of return is identified when the present net worth essentially becomes zero.

The equivalent annual income is calculated for situations involving prospective plantations. The capitalized value of these incomes are provided only when no value has been previously given to land. Neither equivalent annual income nor the capitalized value are calculated for situations involving existing stands.

Uses and Limitations of the Computer Program

The most important step in any forest investment analysis is the determination of the investor's economic and land-use objectives. Once these objectives have been determined, alternative methods of achieving these goals can be identified. The use of computer models is merely an aid in the decision-making process. The final decision is left to the investor's judgment.

To illustrate how this computer program can provide useful information to potential forest investors, consider the following examples. Table 1 represents the output from a situation where a landowner is interested in determining the economic feasibility of converting his land to a loblolly pine plantation. The 100 dollar per acre land value used in the analysis implies that forest production is only one potential use for his land.

The landowner must first determine the wood growing potential (site index) of his land. The yield equations incorporated in the program will calculate the potential loblolly pine yield of the plantation at the desired rotation age for that site index but it is left to the descretion of the landowner to estimate the income and cost streams which he feels are relevant to his situation.

In this example, the income from the timber harvest is based on pulpwood only but as a matter of interest, the landowner can request that the income be expressed for a sawtimber and pulpwood harvest.

To determine the economic potential of the plantation, the landowner may weigh his alternatives according to several economic criteria. At a discount rate of 5 per cent, the landowner in this example could expect a present net worth of $37.27 per acre over the value of land and an equivalent annual income of $2.64 per acre if harvested in year 25. If he decides to use the internal rate of return criterion, he could expect a return of 6.14 per cent on his investment.

There are many possible modifications of this example that a landowner could choose to make. If he were interested in determining the optimum economic rotation, he could select a series of rotation lengths to be analyzed. He would then be able to determine the year at which the relevant decision-making criterion is maximized. He would also be able to determine the effect and relative importance of any changes that may occur in the input information the landowner originally chose to use. As an example, suppose the landowner expects an increase in property taxes. He could then increase the value of the annual cost data and observe the effect this change would have on the criterion of his choice.

Table 2 illustrates the output from a situation in which a forest landowner is faced with the question of what to do with his currently 15 year old loblolly pine plantation. The first part of the table describes the present economic and physical situation. The values given in this portion of the output represent the gross income and income tax that a landowner could expect should he decide to harvest the stand at age 15.

The second portion of the table describes what changes would occur should he decide to hold the stand for another 10 years. The decision to hold the stand produces an increase in volume and subsequent income (the increase being the difference between the potential volume and income at the rotation age and the present volume and income). The consequences of this decision are described by the present net worth and internal rate of return values. With a discount rate of 5 per cent, the present value of the net increase in value of the plantation used for this example is $65.58. The internal rate of return is 7.11 per cent. These figures indicate that it would be better for a landowner to postpone harvest. To determine the optimum rotation age, the landowner should investigate a series of rotation lengths to determine the age at which the chosen decision-making criterion is maximized.

The situation depicted in Table 3 is very similar to that of Table 2. It involves a natural stand of loblolly pine rather than

an existing plantation, but the main approach of the analysis is the same. However, this third example does illustrate how the volume change factor may be used to better approximate the yield of a forest stand.

Although the computer model is quite flexible, there are certain functions it is unable to perform. There is no method built-in to include an increase in stumpage prices due to the increase in timber values over time. This limitation can be overcome by assigning different stumpage prices to the yields at different ages but doing so requires a separate set of input data for each different rotation age-stumpage price combination. The additional expense and time required to make these separate analyses are minor.

Another limitation of the program is the approach taken for calculating the present value of an annual cost. The program assumes that the annual cost will remain constant throughout each rotation considered. There are discounting formulas which take into account constant annual changes in an annuity. But a constant change is not representative of changes in property taxes, since land is re-assessed periodically. If a landowner feels that a constant annual cost will significantly jeopardize the validity of the results of this program, he can treat the annual costs as a series of expensed intermediate costs. He can thus show the changes and the time periods for which each tax value is applicable.

Table 1. (continued)

Intermediate Income In Year 20	$ 5.00 Per Acre

III. Cost Schedule

Value of Land:	$ 100.00 Per Acre
Establishment Cost:	$ 40.00 Per Acre
Annual Cost:	$ 1.50 Per Acre

Intermediate Costs to be Expensed For Tax Purposes:

Intermediate Costs In Year: 10	$ 3.00 Per Acre
Intermediate Costs In Year: 15	$ 5.00 Per Acre

Intermediate Costs to be Capitalized For Tax Purposes:

Intermediate Costs in Year: 7	$ 4.00 Per Acre

Calculation of Federal Income Tax:

Sale Expenses:	$ 1.00 Per Acre
Original Basis:	$ 40.00 Per Acre
Capitalized Carrying Charges:	$ 4.00 Per Acre
Adjusted Basis:	$ 44.00 Per Acre

Taxable Income:
Ordinary Income Tax Rate = 20.0%

Income Tax (Capital Gain Treatment): $45.05 Per Acre

IV. Net Income in Year of Harvest

Total Income:	$ 497.55 Per Acre
Total Expenses:	$ 47.25 Per Acre
Net Income:	$ 450.29 Per Acre

V. Economic Analysis

Value of Land Included in Analysis

Discount Rate	Discounted Incomes	Discounted Costs	Present Net Worth
0.0	539.55	126.45	413.09
0.0050	478.59	128.02	350.57

Table 1. (continued)

	Discount Rate	Discounted Incomes	Discounted Costs	Present Net Worth
	0.0100	424.93	129.31	295.63
	0.0150	377.66	130.34	247.32
	0.0200	335.98	131.16	204.82
	0.0250	299.22	131.80	167.41
	0.0300	266.75	132.29	134.46
	0.0350	238.07	132.65	105.42
	0.0400	212.71	132.90	79.81
	0.0450	190.27	133.05	57.22
	0.0500	170.40	133.13	37.27
	0.0550	152.78	133.14	19.64
	0.0600	137.16	133.10	4.06
IRR =	0.0614	133.07	133.08	-0.01

	Discount Rate	Equivalent Annual Income
	0.0	16.52
	0.0050	14.95
	0.0100	13.42
	0.0150	11.94
	0.0200	10.49
	0.0250	9.09
	0.0300	7.72
	0.0350	6.40
	0.0400	5.11
	0.0450	3.86
	0.0500	2.64
	0.0550	1.46
	0.0600	0.32
IRR =	0.0614	-0.00

Table 2. Example computer print-out for an existing loblolly pine plantation

---

The Economics of Growing Loblolly Pine in Virginia
Site Index (Base Age 50 Years) 90

Single or Multi-Rotation Analysis
of an Existing Stand

Present Age of Stand = 15
Rotation Lengths to be Evaluated: 15, 25,
Stand Type = Plantation
Present Stocking (Trees Per Acre) = 600

I. Physical Yield

Volume Change Factor Equals 1.000
Total Yield if Harvested at Age 15:

Utilization Standard = OB, To a 3 Inch Top Diameter (OB)
1132.4 Bd.-Ft. Per Acre at $40.00 Per Thousand Bd.-Ft., and
31.9 Standard Cords Per Acre at $ 5.00 per Cord, or
2763.1 Cubic Feet Per Acre at $ 0.06 Per Cubic Foot

II. INCOME SCHEDULE

Current Stumpage Price:
$40.00 Per Thousand Bd.-Ft.
$ 5.00 Per Standard Cord

Gross Income from Harvest at Age 15:

Sawtimber:	$ 45.30 Per Acre
Pulpwood:	$ 159.31 Per Acre

Calculation of Federal Income Tax:

Sale Expenses:	$ 1.00 Per Acre
Original Basis:	$ 40.00 Per Acre
Capitalized Carrying Charges:	$ 0.00 Per Acre
Adjusted Basis:	$ 40.00 Per Acre
Taxable Income:	$ 162.60 Per Acre

Ordinary Income Tax Rate = 14.0%

Income Tax (Capital Gain Treatment): $ 11.45 Per Acre

Table 2. (continued)

Single or Multi-Rotation Analysis
of An Existing Stand

Rotation Length = 25 Years
Planning Horizon = 10 Years

Stand Type = Plantation
Present Stocking (Trees Per Acre) = 600
Trees Per Acre at Time of Harvest = 568

I. Physical Yield

Volume Change Factor Equals 1.000

Additional Yield if Harvested at Age 25:

Utilization Standard = OB, To a 3 Inch Top Diameter (OB)
10609.8 Bd.-Ft. Per Acre at $50.00 Per Thousand Bd.-Ft., and
3.5 Standard Cords Per Acre at $ 8.00 Per Cord, or
329.8 Cubic Feet Per Acre at $ 0.08 Per Cubic Foot

II. Income Schedule

Current Stumpage Price:
$40.00 Per Thousand Bd.-Ft.
$ 5.00 Per Standard Cord

Stumpage Price at Time of Harvest:
$50.00 Per Thousand Bd.-Ft.
$ 8.00 Per Standard Cord

Additional Gross Income If Harvested at Age 25:

Sawtimber:	$ 530.49 Per Acre
Pulpwood:	$ 27.95 Per Acre
Annual Income:	$ 0.00 Per Acre

III. Cost Schedule

Value of Land:	$ 100.00 Per Acre
Annual Cost:	$ 2.50 Per Acre

(Note: All Intermediate Incomes and Costs Are
Based on the Present Point in Time and Not
On The Time of Stand Establishment)

Table 2. (continued)

Calculation of Federal Income Tax:	
Sale Expenses:	$ 1.00 Per Acre
Original Basis:	$ 40.00 Per Acre
Capitalized Carrying Charges:	$ 0.00 Per Acre
Adjusted Basis:	$ 40.00 Per Acre
Taxable Income:	$ 517.44 Per Acre
Ordinary Income Tax Rate = 14.0%	
Income Tax (Capital Gain Treatment):	$ 36.22 Per Acre
IV. Net Income in Year of Harvest	
Total Income:	$ 558.44 Per Acre
Total Expenses:	$ 39.37 Per Acre
Net Income:	$ 519.07 Per Acre

V. Economic Analysis

Value of Land Included in Analysis

Discount Rate	Discounted Incomes	Discounted Costs	Present Net Worth
0.0	558.44	263.32	295.12
0.0050	531.28	265.11	266.17
0.0100	505.55	266.80	238.75
0.0150	481.19	268.40	212.80
0.0200	458.12	269.90	188.22
0.0250	436.26	271.31	164.94
0.0300	415.53	272.65	142.89
0.0350	395.89	273.90	121.99
0.0400	377.26	275.09	102.18
0.0450	359.60	276.20	83.40
0.0500	342.84	277.26	65.58
0.0550	326.93	278.25	48.68
0.0600	311.83	279.19	32.65
0.0650	297.50	280.07	17.43
0.0700	283.88	280.91	2.98
IRR = 0.0711	281.08	281.08	-0.00

Table 3. Example computer print-out for a natural stand of loblolly pine

---

The Economics of Growing Loblolly Pine in Virginia

Site Index (Base Age 50 Years) 80

Single Or Multi-Rotation Analysis
Of An Existing Stand

Present Age of Stand = 15
Rotation Lengths to be Evaluated: 15, 20,
Stand Type = Natural Stand
Current Stand Age = 15
Current Basal Area = 120 (Sq. Ft. Per Acre)

I. Physical Yield

Volume Change Factor Equals 1.000

Total Yield If Harvested at Age 15:

Utilization Standard = OB, To a 3 Inch Top Diameter (OB)
175.4 Bd.-Ft. Per Acre at $40.00 Per Thousand Bd.-Ft., and
18.1 Standard Cords Per Acre at $ 5.00 Per Cord, or
1516.9 Cubic Feet Per Acre at $ 0.06 Per Cubic Foot

Volume Change Factor Equals 0.750

Total Yield If Harvested at Age 15:

Utilization Standard = OB, To a 3 Inch Top Diameter (OB)
131.5 Bd.-Ft. Per Acre at $40.00 Per Thousand Bd.-Ft., and
13.7 Standard Cords Per Acre at $ 5.00 Per Cord, or
1150.0 Cubic Feet Per Acre at $ 0.06 Per Cubic Foot

II. Income Schedule

Current Stumpage Price:
$40.00 Per Thousand Bd.-Ft.
$ 5.00 Per Standard Cord

Gross Income from Harvest At Age 15:

Sawtimber:	$ 5.26 Per Acre
Pulpwood:	$ 68.46 Per Acre

Calculation of Federal Income Tax:

Sale Expenses: $ 1.00 Per Acre

Table 3. (continued)

Original Basis:	$ 0.00 Per Acre
Capitalized Carrying Charges:	$ 0.00 Per Acre
Adjusted Basis:	$ 0.00 Per Acre
Taxable Income:	$ 72.72 Per Acre
Ordinary Income Tax Rate = 14.0%	
Income Tax (Capital Gain Treatment):	$ 5.09 Per Acre

Single or Multi-Rotation Analysis
Of An Existing Stand

Rotation Length = 20 Years
Planning Horizon = 5 Years

Stand Type = Natural Stand
Current Stand Age = 15
Current Basal Area = 120 (Sq. Ft. Per Acre)
Basal Area at Rotation Age = 150 (Sq. Ft. Per Acre)

I. Physical Yield

Volume Change Factor Equals 1.000

Additional Yield if Harvested at Age 20:

Utilization Standard = OB, to a 3 Inch Top Diameter (OB)
1191.5 Bd.-Ft. Per Acre at $60.00 Per Thousand Bd.-Ft., and
10.9 Standard Cords Per Acre at $ 8.00 Per Cord, or
976.8 Cubic Feet Per Acre at $ 0.09 Per Cubic Foot

Volume Change Factor Equals 0.750

Additional Yield if Harvested at Age 20:

Utilization Standard = OB, to a 3 Inch Top Diameter (OB)
893.7 Bd.-Ft. Per Acre at $60.00 Per Thousand Bd.-Ft., and
8.2 Standard Cords Per Acre At $ 8.00 Per Cord, or
732.6 Cubic Feet Per Acre At $ 0.09 Per Cubic Foot

II. Income Schedule

Current Stumpage Price:
$40.00 Per Thousand Bd.-Ft.
$ 5.00 Per Standard Cord

Table 3. (continued)

Stumpage Price At Time of Harvest:	
$60.00 Per Thousand Bd.-Ft.	
$ 8.00 Per Standard Cord	
Additional Gross Income If Harvested At Age 20:	
Sawtimber:	$ 53.62 Per Acre
Pulpwood:	$ 65.34 Per Acre
Annual Income:	$ 2.00 Per Acre
III. Cost Schedule	
Value of Land	$ 75.00 Per Acre
Annual Cost:	$ 1.00 Per Acre
Intermediate Costs To Be Capitalized For Tax Purposes:	
(Note: All Intermediate Incomes And Costs Are Based On The Present Point in Time and Not on the Time of Stand Establishment)	
Calculation of Federal Income Tax:	
Sale Expenses	$ 1.00 Per Acre
Original Basis:	$ 0.00 Per Acre
Capitalized Carrying Charges:	$ 0.00 Per Acre
Adjusted Basis:	$ 0.00 Per Acre
Taxable Income:	$ 117.96 Per Acre
Ordinary Income Tax Rate = 14.0%	
Income Tax (Capital Gain Treatment):	$ 8.26 Per Acre
IV. Net Income in Year of Harvest	
Total Income:	$ 120.96 Per Acre
Total Expenses:	$ 10.12 Per Acre
Net Income:	$ 110.84 Per Acre

Table 3. (continued)

V. Economic Analysis

Value of Land Included in Analysis

Discount Rate	Discounted Incomes	Discounted Costs	Present Net Worth
0.0	127.56	87.28	40.28
0.0050	124.50	88.58	35.92
0.0100	121.53	89.84	31.70
0.0150	118.65	91.06	27.59
0.0200	115.85	92.24	23.61
0.0250	113.13	93.39	19.74
0.0300	110.49	94.51	15.98
0.0350	107.93	95.59	12.33
0.0400	105.43	96.65	8.79
0.0450	103.01	97.67	5.34
0.0500	100.65	98.66	1.99
IRR = 0.0530	99.26	99.25	0.00

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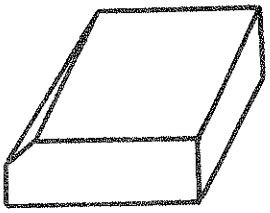
Appendix A. Card input order

System Control Cards



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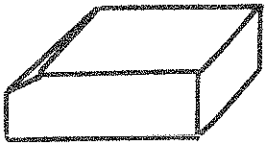

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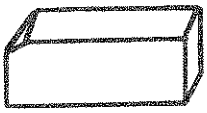
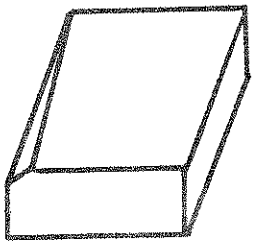


System Control Cards



Source Deck

System Control Cards

Appendix B. Data deck one preparation

Card	Symbol	Format	Columns	Meaning
1	(FPL(1,L)	F10.5	1-10,11-20,...	Coefficients for plantation yield equations
2	(FPL(J,L)	F10.5	1-10,11-20,...	(J = 1,24; L = 1,5)
.				
.				
.				
24	(FPL(J,L)	F10.5	1-10,11-20,...	

Cards 1-24 contain coefficients for plantation yield equations. The equations are given in the publication: Burkhart, Harold E., et al. 1972. Yields of Old-Field Loblolly Pine Plantations. Pub. FWS-3-72, Div. of Forestry and Wildlife Resources, VPI & SU, Blacksburg, Va. The units of measure, by card, are:

Card	Unit of Measure*/	Card	Unit of Measure*/
1	Cords (OB) 3" Top	13	Add. Cu. Ft. (IB) 4" Top
2	Cu. Ft. (OB) 3" Top	14	Cu. Ft. (OB) Total Stem
3	Green Wt. (OB) 3" Top	15	Green Wt. (OB) Total Stem
4	Cords (OB) 4" Top	16	Cu. Ft. (IB) Total Stem
5	Cu. Ft. (OB) 4" Top	17	Green Wt. (IB) Total Stem
6	Green Wt. (OB) 4" Top	18	Dry Wt. (IB) Total Stem
7	Bd. Ft. (IB) 6" Top	19	Cu. Ft. (IB) 3" Top
8	Add. Cu. Ft. (OB) 3" Top	20	Green Wt. (IB) 3" Top
9	Add. Cords (OB) 3" Top	21	Dry Wt. (IB) 3" Top
10	Add. Cu. Ft. (OB) 4" Top	22	Cu. Ft. (IB) 4" Top
11	Add. Cu. Ft. (OB) 4" Top	23	Green Wt. (IB) 4" Top
12	Add. Cu. Ft. (IB) 3" Top	24	Dry Wt. (IB) 4" Top

*/ All top diameter limits for cubic feet, cords, green weight and dry weight are outside bark; the top diameter limit for board feet is inside bark.

Appendix B. (continued)

Card	Symbol	Format	Columns	Meaning
25	FNS(J,L)	F10.5	1-10,11-20,...	Coefficients for natural stand yield equations (J = 1,24; L = 1,6)
26	FNS(J,L)	F10.5	1-10,11-20,...	
.				
.				
.				
48	FNS(J,L)	F10.5	1-10,11-20,...	

Cards 25-48 contain coefficients for natural stand yield equations. The equations are given in the publication: Burkhart, Harold E., et al. 1972. Yields for natural stands of loblolly pine. Pub. FWS-2-72, Div. of Forestry and Wildlife Resources, VPI & SU, Blacksburg, Va. The units of measure, by card, are:

Card	Unit of Measure*/	Card	Unit of Measure*/
25	Cords (OB) 3" Top	37	Add. Cu. Ft. (IB) 4" Top
26	Cu. Ft. (OB) 3" Top	38	Cu. Ft. (OB) Total Stem
27	Green Wt. (OB) 4" Top	39	Green Wt. (OB) Total Stem
28	Cords (OB) 4" Top	40	Cu. Ft. (IB) Total Stem
29	Cu. Ft. (OB) 4" Top	41	Green Wt. (IB) Total Stem
30	Green Wt. (OB) 4" Top	42	Dry Wt. (IB) Total Stem
31	Bd. Ft. (IB) 6" Top	43	Cu. Ft. (IB) 3" Top
32	Add. Cu. Ft. (OB) 3" Top	44	Green Wt. (IB) 3" Top
33	Add. Cords (OB) 3" Top	45	Dry Wt. (IB) 3" Top
34	Add. Cu. Ft. (OB) 4" Top	46	Cu. Ft. (IB) 4" Top
35	Add. Cords (OB) 4" Top	47	Green Wt. (IB) 4" Top
36	Add. Cu. Ft. (IB) 3" Top	48	Dry Wt. (IB) 4" Top

*/ All top diameter limits for cubic feet, cords, green weight and dry weight are outside bark; the top diameter limit for board feet is inside bark.

Appendix C. Data deck two preparation

Card	Symbol	Format	Columns	Meaning
1	MROT	I10	1-10	Total number of separate investment alternatives

Cards 2 through 10 are repeated for each investment alternative. Any card containing no non-zero entries should be omitted.

2	IST	I10	1-10	Stand type: Plantation = 1 Natural stand = 2
2	ISI	I10	11-20	Site index, 50 year base
2	NROT	I10	21-30	Number of rotation lengths to be evaluated: Maximum = 25
2	NOP	I10	31-40	Investment option desired: Single rotation, preinvestment analysis = 1 Multi-rotation, preinvestment analysis = 2 Single or multi-rotation investment analysis of existing stand = 3
2	IUNIT(I)	I10	41-50 51-60 61-70	Unit of measure, maximum of 3 groups possible, groups 1,2,3, or 4 must be included (see Appendix D)
2	VCF(JK)	F10.3	71-80	Volume change factor
3	ROTA(L)	25F3.0	1-3,4-6,...	Rotation lengths to be evaluated: Maximum = 25
4	TR	F10.0	1-10	Initial number of trees per acre (plantation only)

Appendix C. (continued)

Card	Symbol	Format	Columns	Meaning
4	AIR	F10.0	11-20	Current number of trees per acre (plantation only)
4	STP	F10.2	21-30	Estimated future stumpage price, dollars per cord (plantation)
4	STPA	F10.2	31-40	Estimated future stumpage price, dollars per MBF (plantation)
4	STP1	F10.2	41-50	Current stumpage price, dollars per cord (plantation)
4	STPA1	F10.2	51-60	Current stumpage price, dollars per MBF (plantation)
5	AO	F10.0	1-10	Current age of natural stand
5	BO	F10.0	11-20	Current basal area of natural stand, square feet per acre
5	STP	F10.2	21-30	Estimated future stumpage price, dollars per cord (natural stand)
5	STPA	F10.2	31-40	Estimated future stumpage price, dollars per MBF (natural stand)
5	STP1	F10.2	41-50	Current stumpage price, dollars per cord (natural stand)
5	STPA1	F10.2	51-60	Current stumpage price, dollars per MBF (natural stand)
6	NII	I10	1-10	Number of intermediate incomes: Maximum = 10

Appendix C. (continued)

Card	Symbol	Format	Columns	Meaning
6	NIEC	I10	11-20	Number of expensed intermediate costs: Maximum = 50
6	NICC	I10	21-30	Number of capitalized intermediate costs: Maximum = 10
6	VAI	F10.2	31-40	Value of annual income, dollars per acre
6	VAC	F10.2	41-50	Value of annual cost, dollars per acre
7	AGEI(I)	F10.0	1-10	Year intermediate income occurs
7	VII(I)	F10.2	11-20	Value of intermediate income, dollars per acre
8	AGEEC(I)	F10.0	1-10	Year expensed intermediate cost occurs
8	VIEC(I)	F10.2	11-20	Value of expensed intermediate cost, dollars per acre
9	AGECC(I)	F10.0	1-10	Year capitalized intermediate cost occurs
9	VICC(I)	F10.2	11-20	Value of capitalized intermediate cost, dollars per acre
10	VL	F10.2	1-10	Value of land, dollars per acre
10	EC	F10.2	11-20	Establishment cost or other tax basis, dollars per acre
10	ES	F10.2	21-30	Sales expense, dollars per acre
10	FTR	F10.4	31-40	Federal ordinary income tax rate

Appendix D. Units of measure; description and programming code numbers

Unit of Measure	Utilization Standard	Top Diameter (inches)	Code
Units of measure used to calculate income from timber harvest			
Group 1			
Cds.	Wood and bark	3 (OB)	
Cu. Ft.	Wood and bark	3 (OB)	1
Green Wt.	Wood and bark	3 (OB)	
Group 2			
Cds.	Wood and bark	4 (OB)	
Cu. Ft.	Wood and bark	4 (OB)	2
Green Wt.	Wood and bark	4 (OB)	
Group 3			
BF	Wood only	6 (IB)	
Cds.	Wood and bark	3 (OB)	3
Cu. Ft.	Wood and bark	3 (OB)	
Group 4			
BF	Wood only	6 (IB)	
Cds.	Wood and bark	4 (OB)	4
Cu. Ft.	Wood and bark	4 (OB)	
Alternate units of measure not used in the calculation of income			
Group 5			
BF	Wood only	6 (IB)	5
Cu. Ft.	Wood only	3 (OB)	
Group 6			
BF	Wood only	6 (IB)	6
Cu. Ft.	Wood only	4 (OB)	

Appendix D. (continued)

Unit of Measure	Utilization Standard	Top Diameter (inches)	Code
Alternate units of measure not used in the calculation of income			
Group 7			
Cu. Ft.	Wood only	3 (OB)	
Green Wt.	Wood only	3 (OB)	7
Dry Wt.	Wood only	3 (OB)	
Group 8			
Cu. Ft.	Wood only	4 (OB)	
Green Wt.	Wood only	4 (OB)	8
Dry Wt.	Wood only	4 (OB)	
Group 9			
Cu. Ft.	Wood and bark	Total Stem	9
Green Wt.	Wood and bark	Total Stem	
Group 10			
Cu. Ft.	Wood only	Total Stem	
Green Wt.	Wood only	Total Stem	10
Dry Wt.	Wood only	Total Stem	

APPENDIX E. SOURCE DECK LISTING FOR LOBLOLLY PINE INVESTMENT ANALYSIS PROGRAM

```
C
C      A PROGRAM TO ANALYZE THE ECONOMIC WORTH OF
C      LOBLOLLY PINE PRODUCTION OPPORTUNITIES AVAILABLE TO
C      PRIVATE FOREST LANDOWNERS IN THE COASTAL PLAIN
C      AND PIEDMONT REGIONS OF VIRGINIA
C
C      THE MAIN PROGRAM READS INPUT DATA AND COORDINATES
C      THE CALLING OF SUBROUTINES
       DIMENSION IUNIT(3),DR(40),ADR(47),ROT(25),FAI(47)
       COMMON FPL(24,5),FNS(24,6),ROTA(25),BA(25),BF(25),
      1TY(25,24),AY(25,24),TYA(25,24),TSTP(8),AGEI(10),
      2VII(10),AGEEC(50),VIEC(50),AGECC(10),VICC(10),
      3AYA(25,24),IST,SI,IUNITA,NOP,ATR,TR,TREES,AO,BO,
      4STP,STPA,GIT,AGIT,VAI,VAC,VL,ES,EC,NII,NIEC,NICC,
      5FTR,FIT,X,P,L,BFA,J,IU,NROT,JKN,JK,VCF(2),PLH,CAP,
      6STP1,STPA1
C
C      READ YIELD EQUATION COEFFICIENTS FOR PLANTATIONS
C
       DO 1 J=1,24
     1 READ(5,2)(FPL(J,L),L=1,5)
     2 FORMAT(6F10.5)
C
C      READ YIELD EQUATION COEFFICIENTS FOR NATURAL STANDS
C
       DO 3 J=1,24
     3 READ(5,2)(FNS(J,L),L=1,6)
C
C      READ NUMBER OF INVESTMENT ALTERNATIVES
C
       READ(5,4)MROT
       DO 31 K=1,MROT
C
C      READ STAND AND ECONOMIC ANALYSIS PARAMENTERS
C
       READ(5,4)IST,ISI,NROT,NOP,(IUNIT(I),I=1,3),VCF(2)
     4 FORMAT(7I10,F10.3)
       READ(5,5)(ROTA(L),L=1,NROT)
     5 FORMAT(25F3.0)
       GO TO(6,8),IST
C
C      READ PLANTATION CHARACTERISTICS AND STUMPAGE PRICES
C
     6 READ(5,7)TR,ATR,STP,STPA,STP1,STPA1
     7 FORMAT(2F10.0,4F10.2)
       GO TO 9
C
C      READ NATURAL STAND CHARACTERISTICS AND
C      STUMPAGE PRICES
C
```

APPENDIX E. (CONTINUED)

```
    8 READ(5,7)AO,BO,STP,STPA,STPI,STPAI
C
C      READ INTERMEDIATE AND ANNUAL INCOME AND
C      COST SCHEDULES
C
    9 READ(5,10)NII,NIEC,NICC,VAI,VAC
   10 FORMAT(3I10,2F10.2)
      IF(NII .EQ. 0)GO TO 13
      DO 11 I=1,NII
   11 READ(5,12)AGEI(I),VII(I)
   12 FORMAT(F10.0,F10.2)
   13 IF(NIEC .EQ. 0)GO TO 15
      DO 14 I=1,NIEC
   14 READ(5,12)AGEEC(I),VIEC(I)
   15 IF(NICC .EQ. 0)GO TO 17
      DO 16 I=1,NICC
   16 READ(5,12)AGECC(I),VICC(I)
C
C      READ LAND VALUE AND FEDERAL INCOME TAX INFORMATION
C
   17 READ(5,18)VL,EC,ES,FTR
   18 FORMAT(3F10.2,F10.4)
C
C      DETERMINE IF VOLUME IS TO BE ALTERED
C
      VCF(1)=1.
      IF(VCF(2) .EQ. 0)JKN=1
      IF(VCF(2) .GT. 0)JKN=2
C
C      DO ECONOMIC ANALYSIS FOR EACH ROTATION LENGTH
C      CHOSEN WITHIN AN INVESTMENT ALTERNATIVE
C
      DO 30 L=1,NROT
      WRITE(6,19)ISI
   19 FORMAT(1H1,14X,'THE ECONOMICS OF GROWING ',
     1'LOBLOLLY PINE IN VIRGINIA'///24X,'SITE INDEX',
     2' (BASE AGE 50 YEARS)',6X,I3////)
      WRITE(6,20)K
   20 FORMAT(15X,'MANAGEMENT ALTERNATIVE',I5///)
      GO TO(21,23,25),NOP
   21 WRITE(6,22)
   22 FORMAT(15X,'SINGLE ROTATION PRE-INVESTMENT ',
     1'ANALYSIS'//)
      GO TO 27
   23 WRITE(6,24)
   24 FORMAT(15X,'MULTI-ROTATION PRE-INVESTMENT ',
     1'ANALYSIS'//)
      GO TO 27
   25 WRITE(6,26)
   26 FORMAT(15X,'SINGLE OR MULTI-ROTATION ANALYSIS'/
```

APPENDIX E. (CONTINUED)

```
     115X,'OF AN EXISTING STAND'//)
   27 SI=ISI
C
C      MAKE VOLUME CHANGES IF NECESSARY
C
       DO 29 JK=1,JKN
       DO 28 J=1,3
       IUNITA=IUNIT(J)
       CALL YIELD
   28  CALL OUTPUT
   29  CONTINUE
       CALL SIRS
       IF((NOP .EQ. 3) .AND. (L .EQ. 1))GO TO 30
       CALL PNWO
   30  CONTINUE
   31  CONTINUE
       RETURN
       END
C
C      FUNCTION CPL, FUNCTION CNS, AND SUBROUTINE
C      YIELD USE EQUATIONS AS DESCRIBED BY BURKHART, H.E.
C      R.C. PARKER, M.R. STRUB, AND R.G. ODERWALD. 1972.
C      YIELDS OF OLD-FIELD LOBLOLLY PINE PLANTATIONS.
C      VPI&SU. PUBLICATION FWS - 3 - 72. AND BY
C      BURKHART, H.E., R.C. PARKER,AND R.G. ODERWALD. 1972.
C      YIELDS FOR NATURAL STANDS OF LOBLOLLY PINE.
C      VPI&SU. PUBLICATION FWS - 2 - 72.
C
       FUNCTION CPL(X1,X2,X3,X4,X5)
       COMMON FPL(24,5),FNS(24,6),ROTA(25),BA(25),BF(25),
      1TY(25,24),AY(25,24),TYA(25,24),TSTP(8),AGFI(10),
      2VII(10),AGEEC(50),VIEC(50),AGECC(10),VICC(10),
      3AYA(25,24),IST,SI,IUNITA,NOP,ATR,TR,TREES,AO,BO,
      4STP,STPA,GIT,AGIT,VAI,VAC,VL,ES,EC,NII,NIEC,NICC,
      5FTR,FIT,X,P,L,BFA,J,IU,NROT,JKN,JK,VCF(2),PLH,CAP,
      6STP1,STPA1
C
C      FUNCTION CPL CALCULATES STOCKING PER ACRE AND
C      CONSTRUCTS THE FUNCTION FOR CALCULATING YIELDS
C      FOR PLANTATIONS
C
C      CALCULATION OF TREE HEIGHTS AT ROTATION AGE
C
       ALTH=ALOG10(SI)-5.86537*(1.0/ROTA(L)-0.02)
       TH=10.0**ALTH
       IF(NOP .LT. 3)GO TO 1
C
C      WHEN NOP = 3: CALCULATION OF ORIGINAL STOCKING
C      USING CURRENT STOCKING AND AGE
C
```

APPENDIX E. (CONTINUED)

```
      ALTR=-0.63173037+0.14609196*ALOG10(ROTA(1))+
     11.20347729*ALOG10(ATR)
      TR=10.0**ALTR
C
C     CALCULATION OF STOCKING AT ROTATION AGE :
C     PROBIT EQUATION DEVELOPED BY J.D. LENHART AND
C     J.L. CLUTTER  (CUBIC-FOOT YIELD TABLES FOR
C     OLD-FIELD LOBLOLLY PINE PLANTATIONS IN THE
C     GEORGIA PIEDMONT,  GEORGIA FOREST RESEARCH
C     COUNCIL REPORT NO. 22 - SERIES 3,  MARCH, 1971)
C     TO PREDICT PROPORTION OF THE ORIGINAL STOCKING
C     STILL ALIVE AT ROTATION AGE. SUBROUTINE NDTR IS
C     USED TO DETERMINE THE VALUE OF THE STANDARD
C     NORMAL VARIABLE 'Z' SUCH THAT
C     PROBABILITY (Z < ZP) = P.
C
    1 PROBIT=9.3745-0.67637*ALOG10(ROTA(L))-0.96269*
     1ALOG10(TR)
      X=PROBIT-5.0
      CALL NDTR
      TREES=TR*P
C
C     GENERAL FORMULA FOR CALCULATING YIELDS
C     OF LOBLOLLY PINE PLANTATIONS
C
      CPL=X1+X2*(1.0/ROTA(L))+X3*(TH/ROTA(L))+X4*(TREES
     1/100.0)+X5*ROTA(L)*ALOG10(TREES)
      RETURN
      END
      FUNCTION CNS(X1,X2,X3,X4,X5,X6)
      COMMON FPL(24,5),FNS(24,6),ROTA(25),BA(25),BF(25),
     1TY(25,24),AY(25,24),TYA(25,24),TSTP(8),AGEI(10),
     2VII(10),AGEEC(50),VIEC(50),AGECC(10),VICC(10),
     3AYA(25,24),IST,SI,IUNITA,NOP,ATR,TR,TREES,AO,BO,
     4STP,STPA,GIT,AGIT,VAI,VAC,VL,ES,EC,NII,NIEC,NICC,
     5FTR,FIT,X,P,L,BFA,J,IU,NROT,JKN,JK,VCF(2),PLH,CAP,
     6STP1,STPA1
C
C     FUNCTION CNS CALCULATES STOCKING PER ACRE AND
C     CONSTRUCTS THE FUNCTION FOR CALCULATING YIELDS FOR
C     NATURAL STANDS
C
C     CALCULATION OF TREE HEIGHTS FOR DIFFERENT
C     SITE INDEXES AND ROTATION AGES
C
      IF(SI .LT. 75)GO TO 1
      IF(SI .LE. 85)GO TO 2
      ALTH=ALOG10(SI)-(5.98935*(1.0/ROTA(L)-1.0/50.0))
      GO TO 3
    1 ALTH=ALOG10(SI)-(6.93220*(1.0/ROTA(L)-1.0/50.0))
```

APPENDIX E. (CONTINUED)

```
      GO TO 3
    2 ALTH=ALOG10(SI)-(6.91444*(1.0/ROTA(L)-1.0/50.0))
    3 TH=10.0**ALTH
      IF((NOP .NE. 3) .OR. (L .NE. 1))GO TO 4
      BA(L)=BO
      GO TO 5
C
C     CALCULATION OF BASAL AREA PER ACRE AT
C     ROTATION AGE
C
C     BASAL AREA PROJECTION EQUATION FROM CLUTTER,J.L.
C     1963.  COMPATIBLE GROWTH AND YIELD MODELS FOR
C     LOBLOLLY PINE.  FOREST SCIENCE.  9:354-371.
C
    4 ALBA=4.6012+0.013597*SI-AO*(4.6012+0.013597*SI-
     1ALOG(BO))*(1.0/ROTA(L))
      BA(L)=EXP(ALBA)
C
C     GENERAL FORMULA FOR CALCULATING YIELDS
C     OF NATURAL STANDS OF LOBLOLLY PINE
C
    5 CNS=X1+X2*(1.0/ROTA(L))+X3*(TH/ROTA(L))+X4*ALOG10
     1(BA(L))+X5*ROTA(L)*ALOG10(BA(L))+X6
      RETURN
      END
      SUBROUTINE YIELD
      COMMON FPL(24,5),FNS(24,6),ROTA(25),BA(25),BF(25),
     1TY(25,24),AY(25,24),TYA(25,24),TSTP(8),AGEI(10),
     2VII(10),AGEEC(50),VIEC(50),AGECC(10),VICC(10),
     3AYA(25,24),IST,SI,IUNITA,NOP,ATR,TR,TREES,AO,BO,
     4STP,STPA,GIT,AGIT,VAI,VAC,VL,ES,EC,NII,NIEC,NICC,
     5FTR,FIT,X,P,L,BFA,J,IU,NROT,JKN,JK,VCF(2),PLH,CAP,
     6STP1,STPA1
C
C     SUBROUTINE YIELD CALCULATES PHYSICAL YIELD
C     ACCORDING TO THE STAND CONDITIONS AND UNITS OF
C     MEASURE CHOSEN BY THE USER
C
C     IUNITA REFERS TO THE CHOSEN UNIT OF MEASURE
C
      IF(IUNITA .EQ. 0)GO TO 24
      GO TO(1,2,3,3,3,3,8,9,10,11),IUNITA
C
C     'N' AND 'M' REFER TO THE CORRESPONDING YIELD
C     EQUATION COEFFICIENTS NECESSARY TO CALCULATE THE
C     YIELD IN THE DESIRED UNITS OF MEASURE
C
    1 N=1
      M=3
      GO TO 12
```

APPENDIX E. (CONTINUED)

```
     2 N=4
       M=6
       GO TO 12
C
C      CALCULATION OF YIELD IN BOARD-FEET
C
     3 IF(IST .EQ. 1)ALBF=CPL(FPL(7,1),FPL(7,2),FPL(7,3),
      1FPL(7,4),FPL(7,5))
       IF(IST .EQ. 2)ALBF=CNS(FNS(7,1),FNS(7,2),FNS(7,3),
      1FNS(7,4),FNS(7,5),FNS(7,6))
       BF(L)=10.0**ALBF*VCF(JK)
       IF((NOP .EQ. 3) .AND. (L .GT. 1))BF(L)=10.0**ALBF
       JL=7-IUNITA
       GO TO (4,5,6,7),JL
     4 N=22
       M=22
       GO TO 12
     5 N=19
       M=19
       GO TO 12
     6 N=4
       M=5
       GO TO 12
     7 N=1
       M=2
       GO TO 12
     8 N=19
       M=21
       GO TO 12
     9 N=22
       M=24
       GO TO 12
    10 N=14
       M=15
       GO TO 12
    11 N=16
       M=18
C
C      CALCULATION OF YIELDS IN CORDS, CUBIC FEET,
C      GREEN WEIGHT, AND DRY WEIGHT
C
    12 DO 15 I=N,M
       IF(IST .EQ. 1)ALTY=CPL(FPL(I,1),FPL(I,2),FPL(I,3),
      1FPL(I,4),FPL(I,5))
       IF(IST .EQ. 2)ALTY=CNS(FNS(I,1),FNS(I,2),FNS(I,3),
      1FNS(I,4),FNS(I,5),FNS(I,6))
       IF(NOP .EQ. 3)GO TO 13
       IF((IUNITA .GE. 3) .AND. (IUNITA .LE. 6))GO TO 13
       TY(L,I)=10.0**ALTY*VCF(JK)
       GO TO 14
```

APPENDIX E. (CONTINUED)

```
   13 TY(L,I)=10.0**ALTY
   14 IF((IUNITA .GE. 3) .AND. (IUNITA .LE. 6))GO TO 15
      IF((NOP .LT. 3) .OR. (L .EQ. 1))GO TO 15
C
C     CALCULATION OF ADDITIONAL YIELDS WHEN NOP = 3.
C     REFERS TO SITUATIONS WHERE STAND IS HARVESTED
C     FOR ONE PRODUCT ONLY
C
      TYA(L,I)=TY(L,I)-TY(1,I)
      TY(L,I)=TYA(L,I)*VCF(JK)
   15 CONTINUE
      IF((IUNITA .LT. 3) .OR. (IUNITA .GT. 6))GO TO 24
      GO TO (16,17,18,19),JL
   16 NM=13
      MN=13
      GO TO 20
   17 NM=12
      MN=12
      GO TO 20
   18 NM=11
      MN=10
      GO TO 20
   19 NM=9
      MN=8
   20 IF(IST .EQ. 2)GO TO 21
C
C     CALCULATION OF THE PULPWOOD VOLUME OVER AND ABOVE
C     THE BOARD-FOOT VOLUME. REFERS TO SITUATIONS WHERE
C     THE STAND IS TO BE HARVESTED FOR MULTIPLE
C     PRODUCTS.
C
      AY(L,NM)=TY(L,N)-(10.0**FPL(NM,1)*BF(L)**FPL(NM,2))
      AY(L,MN)=TY(L,M)-(10.0**FPL(MN,1)*BF(L)**FPL(MN,2))
      GO TO 22
   21 AY(L,NM)=TY(L,N)-(10.0**FNS(NM,1)*BF(L)**FNS(NM,2))
      AY(L,MN)=TY(L,M)-(10.0**FNS(MN,1)*BF(L)**FNS(MN,2))
   22 IF((NOP .LT. 3) .OR. (L .EQ. 1))GO TO 23
C
C     CALCULATION OF ADDITIONAL BOARD-FOOT YIELDS
C     WHEN NOP = 3
C
      BFA=BF(L)-BF(1)
      BF(L)=BFA*VCF(JK)
C
C     CALCULATION OF ADDITIONAL PULPWOOD YIELDS WHEN
C     NOP = 3. REFERS TO SITUATIONS WHERE THE STAND
C     IS TO BE HARVESTED FOR MULTIPLE PRODUCTS.
C
      AYA(L,NM)=AY(L,NM)-AY(1,NM)
      AYA(L,MN)=AY(L,MN)-AY(1,MN)
```

APPENDIX E. (CONTINUED)

```
      TY(L,NM)=AYA(L,NM)*VCF(JK)
      TY(L,MN)=AYA(L,MN)*VCF(JK)
      GO TO 24
   23 TY(L,NM)=AY(L,NM)*VCF(JK)
      TY(L,MN)=AY(L,MN)*VCF(JK)
   24 RETURN
      END
      SUBROUTINE NDTR
      COMMON FPL(24,5),FNS(24,6),ROTA(25),BA(25),BF(25),
     1TY(25,24),AY(25,24),TYA(25,24),TSTP(8),AGEI(10),
     2VII(10),AGEEC(50),VIEC(50),AGECC(10),VICC(10),
     3AYA(25,24),IST,SI,IUNITA,NOP,ATR,TR,TREES,AO,BO,
     4STP,STPA,GIT,AGIT,VAI,VAC,VL,ES,EC,NII,NIEC,NICC,
     5FTR,FIT,X,P,L,BFA,J,IU,NROT,JKN,JK,VCF(2),PLH,CAP,
     6STP1,STPA1
C
C     SUBROUTINE NDTR DETERMINES THE VALUE OF THE
C     STANDARD NORMAL VARIABLE 'Z'.
C
      AX=ABS(X)
      T=1.0/(1.0+.2316419*AX)
      D=0.3989423*EXP(-X*X/2.0)
      P=1.0-D*T*((((1.330274*T-1.821256)*T+1.781478)*T-
     1  0.3565638)*T+ 0.3193815)
      IF(X .LE. 0)P=1.0-P
      RETURN
      END
      SUBROUTINE OUTPUT
      DIMENSION MROTA(25)
      COMMON FPL(24,5),FNS(24,6),ROTA(25),BA(25),BF(25),
     1TY(25,24),AY(25,24),TYA(25,24),TSTP(8),AGEI(10),
     2VII(10),AGEEC(50),VIEC(50),AGECC(10),VICC(10),
     3AYA(25,24),IST,SI,IUNITA,NOP,ATR,TR,TREES,AO,BO,
     4STP,STPA,GIT,AGIT,VAI,VAC,VL,ES,EC,NII,NIEC,NICC,
     5FTR,FIT,X,P,L,BFA,J,IU,NROT,JKN,JK,VCF(2),PLH,CAP,
     6STP1,STPA1
C
C     SUBROUTINE OUTPUT PRINTS PHYSICAL YIELDS AND
C     INCOME AND COST STREAMS
C
      IF(IUNITA .EQ. 0)GO TO 54
      IF(J .GT. 1)GO TO 19
      IF((JKN .EQ. 2) .AND. (JK .EQ. 2))GO TO 15
      IF((NOP .EQ. 3) .AND. (L .EQ. 1))PLH=0.0
      IF((NOP .EQ. 3) .AND. (L .GT. 1))PLH=ROTA(L)-
     1ROTA(1)
      IF(NOP .LT. 3)PLH=ROTA(L)
      IROTA=ROTA(L)
      IPLH=PLH
      DO 1 LI=1,NROT
```

APPENDIX F. (CONTINUED)

```
     1 MROTA(LI)=ROTA(LI)
       IF((NOP .EQ. 3) .AND. (L .EQ. 1))WRITE(6,2)IROTA
     2 FORMAT(15X,'PRESENT AGE OF STAND =',I3)
       IF(L .EQ. 1)WRITE(6,3)(MROTA(LI),LI=1,NROT)
     3 FORMAT(15X,'ROTATION LENGTHS TO BE EVALUATED :',
      1 12(I3,',')/15X,13(I3,','))
       IF((NOP .LE. 2) .OR. (L .GT. 1))WRITE(6,4)IROTA,IPLH
     4 FORMAT(15X,'ROTATION LENGTH = ',I5,' YEARS'/15X,
      1'PLANNING HORIZON =',I5,' YEARS'///)
       IF(IST .EQ. 2)GO TO 10
C
C      PRINT STAND CHARACTERISTICS FOR PLANTATIONS
C
       WRITE(6,5)
     5 FORMAT(15X,'STAND TYPE = PLANTATION')
       IF(NOP .LT. 3)GO TO 8
       IATR=ATR
       ITREES=TREES
       IF(L .EQ. 1)WRITE(6,6)IATR
     6 FORMAT(15X,'PRESENT STOCKING (TREES PER ACRE) =',I4)
       IF(L .GT. 1)WRITE(6,7)IATR,ITREES
     7 FORMAT(15X,'PRESENT STOCKING (TREES PER ACRE)=',
      1I4/15X,'TREES PER ACRE AT TIME OF HARVEST =',I5/)
       GO TO 13
     8 ITR=TR
       ITREES=TREES
       WRITE(6,9)ITR,ITREES
     9 FORMAT(15X,'INITIAL STOCKING (TREES PER ACRE)= ',
      1I5/15X,'TREES PER ACRE AT TIME OF HARVEST =',I5/)
       GO TO 13
C
C      PRINT STAND CHARACTERISTICS FOR NATURAL STANDS
C
    10 IAO=AO
       IBO=BO
       IBA=BA(L)
       IF(L .EQ. 1)WRITE(6,11)IAO,IBO
    11 FORMAT(15X,'STAND TYPE = NATURAL STAND'/15X,
      1'CURRENT STAND AGE =',I5/15X,'CURRENT BASAL AREA ='
      2,I5,' (SQ. FT. PER ACRE)')
       IF(L .GT. 1)WRITE(6,12)IAO,IBO,IBA
    12 FORMAT(15X,'STAND TYPE = NATURAL STAND'/15X,
      1'CURRENT STAND AGE =',I5/15X,'CURRENT BASAL AREA ='
      2,I5,' (SQ. FT. PER ACRE)'/15X,'BASAL AREA AT ',
      3'ROTATION AGE =',I5,' (SQ. FT. PER ACRE)'/)
C
C      THE FOLLOWING SECTION PRINTS THE PHYSICAL YIELDS.
C
    13 WRITE(6,14)
    14 FORMAT(11X,'I. PHYSICAL YIELD'//)
```

APPENDIX E. (CONTINUED)

```
   15 WRITE(6,16)VCF(JK)
   16 FORMAT(15X,'VOLUME CHANGE FACTOR EQUALS',F8.3/)
      IF((NOP .LT. 3) .OR. (L .EQ. 1))WRITE(6,17)IROTA
      IF((NOP .EQ. 3) .AND. (L .GT. 1))WRITE(6,18)IRCTA
   17 FORMAT(15X,'TOTAL YIELD IF HARVESTED AT AGE',I3,' :'/)
   18 FORMAT(15X,'ADDITIONAL YIELD IF HARVESTED AT AGE',
     1I3,' :'/)
   19 IF(IUNITA .GT. 4)GO TO 39
C
C     INCOMES ARE BASED ONLY ON CORDS OR BOARD-FEET
C     AND ADDITIONAL PULPWOOD. THEY ARE NOT BASED ON THE
C     ALTERNATE UNITS OF MEASURE. (BASED ONLY ON
C     IUNITA = 1,2,3,4).
C
      GO TO (20,25,29,29),IUNITA
   20 GIT=TY(L,1)*STP
C
C     WHEN NOP = 3 THE INCREASE IN VALUE OF A STAND
C     IS COMPARED TO THE VALUE OF THE CURRENT STAND.
C     'CAP' IS THE VALUE OF THE CURRENT STAND
C
      IF(NOP .EQ. 3)CAP=TY(1,1)*STP1
      IF((NOP .EQ. 3) .AND. (L .EQ. 1))GIT=CAP
      DO 21 I=1,3
   21 TSTP(I)=GIT/TY(L,I)
      IF((NOP .EQ. 3) .AND. (L .EQ. 1))WRITE(6,22)
     1TY(L,1),STP1
      IF((NOP .LT. 3) .OR. (L .GT. 1))WRITE(6,22)TY(L,1),STP
   22 FORMAT(15X,'UTILIZATION STANDARD = OB, TO A 3 ',
     1'INCH TOP DIAMETER (OB)'/15X,F6.1,' STANDARD CORDS ',
     2'PER ACRE AT $',F5.2,' PER CORD, OR')
      WRITE(6,23)TY(L,2),TSTP(2)
   23 FORMAT(15X,F6.1,' CUBIC FEET PER ACRE AT $',
     1F5.2,' PER CUBIC FOOT, OR')
      WRITE(6,24)TY(L,3),TSTP(3)
   24 FORMAT(15X,F6.1,' GREEN WT., 1000 LBS. PER ACRE ',
     1'AT $',F5.2,' PER 1000 LBS.'/)
      GO TO 54
   25 GIT=TY(L,4)*STP
      IF(NOP .EQ. 3)CAP=TY(1,4)*STP1
      IF((NOP .EQ. 3) .AND. (L .EQ. 1))GIT=CAP
   26 DO 27 I=4,6
   27 TSTP(I)=GIT/TY(L,I)
      IF((NOP .EQ. 3) .AND. (L .EQ. 1))WRITE(6,28)
     1TY(L,4),STP1
      IF((NOP .LT. 3) .OR. (L .GT. 1))WRITE(6,28)TY(L,4),STP
   28 FORMAT(15X,'UTILIZATION STANDARD = OB, TO A 4 ',
     1'INCH TOP DIAMETER (OB)'/15X,F6.1,' STANDARD CORDS ',
     2'PER ACRE AT $',F5.2,' PER CORD, OR')
      WRITE(6,23)TY(L,5),TSTP(5)
```

APPENDIX E. (CONTINUED)

```
      WRITE(6,24)TY(L,6),TSTP(6)
      GO TO 54
   29 IF(IUNITA .EQ. 4)GO TO 30
      AGIT=TY(L,9)*STP
      IF(NOP .EQ. 3)CAP1=TY(1,9)*STP1
      IF((NOP .EQ. 3) .AND. (L .EQ. 1))AGIT=CAP1
      GO TO 31
   30 AGIT=TY(L,11)*STP
      IF(NOP .EQ. 3)CAP1=TY(1,11)*STP1
      IF((NOP .EQ. 3) .AND. (L .EQ. 1))AGIT=CAP1
   31 GIT=(BF(L)*STPA)/1000.0
      IF((NOP .LT. 3) .OR. (L .GT. 1))GO TO 32
      GIT=(BF(1)*STPA1)/1000.0
      CAP=CAP1+GIT
   32 IF(IUNITA .EQ. 4)GO TO 36
      TSTP(1)=AGIT/TY(L,8)
      IF((NOP .LT. 3) .OR. (L .GT. 1))GO TO 35
      WRITE(6,33)BF(L),STPA1
   33 FORMAT(15X,'UTILIZATION STANDARD = OB, TO A 3 ',
     1'INCH TOP DIAMETER (OB)'/15X,F8.1,' BD.-FT. PER ',
     2'ACRE AT $',F5.2,' PER THOUSAND BD.-FT., AND')
      WRITE(6,34)TY(L,9),STP1,TY(L,8),TSTP(1)
   34 FORMAT(15X,F6.1,' STANDARD CORDS PER ACRE AT $',
     1F5.2,' PER CORD,OR'/15X,F6.1,' CUBIC FEET PER',
     2' ACRE AT $',F5.2,' PER CUBIC FOOT'/)
      GO TO 54
   35 WRITE(6,33)BF(L),STPA
      WRITE(6,34)TY(L,9),STP,TY(L,8),TSTP(1)
      GO TO 54
   36 TSTP(1)=AGIT/TY(L,10)
      IF((NOP .LT. 3) .OR. (L .GT. 1))GO TO 38
      WRITE(6,37)BF(1),STPA1
   37 FORMAT(15X,'UTILIZATION STANDARD = OB, TO A 4 ',
     1'INCH TOP DIAMETER (OB)'/15X,F8.1,' BD.-FT. PER ',
     2'ACRE AT $',F5.2,' PER THOUSAND BD.-FT., AND')
      WRITE(6,34)TY(L,11),STP1,TY(L,10),TSTP(1)
      GO TO 54
   38 WRITE(6,37)BF(L),STPA
      WRITE(6,34)TY(L,11),STP,TY(L,10),TSTP(1)
      GO TO 54
   39 WRITE(6,40)
   40 FORMAT(15X,'ALTERNATE UNITS OF MEASURE FOR THE ',
     1'SAME YIELD AS ABOVE :'/)
      IF(IUNITA .GT. 6)GO TO 45
      IF(IUNITA .EQ. 6)GO TO 43
      WRITE(6,41)
   41 FORMAT(15X,'UTILIZATION STANDARD = IB, TO A 3 ',
     1'INCH TOP DIAMETER (OB)')
      WRITE(6,42)BF(L),TY(L,12)
   42 FORMAT(15X,F8.1,' BD.-FT. PER ACRE, AND'/15X,
```

APPENDIX E. (CONTINUED)

```
     1F6.1,' CUBIC FEET PER ACRE'/)
      GO TO 54
   43 WRITE(6,44)
   44 FORMAT(15X,'UTILIZATION STANDARD =IB, TO A 4 INCH ',
     1'TOP DIAMETER (OB)')
      WRITE(6,42)BF(L),TY(L,13)
      GO TO 54
   45 JL=11-IUNITA
      GO TO (52,49,48,46),JL
   46 WRITE(6,40)
      WRITE(6,47)(TY(L,I),I=19,21)
   47 FORMAT(15X,F7.1,' CUBIC FEET PER ACRE, OR'/15X,
     1F6.1,' GREEN WT. 1000 LBS. PER ACRE, OR'/15X,
     2F6.1,' DRY WT. 1000 LBS. PER ACRE'/)
      GO TO 54
   48 WRITE(6,44)
      WRITE(6,47)(TY(L,I),I=22,24)
      GO TO 54
   49 WRITE(6,50)
   50 FORMAT(15X,'UTILIZATION STANDARD = TOTAL STEM ',
     1'(OB)')
      WRITE(6,51)(TY(L,I),I=14,15)
   51 FORMAT(15X,F7.1,' CUBIC FEET PER ACRE, OR'/15X,
     1F6.1,' GREEN WT. 1000 LBS. PER ACRE'/)
      GO TO 54
   52 WRITE(6,53)
   53 FORMAT(15X,'UTILIZATION STANDARD = TOTAL STEM ',
     1'(IB)')
      WRITE(6,47)(TY(L,I),I=16,18)
   54 IF(J .EQ. 1)IU=IUNITA
      IF(J .LT. 3)GO TO 94
      IF((JKN .EQ. 2) .AND. (JK .EQ. 1))GO TO 94
C
C     PRINT INCOME SCHEDULE
C
      WRITE(6,55)
   55 FORMAT(10X,'II.  INCOME SCHEDULE'//)
      IF(NOP .NE. 3)GO TO 58
      WRITE(6,56)
   56 FORMAT(15X,'CURRENT STUMPAGE PRICE:')
      IF(STPA1 .GT. 0)WRITE(6,61)STPA1
      WRITE(6,62)STP1
      IF(L .EQ. 1)GO TO 65
      WRITE(6,57)
   57 FORMAT(15X,'STUMPAGE PRICE AT TIME OF HARVEST:')
      GO TO 60
   58 WRITE(6,59)
   59 FORMAT(15X,'STUMPAGE PRICE:')
   60 IF(STPA .GT. 0)WRITE(6,61)STPA
   61 FORMAT(15X,'$',F5.2,' PER THOUSAND BD.-FT.')
```

APPENDIX F. (CONTINUED)

```
      WRITE(6,62)STP
   62 FORMAT(15X,'$',F5.2,' PER STANDARD CORD'/)
      IF((NOP .LT. 3) .OR. (L .EQ. 1))GO TO 65
      IF(STPA .GT. 0)WRITE(6,63)IROTA,GIT,AGIT
   63 FORMAT(15X,'ADDITIONAL GROSS INCOME IF HARVESTED ',
     1'AT AGE',I3,' :'/30X,'SAWTIMBER :', 9X,'$',F7.2,
     2' PER ACRE'/30X,'PULPWOOD  :', 9X,'$',F7.2,' PER ,',
     3'ACRE'/)
      IF(STPA .EQ. 0)WRITE(6,64)IROTA,GIT
   64 FORMAT(15X,'ADDITIONAL GROSS INCOME IF HARVESTED ',
     1' AT AGE',I3,' :'/30X,'PULPWOOD  :',9X,'$',F7.2,
     2' PER ACRE'/)
      GO TO 68
   65 IF(STPA .GT. 0)WRITE(6,66)IROTA, GIT,AGIT
   66 FORMAT(15X,'GROSS INCOME FROM HARVEST AT AGE',
     1I3,' :'/30X,'SAWTIMBER :',9X,'$',F7.2,' PER ACRE'/,
     230X,'PULPWOOD  :',9X,'$',F7.2,' PER ACRE'/)
      IF(STPA .EQ. 0)WRITE(6,67)IROTA,GIT
   67 FORMAT(15X,'GROSS INCOME FROM HARVEST AT AGE',I3,
     1' :'/30X,'PULPWOOD  :',9X,'$',F7.2,' PER ACRE'/)
   68 IF((NOP .EQ. 3) .AND. (L .EQ. 1))GO TO 94
      WRITE(6,69)VAI
   69 FORMAT(15X,'ANNUAL INCOME:',21X,'$',F7.2,
     1' PER ACRE'/)
      IF(NII .EQ. 0)GO TO 75
      DO 74 I=1,NII
      GO TO (72,70,71),NOP
   70 IF(AGEI(I) .GT. ROTA(L))GO TO 74
      GO TO 72
   71 IF(AGEI(I) .GT. PLH)GO TO 74
   72 IAGE=AGEI(I)
      WRITE(6,73)IAGEI,VII(I)
   73 FORMAT(15X,'INTERMEDIATE INCOME IN YEAR',I3,5X,
     1'$',F7.2,' PER ACRE')
   74 CONTINUE
   75 WRITE(6,76)
C
C     PRINT COST SCHEDULE
C
   76 FORMAT(1HO,9X,'III. COST SCHEDULE'//)
      WRITE(6,77)VL
   77 FORMAT(15X,'VALUE OF LAND:',21X,'$',F7.2,
     1' PER ACRE'/)
      IF((IST .EQ. 1) .AND. (NOP .LT. 3))WRITE(6,78)EC
   78 FORMAT(15X,'ESTABLISHMENT COST:',16X,'$',F7.2,
     1' PER ACRE'/)
      WRITE(6,79)VAC
   79 FORMAT(15X,'ANNUAL COST:',23X,'$',F7.2,
     1' PER ACRE'/)
      IF((NIEC+NICC) .EQ. 0)GO TO 92
```

APPENDIX E. (CONTINUED)

```
      IF(NIEC .EQ. 0)GO TO 86
      IF((NOP .EQ. 3) .AND. (L .EQ. 1))GO TO 86
      WRITE(6,80)
   80 FORMAT(15X,'INTERMEDIATE COSTS TO BE EXPENSED',
     1' FOR TAX PURPOSES:')
      DO 85 I=1,NIEC
      GO TO (83,81,82),NOP
   81 IF(AGEEC(I) .GT. ROTA(L))GO TO 85
      GO TO 83
   82 IF(AGEEC(I) .GT. PLH)GO TO 85
   83 IAGEEC=AGEEC(I)
      WRITE(6,84)IAGEEC,VIEC(I)
   84 FORMAT(15X,'INTERMEDIATE COSTS IN YEAR:',I3,5X,
     1'$',F7.2,' PER ACRE')
   85 CONTINUE
   86 IF(NICC .EQ. 0) GO TO 92
      WRITE(6,87)
   87 FORMAT(1HO,14X,'INTERMEDIATE COSTS TO BE ',
     1'CAPITALIZED FOR TAX PURPOSES:')
      DO 91 I=1,NICC
      GO TO (90,88,89),NOP
   88 IF(AGECC(I) .GT. ROTA(L))GO TO 91
      GO TO 90
   89 IF(AGECC(I) .GT. PLH)GO TO 91
   90 IAGECC=AGECC(I)
      WRITE(6,84)IAGECC,VICC(I)
   91 CONTINUE
   92 IF(NOP .EQ. 3)WRITE(6,93)
   93 FORMAT(1HO,18X,'(NOTE: ALL INTERMEDIATE INCOMES AND ',
     1'COSTS ARE'/20X,'BASED ON THE PRESENT POINT IN TIME',
     2' AND NOT'/22X,'ON THE TIME OF STAND ESTABLISH',
     3'MENT)'/)
   94 RETURN
      END
      SUBROUTINE SIRS
      COMMON FPL(24,5),FNS(24,6),ROTA(25),BA(25),BF(25),
     1TY(25,24),AY(25,24),TYA(25,24),TSTP(8),AGEI(10),
     2VII(10),AGEEC(50),VIEC(50),AGECC(10),VICC(10),
     3AYA(25,24),IST,SI,IUNITA,NOP,ATR,TR,TREES,AO,BO,
     4STP,STPA,GIT,AGIT,VAI,VAC,VL,ES,EC,NII,NIEC,NICC,
     5FTR,FIT,X,P,L,BFA,J,IU,NROT,JKN,JK,VCF(2),PLH,CAP,
     6STP1,STPA1
C
C     SUBROUTINE SIRS CALCULATES FEDERAL INCOME TAX
C
      TVICC=0.0
      IF(NICC .EQ. 0)GO TO 5
      DO 4 I=1,NICC
      GO TO (3,1,2),NOP
    1 IF(AGECC(I) .GT. ROTA(L))GO TO 4
```

APPENDIX F. (CONTINUED)

```
      GO TO 3
    2 IF(AGECC(I) .GT. PLH)GO TO 4
    3 TVICC=TVICC+VICC(I)
    4 CONTINUE
C
C     ADJB = ADJUSTED BASIS
C
    5 ADJB=EC+TVICC
      IF((IU .LT. 3) .OR. (IU .GT. 6))AGIT=0.0
      GI=GIT+AGIT
      TI=GI-ADJB-ES
C
C     CAPITAL GAIN TAX RATE = ONE HALF THE ORDINARY
C     INCOME TAX RATE
C
      CGFTR=FTR/2.0
      FIT=TI*CGFTR
      FTRC=FTR*100.0
      WRITE(6,6)ES,EC,TVICC,ADJB,TI,FTRC
    6 FORMAT(1HO,14X,'CALCULATION OF FEDERAL INCOME TAX:'
     1//15X,'SALE EXPENSES:',21X,'$',F7.2,2X,'PER ACRE'//
     215X,'ORIGINAL BASIS:',20X,'$',F7.2,2X,'PER ACRE'/
     315X,'CAPITALIZED CARRYING CHARGES:',6X,'$',F7.2,2X,
     4'PER ACRE'/15X,'------------------------------------ ',
     5'----------'/15X,'ADJUSTED BASIS:',20X,'$',F7.2,
     62X,'PER ACRE'//15X,'TAXABLE INCOME:',20X,'$',F7.2,
     72X,'PER ACRE'/15X,'ORDINARY INCOME TAX RATE =',
     8F5.1,'%')
      IF(TI)7,9,11
    7 WRITE(6,8)
    8 FORMAT(1HO,15X,'LANDOWNER INCURRED A LOSS'//)
      GO TO 13
    9 WRITE(6,10)
   10 FORMAT(1HO,15X,'LANDOWNER INCURRED NEITHER LOSS ',
     1'NOR GAIN'//)
      GO TO 13
   11 WRITE(6,12)FIT
   12 FORMAT(1HO,14X,'INCOME TAX (CAPITAL GAIN ',
     1'TREATMENT):$',F6.2,2X,'PER ACRE'//)
   13 RETURN
      END
      SUBROUTINE PNWO
      DIMENSION DR(80),ADR(80),ROT(25),EAI(80),VNI(25),
     1PNW(80),CV(80)
      COMMON FPL(24,5),FNS(24,6),ROTA(25),BA(25),BF(25),
     1TY(25,24),AY(25,24),TYA(25,24),TSTP(8),AGEI(10),
     2VII(10),AGEEC(50),VIEC(50),AGECC(10),VICC(10),
     3AYA(25,24),IST,SI,IUNITA,NOP,ATR,TR,TREES,AO,BO,
     4STP,STPA,GIT,AGIT,VAI,VAC,VL,ES,EC,NII,NIEC,NICC,
     5FTR,FIT,X,P,L,BFA,J,IU,NROT,JKN,JK,VCF(2),PLH,CAP,
```

APPENDIX E. (CONTINUED)

```
     6STP1,STPA1
C
C      SUBROUTINE PNWO DETERMINES THE VALUE OF THE
C      DESIRED DECISION-MAKING CRITERIA
C
C      CALCULATION OF NET INCOME IN THE YEAR OF HARVEST
C
       WRITE(6,1)
     1 FORMAT(10X,'IV.  NET INCOME IN YEAR OF HARVEST'//)
       VFIT=0.00
       IF(NII .EQ. 0)GO TO 3
       DO 2 I=1,NII
       IF(AGEI(I) .NE. PLH)GO TO 2
       VFIT=VFIT+VII(I)
     2 CONTINUE
     3 VNR=GIT+AGIT+VAI+VFIT
       VFIEC=0.00
       VFICC=0.00
       IF(NIEC .EQ. 0)GO TO 5
       DO 4 I=1,NIEC
       IF(AGEEC(I) .NE. PLH)GO TO 4
       VFIEC=VFIEC+(VIEC(I)*(1.0-FTR))
     4 CONTINUE
     5 IF(NICC .EQ. 0)GO TO 7
       DO 6 I=1,NICC
       IF(AGECC(I) .NE. PLH)GO TO 6
       VFICC=VFICC+VICC(I)
     6 CONTINUE
     7 VNC=FS+FIT+(VAC*(1.0-FTR))+VFIEC+VFICC
       VNI(L)=VNR-VNC
       WRITE(6,8)VNR,VNC,VNI(L)
     8 FORMAT(15X,'TOTAL INCOME:',22X,'$',F7.2,2X,
      1'PER ACRE'//15X,'TOTAL EXPENSES:',20X,'$',F7.2,2X,
      2'PER ACRE'//15X,'NET INCOME:',24X,'$',F7.2,2X,
      3'PER ACRE'//)
C
C      STARTING POINT OF THE ECONOMIC ANALYSIS
C
       WRITE(6,9)
     9 FORMAT(11X,'V. ECONOMIC ANALYSIS'/)
       IF(VL .GT. 0)GO TO 11
       WRITE(6,10)
    10 FORMAT(25X,'VALUE OF LAND NOT CONSIDERED IN ANALYSIS'//)
       GO TO 13
    11 WRITE(6,12)
    12 FORMAT(23X,'VALUE OF LAND INCLUDED IN ANALYSIS'//)
    13 WRITE(6,14)
    14 FORMAT(19X,'DISCOUNT',3X,'DISCOUNTED',2X,
      1'DISCOUNTED',2X,'PRESENT'/21X,'RATE',6X,'INCOMES',
      26X,'COSTS',4X,'NET WORTH')
```

APPENDIX E. (CONTINUED)

```
      N1=2
C
C     DETERMINATION OF THE INTEREST RATE
C
      N2=80
      DR(1)=-0.005
   15 DO 49 II=N1,N2
      IF(N1 .EQ. 2)DR(II)=DR(II-1)+0.005
      IF(N1 .EQ. 3)DR(II)=(DR(II-1)+DR(II-2))/2.0
      PDR=DR(II)
C
C     DISCOUNT INCOMES
C
C     INTERMEDIATE INCOMES
C
      IF((NDP .LT. 3) .OR. (NROT .EQ. 1))GO TO 16
      ROT(L)=PLH
      GO TO 17
   16 ROT(L)=ROTA(L)
   17 TPVII=0.00
      IF(NII .EQ. 0)GO TO 22
      DO 21 I=1,NII
      GO TO (20,18,19),NCP
   18 IF(AGEI(I) .GT. ROTA(L))GO TO 21
      GO TO 20
   19 IF(AGEI(I) .GT. ROT(L))GO TO 21
   20 IF(PDR .EQ. 0)PVII=VII(I)*(1.0-FTR)
      IF(PDR .GT. 0)PVII=(VII(I)*(1.0-FTR))/(1.0+DR(II))
     1**AGEI(I)
      TPVII=TPVII+PVII
   21 CONTINUE
C
C     ANNUAL INCOMES
C
   22 IF(PDR .EQ. 0)PVAI=(VAI*(1.0-FTR))*ROT(L)
      IF(PDR .GT. 0)PVAI=(VAI*(1.0-FTR))*(((1.0+DR(II))
     1**ROT(L)-1.0)/(DR(II)*(1.0+DR(II))**ROT(L)))
C
C     FINAL INCOME
C
      TGI=GII+AGII
      PVTGI=TGI/(1.0+DR(II))**ROT(L)
      PVI=TPVII+PVAI+PVTGI
C
C     DISCOUNT COSTS
C
C     INTERMEDIATE COSTS
C
      TPVIEC=0.00
      IF(NIEC .EQ. 0)GO TO 27
```

APPENDIX E. (CONTINUED)

```
      DO 26 I=1,NIEC
      GO TO (25,23,24),NOP
   23 IF(AGEEC(I) .GT. ROTA(L))GO TO 26
      GO TO 25
   24 IF(AGEEC(I) .GT. ROT(L))GO TO 26
   25 PVIEC=(VIEC(I)*(1.0-FTR))/(1.0+DR(II))**AGEEC(I)
      TPVIEC=TPVIEC+PVIEC
   26 CONTINUE
   27 TPVICC=0.00
      IF(NICC .EQ. 0)GO TO 32
      DO 31 I=1,NICC
      GO TO (30,28,29),NCP
   28 IF(AGECC(I) .GT. ROTA(L))GO TO 31
      GO TO 30
   29 IF(AGECC(I) .GT. ROT(L))GO TO 31
   30 PVICC=VICC(I)/(1.0+DR(II))**AGECC(I)
      TPVICC=TPVICC+PVICC
   31 CONTINUE
C
C     ANNUAL COSTS
C
   32 IF(PDR .EQ. 0)PVAC=VAC*(1.0-FTR)*ROT(L)
      IF(PDR .GT. 0)PVAC=(VAC*(1.0-FTR))*(((1.0+DR(II))
     1**ROT(L)-1.0)/(DR(II)*(1.0+DR(II))**ROT(L)))
C
C     VALUE OF LAND
C
      IF(PDR .EQ. 0)PVVL=0.00
      IF(PDR .GT. 0)PVVL=VL*(1-FTR)*((1.0+DR(II))**ROT(L)
     1-1.0)/(1.0+DR(II))**ROT(L)
C
C     INCOME TAX
C
      IF(PDR .EQ. 0)GO TO 33
      PVIT=FIT/(1.0+DR(II))**ROT(L)
      GO TO 34
   33 PVIT=FIT
C
C     SALE EXPENSES
C
   34 PVES=ES/(1.0+DR(II))**ROT(L)
      IF(NOP .EQ. 3)GO TO 35
      PVC=TPVIEC+TPVICC+PVAC+PVIT+PVES+EC+PVVL
      GO TO 36
   35 PVC=TPVIEC+TPVICC+PVAC+PVIT+PVES+PVVL+CAP
C
C     PRESENT NET WORTH
C
   36 PNW(II)=PVI-PVC
C
```

APPENDIX E. (CONTINUED)

```
C      EQUIVALENT ANNUAL INCOME
C
       IF(N1 .EQ. 3)GO TO 44
       IF(PDR .EQ. 0)EAI(II)=PNW(II)/ROT(L)
       IF(PDR .GT. 0)EAI(II)=(PNW(II)*(1.0+DR(II))**ROT(L))
      1*(DR(II)/((1.0+DR(II))**ROT(L)-1.0))
C
C      CAPITALIZED VALUE OF THE EQUIVALENT ANNUAL INCOME
C
       IF(PDR .GT. 0)CV(II)=EAI(II)/DR(II)
       IF(II .EQ. 80)GO TO 40
       NA=II-1
       IF(II .EQ. 2)GO TO 37
       IF(PNW(II))50,40,42
   37  IF(PNW(II))38,40,42
   38  WRITE(6,43)DR(II),PVI,PVC,PNW(II)
       WRITE(6,39)
   39  FORMAT(1H0,20X,'PRESENT VALUE OF COSTS ',
      1'IS GREATER'/22X,'THAN PRESENT VALUE OF INCOMES')
       GO TO 50
   40  WRITE(6,41)DR(II),PVI,PVC,PNW(II)
   41  FORMAT(15X,'IRR =',F6.4,3X,F8.2,4X,F8.2,3X,F8.2)
       IF((N1 .EQ. 2) .AND. (NOP .LT. 3))ADR(II)=DR(II)
       GO TO 51
   42  WRITE(6,43)DR(II),PVI,PVC,PNW(II)
   43  FORMAT(20X,F6.4,3X,F8.2,4X,F8.2,3X,F8.2)
       GO TO 48
   44  IF(PNW(II))45,40,47
   45  IF((II .EQ. 11) .AND. (N1 .EQ. 3))GO TO 40
       IF(PNW(II-1) .GT. 0.00)GO TO 49
   46  DR(II-1)=DR(II-2)
       GO TO 49
   47  IF((II .EQ. 11) .AND. (N1 .EQ. 3))GO TO 40
       IF(PNW(II-1) .LT. 0.00)GO TO 49
       GO TO 46
   48  IF((N1 .EQ. 2) .AND. (NOP .LT. 3))ADR(II)=DR(II)
   49  CONTINUE
C
C      BISECTION METHOD FOR MORE ACCURATELY DETERMINING
C      RATE OF RETURN AS DEVELOPED BY CAPPELLE,D.E..
C      1969. A COMPUTER PROGRAM FOR EVALUATING FORESTRY
C      OPPORTUNITIES UNDER THREE INVESTMENT CRITERIA.
C      PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT
C      STATION.  PNW - 78.
C
C      REDEFINITION OF THE INTEREST RATE PARAMETERS
C      FOR THE BISECTION PROCEDURE
C
   50  DR(1)=DR(II)
       DR(2)=DR(II-1)
```

APPENDIX E. (CONTINUED)

```
      N1=3
      N2=11
      GO TO 15
   51 IF(NOP .EQ. 3)GO TO 59
      DRA=DR(II)
      AEAI=(PNW(II)*(1.0+DR(II))**ROT(L))*(DR(II)/
     1((1.0+DR(II))**ROT(L)-1.0))
      ACV=AEAI/DR(II)
      IF(VL .EQ. 0)WRITE(6,52)
   52 FORMAT(1H0,18X,'DISCOUNT',2X,'EQUIVALENT',2X,
     1'CAPITALIZED'/21X,'RATE',3X,'ANNUAL INCOME',
     23X,'VALUE')
      IF(VL .GT. 0)WRITE(6,53)
   53 FORMAT(1H0,18X,'DISCOUNT',2X,'EQUIVALENT'/21X,
     1'RATE',3X,'ANNUAL INCOME')
      DO 58 III=2,NA
      IF(ADR(III) .EQ. 0)WRITE(6,54)ADR(III),EAI(III)
   54 FORMAT(20X,F6.4,3X,F8.2)
      IF((VL .EQ. 0) .AND. (ADR(III) .EQ. 0))WRITE(6,55)
   55 FORMAT(1H+,42X,'--------')
      IF(VL .EQ. 0)GO TO 57
      IF(ADR(III) .GT. 0)WRITE(6,56)ADR(III),EAI(III)
   56 FORMAT(20X,F6.4,3X,F8.2)
      GO TO 58
   57 IF(ADR(III) .GT. 0)WRITE(6,43)ADR(III),EAI(III),
     1CV(III)
   58 CONTINUE
      IF((VL .EQ. 0) .AND. (NOP .LT. 3))WRITE(6,41)
     1DRA,AEAI,ACV
      IF(VL .GT. 0)WRITE(6,41)DRA,AEAI
   59 RETURN
      END
C
C         THE NEXT CARD IS THE START OF DATA DECK ONE
C
0.76479    -9.48111  0.38508   -0.01165  0.00632
2.68536    -9.61891  0.39235   -0.01307  0.00671
1.41301    -11.19215 0.42667   -0.01510  0.00667
0.73019    -11.22644 0.42333   -0.01394  0.00628
2.65264    -11.38212 0.43070   -0.01533  0.00666
1.40443    -13.57138 0.47500   -0.01765  0.00630
3.61623    -54.68953 1.20010   -0.13601  0.00169
0.03496    0.83645
-1.95492   0.84192
0.00095    0.84413
-1.97211   0.84486
-0.13573   0.85035
-0.17400   0.85889
2.48451    -5.45086  0.29954   0.00946   0.00886
1.21951    -7.02499  0.34034   0.00419   0.00877
```

APPENDIX E. (CONTINUED)

```
2.37288    -6.19378   0.31876    0.00706    0.00884
1.17817    -7.56027   0.35466    0.00213    0.00871
0.90223    -7.79316   0.31881    0.00720    0.00864
2.56915    -10.26901  0.40684    -0.01395   0.00672
1.37009    -11.65703  0.43640    -0.01564   0.00662
1.09538    -11.76794  0.40689    -0.01385   0.00655
2.54447    -12.38362  0.45136    -0.01645   0.00653
1.36893    -14.17656  0.48683    -0.01823   0.00616
1.07452    -13.84583  0.45142    -0.01635   0.00637
-0.86665   -9.83844   0.21349    0.84393    0.00159    0.45212
1.09894    -10.65329  0.23675    0.82303    0.00195    0.43976
-0.19443   -12.83394  0.28456    0.80858    0.00234    0.43485
-0.91362   -11.91054  0.25910    0.83009    0.00197    0.44522
1.05155    -12.73563  0.28245    0.80904    0.00232    0.43500
-0.24703   -15.20935  0.33468    0.79787    0.00268    0.43201
0.65136    -44.05023  0.86790    1.00569    0.00758
-0.15109   0.89579
-2.11416   0.89306
-0.19531   0.90473
-2.16224   0.90306
-0.42904   0.93793
-0.47387   0.94709
0.90099    -7.19583   0.16497    0.93605    0.00175    0.46452
-0.33595   -9.72976   0.22006    0.89634    0.00212    0.45562
0.81129    -8.23404   0.18782    0.91938    0.00191    0.46069
-0.37380   -10.22765  0.23060    0.88892    0.00218    0.45399
-0.64948   -10.19236  0.18813    0.92095    0.00184    0.45978
0.97153    -12.22892  0.27149    0.81208    0.00224    0.43596
-0.24276   -13.19926  0.29240    0.80660    0.00240    0.43417
-0.48877   -14.12292  0.27178    0.81344    0.00218    0.43518
0.91458    -14.78118  0.32578    0.79943    0.00263    0.43238
-0.29591   -15.59714  0.34265    0.79664    0.00273    0.43188
-0.54577   -16.55751  0.32603    0.80073    0.00257    0.43162
C
C         THE NEXT CARD IS THE START OF DATA DECK TWO
C
          3
          1          90          2          3          3
 15 25
             600.       8.         50.        5.         40.
                                              2.5
100.         40.        1.         .14
          2          80          2          3          3              .75
 15 20
         15         120         8    60.              5          40
                                   1    2.         1.
17.           4.
75.                      1.           .14
          1          80          1          1          1          5    10
 25
```

APPENDIX E. (CONTINUED)

750.			10.				
	1		2		1	2.	1.5
20.		5.					
10.		3.					
15.	5.						
7.	4.						
100.	40.		1.			.20	