An Appraisal Tool for Valuing Forest Lands

By Thomas J. Straka and Steven H. Bullard

Abstract

Forest and natural resources valuation can present challenging analysis and appraisal problems. Calculations range from specialized problems like bare land value to standard criteria like net present value and internal rate of return. Financial calculators are fine for simple analyses but forestry problems tend to be complex and often require the use of a computer investment analysis program. FORVAL is a user-friendly, free, menu-driven forestry and natural resources investment analysis program. It contains all the standard tools used in discounted cash flow analysis, plus financial criteria and valuation procedures that are unique to forestry. We describe the program, how to use it for forestry and timber valuation analysis, and explain the basic forestry valuation theory behind the procedures. Formulas and financial criteria are footnoted back to the basic appraisal literature. FORVAL is appropriate for any general appraisal valuation problem.

Introduction

Forestry and natural resources valuation can present a challenging valuation and appraisal problems. Calculations range from specialized timber valuation criteria like bare land value to standard criteria like net present value and internal rate of return. Many of these analyses are complex enough to require the use of computer investment analysis software. Most of these computer packages are not particularly user-friendly and most are not free.

We describe a user-friendly, free, menu-driven forestry and natural resources valuation package. It contains all the standard criteria used in discounted cash flow (DCF) analysis, plus several specialized forestry financial criteria and valuation procedures. Ease-of-use has made it a very popular software package.

Thomas J. Straka is a professor in the Department of Forestry and Natural Resources at Clemson University, Clemson, SC. He has a B.S. and M.S. in forestry from the University of Wisconsin-Madison and a Ph.D. in forest management from Virginia Tech. His specialty is forest resource management and economics and he teaches and researches in the area of forest valuation. He has numerous publications on forest valuation.

Steven H. Bullard is professor and chair of the Department of Forestry at the University of Kentucky. As chair, he serves as the administrative leader of the department. He has a B.S. and M.S. in forestry from Mississippi State University and a Ph.D. in forest management from Virginia Tech. He has extensive teaching and research experience in the area of forest valuation and an extensive publication record on the subject, including a text on forest valuation co-authored with Dr. Straka.

FORVAL (FORest VALuation) is a computer program for DCF analysis of forestry and natural resources investments. FORVAL was designed for use without a manual. Users simply answer questions displayed on the computer screen. The program can be downloaded directly from a Web site (http://www.cfr.msstate.edu/fwrc/products/software/forval.htm) or an online version is available for immediate use (http://www.cfr.msstate.edu/forval). A user's manual is available from Mississippi State University,[1] but the program is designed to operate using prompts. The user is first prompted to choose one of four options: financial criteria, monthly or annual payment, precommercial timber value, or projected stumpage price.

Type of Calculation (Formulas Used)

Before we discuss each of the financial criteria, it would pay to identify the formulas used to discount in the net present value (NPV) option. The program will discount any combination of single sum, terminating annual series, perpetual annual series, and perpetual periodic series cash flows. The user specifies "Type of Calculation" for each cash flow. If just a single cash flow is entered, the solution will be that of simply discounting or compounding using one of the basic formulas.

Single sum relates to a single cost or revenue that occurs just once during the life of the investment (i.e., the cost of preparing a site for tree planting). This is called discounting and the basic formula to discount a future value to a present value is used.[2] Terminating annual cash flow series experience level or uniform costs or revenues for a fixed period of time. An example is a payment of $20.00 per year for twenty years for a hunting lease. The formula used is for the present value of an ordinary level annuity.[3]

Two perpetual cash flow series are included. The first is a perpetual annual series where a cost or revenue occurs annually for an infinite period of time (an example is a payment of $5.00/acre/year for property tax forever). This is the case of "capitalization in perpetuity" for "level income with no change in value."[4] The second perpetual series formula is a bit unusual but common in forestry investment analysis. Often timber rotations are valued into perpetuity and costs or revenues occur on a non-annual but regular periodic basis. For example, a cost might occur every three years forever or timber income might occur every 30 years forever. This is consistent with capitalization in perpetuity; the formula becomes:

$$a\left[\frac{1}{(1+i)^t-1}\right]$$

Where a = dollar amount of periodic annual payment
i = interest rate, expressed as a decimal
t = time period between payments

FORVAL makes the assumption that all cash flows occur at the end of the year. An exception is Year 0, which represents now or today. Sometimes tree planting or site preparation occur immediately and that equates to Year 0. Basic discounting is accomplished via the Net Present Value option; compounding can be accomplished using the Future Value option. Future Value will work for the Single Sum and Terminating Annual Series. Of course, the future value of the two perpetual series can not be calculated.

Figure 1 shows four simple examples that illustrate the use of the Financial Criteria-Net Present Value calculation option to solve for solving single sum, terminating annual series, perpetual annual series, and perpetual periodic series problems. In each case the program prompted for the interest rate after the Calculate key was pressed. Note that with the use of the Future Value function, one half of the factors in the standard Compound Interest Table for 10 percent are used in these calculations.[5] Options discussed later will utilize the other half. Thus, FORVAL contains most of the standard discounting formulas and can conveniently discount single cash flows of many types.[6]

Financial Criteria

This option accesses the standard DCF financial criteria and several specialized forestry criteria. Any series of cash flows or forestry investment can be analyzed. The financial criteria option requires the user to choose the type of financial calculations to make. The program presents the following financial criteria: net present value (NPV), rate of return (ROR), equal annual income (EAI), benefit/cost ratio (B/C), all of the above, land expectation value (LEV), and future value (FV). Some of these are very familiar to the average appraiser and some are not. Rate of return is internal rate of return (IRR).

Both NPV and IRR are standard criteria that need no explanation.[7]

EAI is used in forestry to "annualize" a net present value. It is the annual income equivalent to a specified NPV at a specific interest rate. This criterion is often used to compare or rank investments that are not equal in time length. It is popular in forestry investment analysis for comparing timberland investment with the annual income from other land uses such as pasture rent or agricultural crops. What EAI does is convert the NPV of an investment into its level annual payment equivalent. It does this by multiplying NPV by the direct reduction annual factor.[8] Since compound interest is used to calculate the level payments, they are equivalent; hence, the term EAI. Obviously, EAI is directly correlated to the NPV since it is calculated with the same discount rate.

B/C ratio is the discounted revenues from a project divided by the discounted costs. It too is directly correlated with NPV. When NPV is positive, B/C will be greater than one; when NPV is negative, B/C will be less than one; and when NPV equals zero, B/C will equal one. The B/C ratio is popular with governmental agencies.

LEV is a fundamental forestry valuation technique and will be discussed in detail in the next section. The future value option is included to allow the user to quickly calculate the future value of single sums. The only inputs are amount, interest rate, and number of compounding periods. This is simply based on Future Value of $1 or compound interest.[9]

The "All of the Above" option simultaneously calculates the NPV related criteria (NPV, EAI, and B/C) and IRR. These calculations will be illustrated with an example of a typical forestry rotation.[10] The problem is to determine the NPV of regenerating 40 acres of land using a 4 percent discount rate (net of inflation, as are all costs and revenues in the example). The investment is outlined in Table 1 and the investor desires to know what one 27-year rotation will pay. Note that the establishment costs (site preparation and planting) occur in Year 0 or today and that annual costs are included. Forestry usually has the annual cost of property taxes and an annual management fee is not unusual. Figure 2 illustrates the steps necessary to solve this problem.

Figure 3 illustrates the interactive Web page used for the calculation and the FORVAL-online output of the solution. NPV is calculated in Table 2 and FORVAL confirms NPV is 363.41. If NPV is multiplied by the direct reduction annual factor for 27 years and 4 percent (0.0612385), we obtain an EAI of $22.25. If discounted total revenues are divided by discounted total costs ($564.23 / $200.82), we obtain a B/C ratio of 2.8. IRR is given as 8.7 percent.

FORVAL is an appropriate valuation tool for much more than forestry applications. It can easily solve general appraisal valuation problems. Consider a small farm with a Conservation Reserve Program (CRP) contract expiring in eight years and paying $20,000 per year. At the end of eight years the timber and land are expected to be worth $600,000. At four percent interest, what are the cash flows worth today? What if the purchaser offered to pay with annual payments over eight years at four percent interest, what would the payment be? FORVAL can easily solve a problem like this with just two sets of entries: first, a terminating annual series of $20,000 for years 1 to 8, and, second, a single sum of $600,000 in year 8. The net present value is $573,069 and the equal annual equivalent is $85,117. Of course, an easier method would be to enter the $600,000 single sum and ask FORVAL for equivalent annual income. That is calculated as $65,117 and added to the $20,000 annual series is $85,117 per year.

Land Expectation Value

Land expectation value (LEV) is the value of bare land if put into perpetual forest production.[11] It is also often called soil expectation value. The user inputs all costs and revenues associated with a single rotation of the forest, including establishment costs. LEV is a fundamental calculation used in forest valuation, but it is actually a standard NPV calculation with several critical assumptions:

(1) The values of all costs and revenues are identical for all rotations. All costs and revenues are compounded to the end of the rotation to get the future value of one rotation. This will be the amount received every n years, where n is the rotation length.

(2) The land will be forested in perpetuity.

(3) The land requires regeneration costs at the beginning of the rotation.

(4) Land value does not enter into the calculation. Land value is what you are calculating.

The LEV calculation involves compounding all costs and revenues to the end of a single rotation. This net future value is assumed to occur at the end of every rotation length to form a perpetual periodic series. The value of the bare land in perpetual forest production calculation can be illustrated using the data in Table 2 because land cost was not included in the problem and the four percent discount rate is a real interest rate (net of inflation). Table 3 shows the LEV calculation.

LEV is $556.37 per acre. This represents the maximum amount that could be paid for the land for forestry uses-if the required interest rate of four percent must be earned and if the timber values assumed are those actually expected for the property.

Precommercial Timber Stands

This option calculates the value of a stand of immature timber at the stand's current age. Immature timber is all timber that is less than the age of financial maturity; it tends to be undervalued because it often contains lower-valued timber products that will grow into higher-valued products over time (e.g., a pulpwood stand that will be a sawtimber stand in a few years). Immature timber includes precommercial or premerchantable timber stands that are too young to contain any timber products of commercial value. The calculation discounts the future stand value using the internal rate of return earned by the timber rotation as the discount rate. Land opportunity cost is included in the calculation (annual land rent).[12] Inputs are costs and revenues for one rotation, beginning and ending land values, and the stand's current age.[13]

Consider a simple example. You need to calculate the value of a 10-year-old pine plantation. Originally the land was worth $400 per acre. To keep the calculation simple we will assume no land appreciation and that annual management costs equal annual hunting lease revenues. Therefore, at the end of the 25-year rotation land will still be worth $400 per acre and net annual costs/revenues equal zero. FORVAL will handle any combination of cash flows; the assumptions are necessary only to make the example easier to understand. Regeneration at Year O costs $100 per acre and timber revenue at Year 25 will be $2,500 per acre.

The program calculates a 7.28 percent internal rate of return and an estimated value of timber of $610.04. Figure 4 illustrates the calculation. Costs and revenues can be combined in our simple example as they occur at the same point in time. This equates to a single cost of $500 per acre at Year 0 and a single revenue at Year 25 of $2,900. With only one cost and one revenue, the internal rate of return can be calculated directly as 7.285 percent. That is, a single rotation using these costs and revenues earns a 7.285% internal rate of return. Since $400 of capital is tied up in growing the trees (the land), an annual opportunity cost must be calculated. Figure 4 shows it to be $29.14 per acre per year.[14]

In Figure 4 the two costs are then compounded to Year 10 to obtain the value of the precommercial timber. The $100 regeneration cost and the $29.14 terminating series are compounded for ten years at 7.285 percent. The future value of a terminating 10-year annual series of $29.14 payments is $408.07.[15] Adding the two compounded costs yields $610.09. The small difference is due to rounding. The value of compounded costs, $610.09, is the value of the precommercial timber.

Using the 7.285 percent interest rate, all future costs and revenues could be discounted to Year 10. This would again produce a value of $610.09. Thus, the model produces a consistent value using standard appraisal formulas. Figure 5 shows the web page for this FORVAL calculation. We are not saying this is the proper technique for valuing precommercial timber stands. It is one model. It does have the advantage of explicitly acknowledging land opportunity cost and providing an interest rate which will provide a consistent value to both the seller and buyer.

Other Options

FORVAL is capable of calculating the amount of a monthly or annual payment necessary to repay an installment loan (capital recovery) or to accumulate a future sum of money (sinking fund). On the upper right of the screen, choose “Monthly or Annual Payments.” Installment loan or mortgage payments are calculated using the direct reduction loan factor, or monthly constant, for monthly payment loans and the direct reduction annual factor, or annual constant, for annual payment loans.[16] Sinking fund payments necessary to accumulate a future sum of money are calculated using the annual and monthly sinking fund factors.[17]

Two simple examples will illustrate these options. First, assume you need to accumulate $250,000 of capital in 10 years. How much must you deposit into an account annually that pays 10 percent interest? The answer from FORVAL is $15,686.34 per year. Or, if the type of payment is changed to monthly, the payment becomes $1,220.43 per month. Second, the opposite problem is to borrow $250,000 at 10 percent for 10 years. What is the annual loan payment? The answer from FORVAL is $40,686.34 per year. Or, 120 months payments of $3,303.76 would repay the same loan. The standard Compound Interest Table for 10 percent contains the factors to duplicate these results.[18]

A second option on the upper right of the screen is “Projected Stumpage Price.” It calculates the future value of a specific stumpage price. Stumpage is standing timber and, obviously, this option simply calculates a future value in the standard manner.[19] The option requires only three inputs: current stumpage price, annual rate of increase, and number of years. For example, a $1,000 current price projected to increase annually at 10% for 10 years is projected to be $2,593.74.

Conclusion

FORVAL performs all the basic valuation calculations used in forestry. It was originally designed for instructional purposes and intentionally stressed ease-of-use. The current version is for general forestry valuation use, but its popularity is still centered on ease-of-use. It is not limited to forestry uses and appraisers may find it to be a useful tool.

Endnotes

1 Steven H. Bullard, Thomas J. Straka, and James L. Carpenter, FORVAL for Windows: A Computer Program for Forest Valuation and Investment Analysis, FWRC Research Bulletin FO 115 (Mississippi State, MS: Mississippi State University Forest and Wildlife Research Center, 1999).

2 Appraisal Institute, The Appraisal of Real Estate, 12th ed. (Chicago: Appraisal Institute, 2001), 550-54.

3 Appraisal Institute, 689-690 and 720-722.

4 Appraisal Institute, 561-562.

5 Appraisal Institute, 719.

6 Steven H. Bullard, Thomas J. Straka, and Thomas G. Matney, FORVAL: A Computer Program for Forest Valuation, Research Report Vol.12, No.23 (Mississippi State, MS: Mississippi Agricultural & Forestry Experiment Station, 1987).

7 Appraisal Institute, 375-380.

8 Appraisal Institute, 725-727.

9 Appraisal Institute, 718-720.

10 Steven H. Bullard and Thomas J. Straka, Basic Concepts in Forest Valuation and Investment Analysis, (Auburn, AL: Preceda, L.C.C., 1998).

11 Thomas J. Straka and Steven H. Bullard, "Land Expectation Value Calculation in Timberland Valuation, The Appraisal Journal (October 1996): 399-405.

12 Appraisal Institute, 282.

13 Thomas J. Straka, "Valuing Stands of Precommercial Timber," Real Estate Review (Summer 1991): 92-96.

14 Appraisal Institute, 561-562.

15 Appraisal Institute, 724-725.

16 Appraisal Institute, 693-698 and 725-726.

17 Appraisal Institute, 689 and 724-725.

18 Appraisal Institute, 719.

19 Appraisal Institute, 717-719.

Table 1. Cash flow from a typical forestry investment (per acre)

Item	Year Incurred	Type of Cost or Revenue	Amount (Dollars)
Establishment cost	0	Single sum	-160.00
Annual management & tax costs	1-27	Terminating annual	-2.50
Thinning revenue	16	Single sum	97.50
Thinning revenue	22	Single sum	156.00
Harvest Revenue	27	Single sum	1,287.00

Table 2. Calculation of net present value for forestry investment (interest rate = 4%)

Item	Year Incurred	Dollar Amount	Type	DCF ($)
Establishment cost	0	-160.00	Single sum	-160.00
Annual mgmt.& tax cost	1-27	2.50	Terminating annual	-40.82
Total Costs				**-$200.82**
Thinning revenue	16	97.50	Single sum	52.05
Thinning revenue	22	156.00	Single sum	65.83
Harvest revenue	27	1,287.00	Single sum	446.35
Total revenues				**564.23**

NPV = $564.23 - $200.82 = $363.41

Table 3. Calculation of land expectation value per acre (interest rate = 4%)

Item	Year Incurred	Dollar Amount	Future Value ($)
Established Cost	0	-160.00	-461.34
Annual Management & Taxes	1-27	-2.50	-117.71
Thinning Revenue	16	97.50	150.10
Thinning Revenue	22	156.00	189.80
Harvest Revenue	27	1,287.00	1,287.00
			Net Future Value = 1,047.85

$$LEV = \frac{\$1{,}047.85}{(1.04)^{27} - 1} = \$556.37$$

Figure 1. Financial Criteria - Net Present Value and Future Value can be used to solve basic discounting cash flow problems. In each case click on "Add Revenue" or "Add Cost", then enter the discount rate when prompted and then click on "Calculate".

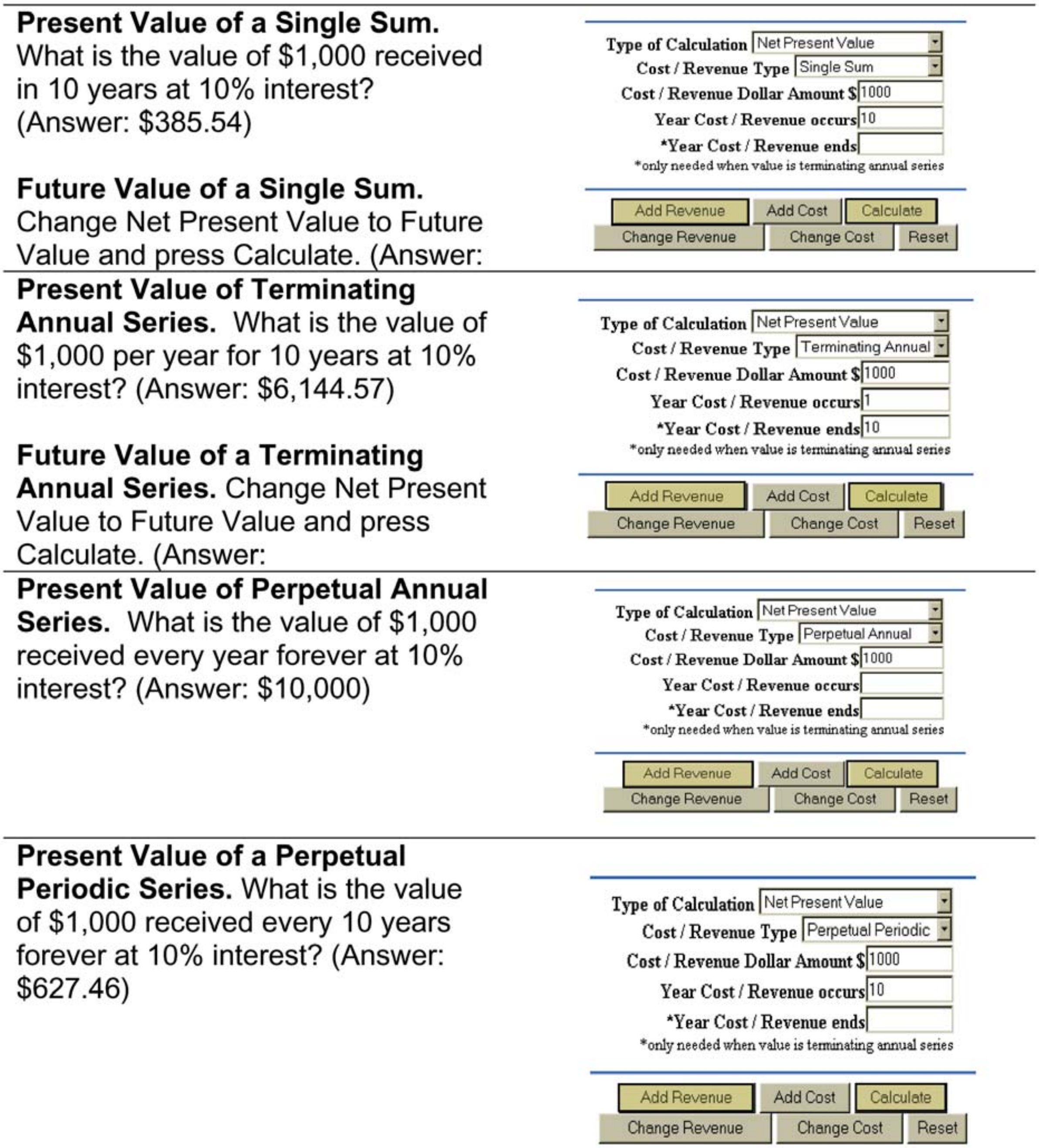


Figure 2. FORVAL procedure for 40-acre regeneration problem. For thinning and final harvest revenues click on "Add Revenue" at end of each entry. For establishment and annual cost click on "Add Cost" at end of each entry. At end click on "Calculate" and you will be prompted for an interest rate (enter "4").

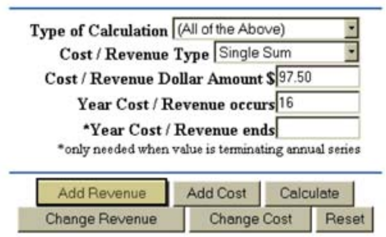
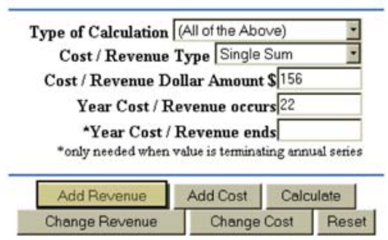
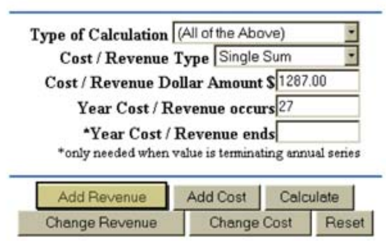
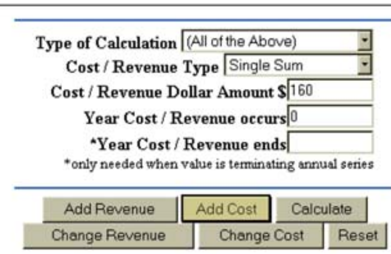
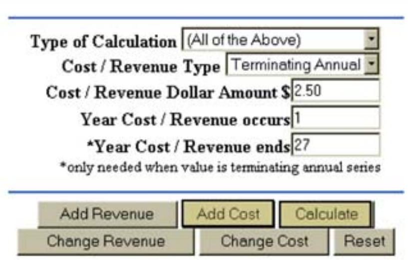
Enter first thinning of $9,750 at year 16	
Enter second thinning at $156.00 at year 22.	
Enter final harvest of $1,287.00 at year 27	
Enter establishment costs of $160.00 at year 0	
Enter annual costs of $2.50 for years 1 to 27.	

Figure 3. FORVAL Web page of calculation results from timber rotation example.

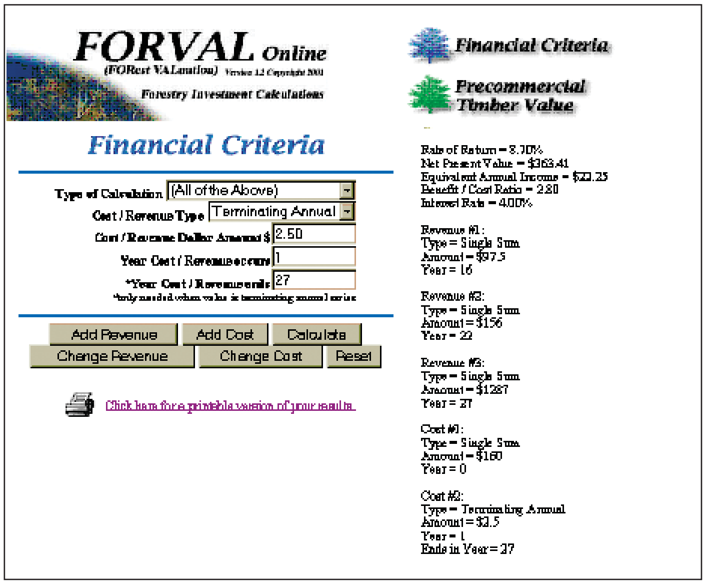


Figure 4. Calculation of precommercial timber value at age 10 for example.

Year Zero Cost		**Year 25 Revenue**	
Land Cost =	$400	Land Sale =	$400
Regeneration Cost =	$100	Timber Revenue =	$2,500
Total Cost =	$500	Total Revenue =	$2,900

1. $$Rate\ of\ Return = \sqrt[25]{\frac{\$2{,}900}{\$500}} - 1 = 7.285\%$$

2. Annual Land Opportunity Cost = $400 x 0.07285 = $29.14/year

3. Regeneration Cost at year 10 = $100 (1.07285) ^{10} = $202.02

4. Future Value of Ten Annual Payments of $29.14 = $408.07

5. Precommercial Timber Value at age 10 = $202.02 + $408.07 = $610.09

Figure 5. FORVAL web page of calculation results from precommercial timber value example.