1994

FORVAL A software package for forestry and natural resources project valuation

Thomas J. Straka

Steven H. Bullard
Stephen F. Austin State University, Arthur Temple College of Forestry and Agriculture,
bullardsh@sfasu.edu

FORVAL—A Computer Software Package for Forestry and Natural Resources Project Valuation

Thomas J. Straka* and Steven H. Bullard

ABSTRACT

FORVAL (FORest VALuation) is an interactive, user-friendly computer program for discounted cash flow analysis of forestry and natural resource investments. Many forest economics applications are included and emphasis is on the nonindustrial private forest sector; however, industry and public sector applications are easily performed with the program. Calculations include net present value, equivalent annual income, benefit/cost ratio, internal rate of return, future value, sinking funds, installment payments, and land expectation value. The program also allows the user to account for amortization of reforestation costs and depletion allowances. It includes self-contained instructions and will generate the details of key calculations. FORVAL should prove useful in any natural resource economics course that deals with valuation issues.

THE VALUATION of natural resources projects presents challenging investment analysis problems. Calculations range from specialized problems like bare land value, depletion allowance, or reforestation cost to standard criteria such as net present value or rate of return. Students are faced with complex calculations and a myriad of possible decision criteria. Financial calculators are fine for simple analyses, but natural resource investments tend to be complex and often require the use of a computer investment analysis package. Most of these packages are not particularly user-friendly, and few are free.

Described below is a user-friendly, menu-driven forestry and natural resources investment analysis computer package. It can be integrated into any university-level financial/economics course that requires analysis of complex investments or projects (including after-tax analysis). It has been used in such courses and allows the instructor to assign many types of problems that otherwise would be computationally too difficult for normal exercises. FORVAL is equally applicable to industrial private forestry (NIPF) investments, forest industry situations, or public agency analyses. Some sections, such as reforestation costs, apply primarily to NIPF owners; others, such as depletion allowance, apply primarily to forest industry.

FOREST DESCRIPTION[1]

FORVAL (FORest VALuation) is a computer program for cash-flow analysis of forestry and natural resources investments. FORVAL is designed for use without a manual. Users simply answer questions displayed on the screen. The options are summarized in Fig. 1. The following question is one of the first ones in the program.

What Would You Like to calculate?

Enter: **PV** for the following present value criteria—present net value, equivalent annual income, benefit/cost ratio, and internal rate of return,
FV for future values of costs and revenues,
LE for land expectation value.
SF for sinking fund amounts,
IP for installment payments,
RC for after-tax present value of reforestation costs, or
DA for depletion allowances and after-tax sale income.

After the user selects an option, the program leads him or her through a set of questions and supplies the requested values. If the user does not ask for abbreviated instructions, a series of questions is automatically provided by the program. Also, if detailed instructions are requested, additional detail is provided by the program. The options are described below.

Present Value (PV)

The present value option is used for standard financial calculations. Any cash flow or forestry investment can be analyzed. The results include net present value of the cash flow at a specified interest rate, the equivalent annual income, the benefit/cost ratio, and the investment's internal rate of return.

FORVAL uses the standard assumption that all cash flows occur at the end of the year. A 30-yr rotation of pine (*Pinus* sp.) trees then means the trees will be harvested at the end of 30 yr. One exception is Year 0, which represents now or today. Sometimes site preparation and tree planting occur immediately. Immediately equates to Year 0.

Besides basic single sum payments or revenues (a single cost or revenue that occurs just once; e.g., the costs of preparing a site for tree planting), four types of payment series or annuities may be specified by the user: (i) terminating annual series (an example is a payment of $3.00 per acre annual property tax for 30 yr); (ii) terminating periodic series (an example is a payment for prescribed burning on a tract to reduce catastrophic wildfires planned for every 5 yr for 30 yr); (iii) perpetual annual series (an example is a payment of $3.00 per acre annual

T.J. Straka, Dep. of Forest Resources, Clemson Univ., Clemson, SC 29634-1003; S.H. Bullard, Dep. of Forestry, Mississippi State Univ., P.O. Drawer FR, Mississippi State, MS 39762. Received 20 May 1993. *Corresponding author.

Published in J. Nat. Resour. Life Sci. Educ. 23:51-55 (1994).

[1] Due to the nature of the program FORVAL, this computer software article uses the unit *acres* instead of *hectares* (1 acre = 0.4 ha). Other contributions to the journal should use SI units.

Abbreviations: NIPF, nonindustrial private forestry.

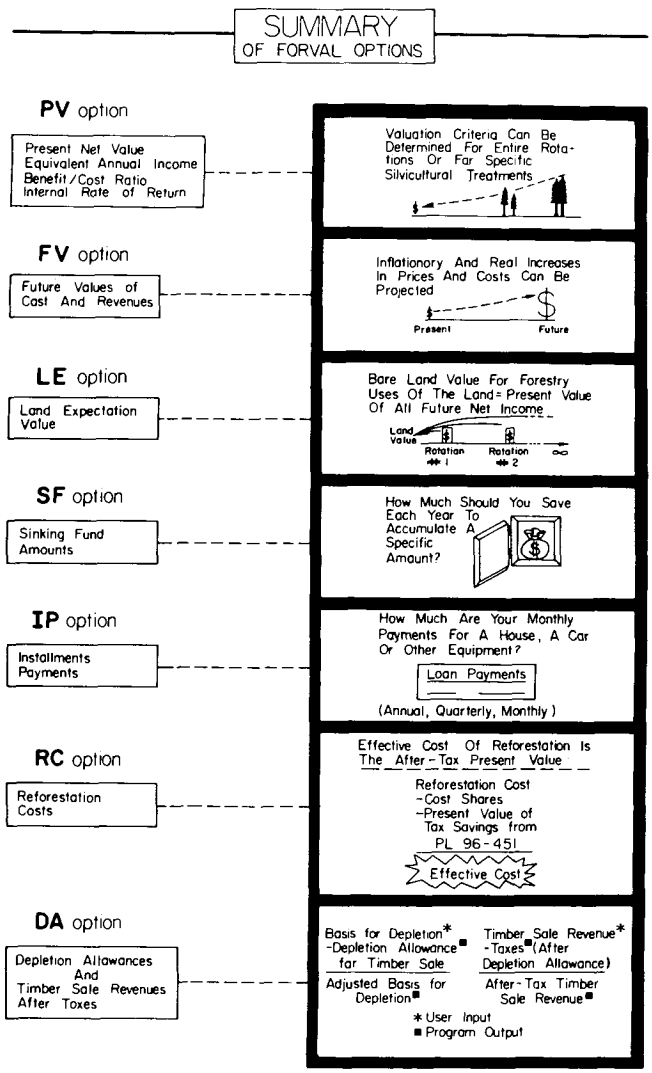

Fig. 1. Summary of FORVAL options.

property tax forever); and (iv) perpetual periodic series (an example is timber harvest revenue every 30 yr forever). Bullard et al. (1987) outline the use of these options in more detail.

The present value option will be illustrated with examples from Bullard et al. (1986). A landowner asks you to determine the net present value of regenerating 40 acres. His alternative rate of return is 4% (net of inflation, as are costs and revenues in the examples). The landowner desires to know how much the investment in one 27-yr rotation will pay. The investment is outlined in Table 1.

The user inputs a 4% interest rate and specifies the PV option. The program asks the number of costs and revenues (five in this case) and then prompts the user to input each cost or revenue. The first item is for establishment cost. The user inputs Year 0, single sum, and −$160.00. Year 0 implies we replant today. if we planned to take a year for site preparation and planting, for example, we would allocate this cost to Year 1. The second item is for annual management and taxes. The user inputs terminating annual series that ends in Year 27 for

Table 1. Cash flow from a typical forestry investment.

Item	Year	Type of cost/revenue	Amount (per acre)
			$
Establishment cost	0	Single sum	−160.00
Annual management and tax cost	1-27	Annual	−2.50
Thinning revenue	16	Single sum	97.50
Thinning revenue	22	Single sum	156.00
Final harvest revenue (clearcut)	27	Single sum	1287.00

an amount of −$2.50. Many costs and revenues in forestry are *annual* or occur every year. Property taxes are due each year. An annual management fee is common. Hunting lease revenue often accrues on an annual basis. The next three items are revenues in Years 16, 22, and 27 for $97.50, $156.00, and $1287.00, respectively. The first two revenues are for thinnings. A portion of the forest is removed to provide some early revenue and to "open the forest up" for more and faster growth of the remaining trees. The last revenue, at Year 27, is the final harvest where all the trees are removed. Each item is entered via a series of prompts, ranging from three prompts for a single sum to five prompts for a terminating periodic series.

The present value option will provide the following numerical values. The net present value of this investment is $363.41 per acre. This means the investment would earn a 4% rate of return, plus $363.41. The equivalent annual income is $22.25. The investment yields a net income equivalent to an annual income of $22.25 per acre per year over the 27-yr rotation. The benefit/cost ratio is 2.81 to 1. At 4% interest, benefits exceed costs by a factor of 2.81 to 1.00. The investment has an internal rate of return of 8.7%. The calculations are outlined in Table 2.

Future Value (FV)

The future value option allows the user to compute the value of a single cash flow at a future date, considering the real rate of increase (net of inflation) and the expected inflation rate separately. For example, a pine plantation is established at a cost of $120 per acre. Timber prices and related costs increased 3.5% annually in real terms (net of inflation). Inflation averaged 6% over the same period. What will be the future value (the real 3.5% increase and the 6% inflation) for his investment? The future value option shows this cost compounds to $1464.97 in 27 yr.

Land Expectation Value (LE)

Land expectation value is the value of bare land if put into perpetual forest production. It is often also called bare land value or soil expectation value. The user inputs all costs and revenues associated with a rotation of the forest, including establishment costs. This option performs a fundamental calculation used in forest valuation: the value of bare land in permanent forest production. This is actually a standard NPV calculation, but with several critical assumptions:

Table 2. Calculation of net present value, internal rate of return, equivalent annual income, and benefit/cost ratio for typical forestry investment outlined in Table 1.

Year	Item	Amount	Discounting formula	Present value
		$		$
The net present value (NPV) is calculated as follows:				
		Present value of revenues		
16	Thinning	97.50	$\frac{1}{(1.04)^{16}}$	52.06
22	Thinning	156.00	$\frac{1}{(1.04)^{22}}$	65.82
27	Clearcut	1287.00	$\frac{1}{(1.04)^{27}}$	446.35
	Present value of revenues			564.23
		Present value of revenues		
0	Establishment	−160.00	--	−160.00
1-27	Annual cost	−2.50	$\frac{(1.04)^{27} - 1}{0.04(1.04)^{27}}$	−40.82
	Present value of costs			−200.82
	Net present value = $564.23 − $200.82 =			363.41
The internal rate of return (IRR) defined is the interest rate that makes the net present value equal zero. FORVAL gives an IRR of 8.70%. Recalculating NPV as above, but with an interest rate of 8.70%, gives a value of:				
0	Establishment	−160.00	--	−160.00
16	Thinning	97.50	$\frac{1}{(1.087)^{16}}$	25.66
22	Thinning	156.00	$\frac{1}{(1.087)^{22}}$	24.89
27	Clearcut	1287.00	$\frac{1}{(1.087)^{27}}$	135.33
0-27	Annual cost	−2.50	$\frac{(1.087^{27} - 1}{0.087(1.087)^{27}}$	−25.71
	Net present value			−0.17

The −$0.17 is very close to a zero NPV. We would have to take the IRR to several more places to get exactly zero.

The net present value is converted to an equivalent annual income via:

$$\text{Equivalent annual income} = \$363.41 \left[\frac{0.04(1.04)^{27}}{(1.04)^{27} - 1}\right] = \$22.25$$

The discounted benefit/cost ratio is calculated as

$$\text{B/C ratio} = \frac{\$564.23}{\$200.82} = 2.81$$

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 value will be the amount received every *n* years.
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.

Consider a forest tract that is presently bare of any timber. Following reforestation, the tract will be managed as in Table 1. If you intend to follow the above management sequence in perpetuity and you want to earn at least 4% in real terms on your investment, how much can you afford to pay for the bare land? The LE option gives a bare land value of $556.37 per acre. This represents the maximum amount that could be paid for the land for forestry uses—if the required interest must be earned and if all costs and timber revenues are as given.

Sinking Fund (SF)

The sinking fund option assumes you will put money into an account at the end of each year, beginning 1 yr from the present, and that interest is compounded annually. This option answers the question: "How much money must be placed into an interest-bearing account annually to have a specified sum in a certain number of years?"

Sinking funds often relate to equipment replacement decisions. Suppose a $220 000 tractor must be replaced in 4 yr. If a 12% sinking fund is established to pay for this tractor in 4 yr, how much is the annual payment into the fund? The SF option gives a value of $46 031.70.

Installment Payment (IP)

The installment payment option calculates the payment that will pay off a loan in a specified period of time. This option can be used to determine mortgage payments, or automobile and other equipment payments.

Suppose you borrow $9000 for a pickup truck and the dealer quotes you an annual percentage rate of 8.8%. What would your monthly payment be for 48 m? The IP option calculates a payment of $223.11.

Effective Reforestation Costs (RC)

The reforestation cost subroutine calculates the after-tax cost of reforestation, reduced by state or federal cost-sharing programs (e.g., the federal forestry incentive program), the 10% investment tax credit, and accelerated amortization of net cost (Internal Revenue Code Sec. 194). The benefits are subject to an annual limit of $10 000 of reforestation costs. Effective regeneration costs depend on the landowner's interest rate, marginal tax rate, and whether or not the landowner receives cost-sharing. These tax advantages are available to NIPF landowners on an annual basis and FORVAL performs an annual calculation. That is, a landowner could equally allocate $20 000 of forest regeneration across 2 yr. This would entitle him or her to two tax credits of $1000 each year (assuming no cost share) and amortization of half the amount in each year. FORVAL does its reforestation cost calculation only on an annual basis, but this is a very realistic approach.

Cost-sharing can represent up to a 75% federal subsidy of private reforestation efforts. Some states have complementary programs that can add to federal cost-sharing dollars. Landowners generally have an option on whether or not to treat cost-share payments as income; FORVAL assumes that cost-share payments are not included in taxable income.

FORVAL allows the user to consider investments made at the beginning or end of the year. The timing of the investment in relation to the tax year is important because tax savings from the law are delayed for a year if the ex-

Table 3. Calculation of effective reforestation costs for a $10 000 investment at the end of the tax year by an NIPF landowner receiving 50% cost-sbaring, with a 10% discount rate and a 28% martinal tax rate.

Year	Item	Savings	Present value
0	Cost-share	$5 000.00	$5 000.00
0	10% credit	500.00	500.00
0	(1/14) (0.95) (5 000) (0.28)	95.00	95.00
1	(1/7) (0.95) (5 000) (0.28)	190.00	172.73
2	(1/7) (0.95) (5 000) (0.28)	190.00	157.02
3	(1/7) (0.95) (5 000) (0.28)	190.00	142.75
4	(1/7) (0.95) (5 000) (0.28)	190.00	129.77
5	(1/7) (0.95) (5 000) (0.28)	190.00	117.98
6	(1/7) (0.95) (5 000) (0.28)	190.00	107.25
7	(1/14) (0.95) (5 000) (0.28)	95.00	48.75
Total present value of savings =			$6 471.25
Effective costs = $10 000 − 6 471.25 =			$3 528.75

pense is incurred toward the beginning of the tax year. For example, if a landowner incurs regeneration costs in January 1993, he/she will not be allowed to claim the tax savings until early 1994. Savings are assumed to be immediate if the investment is made toward the end of the tax year. if he/she incurred the regeneration costs in December 1992, he/she could claim the tax savings in early 1993.

The user can determine effective reforestation cost using only three factors: (i) the interest rate, commonly called *discount rate*, or the rate that could be earned in alternative investments; (ii) the marginal tax rate, or the percentage tax rate charged on any additional income; and (iii) the percentage of costs reimbursed through cost-shares. The method is simple and accurate, and can be applied to any NIPF landowner investing in reforestation, regardless of whether of not a calendar tax year is used.

The method requires four assumptions that should apply to most nonindustrial private landowner reforestation investments:

1. Total reforestation expenses, after cost-sharing, are less than or equal to $10 000 in a single year,
2. The landowner claims a 10% initial tax credit and amortizes 95% of the expense,
3. Initial tax savings are immediate for expenses toward the end of a landowner's tax year, and
4. Any cost-shares received are not included as taxable income.

For example, consider a landowner with a discount rate of 10%, a 28% marginal income tax rate, and an opportunity to receive 50% costs-sharing. If he/she invests $10 000 in reforestation, what is the effective reforestation cost? We'll assume the investment takes place at the end of the tax year, so that the tax savings are immediately available. Table 3 illustrates the calculation of effective reforestation cost. Year 0 refers to the present. From Table 3, we see that the landowner immediately receives $5000 in cost-sharing, a $500 tax credit, and an additional reduction in taxes of $95.00. The landowner also receives tax savings in each of the next 7 yr.

Where did the $95.00 come from? The investment after cost-sharing was $5000. Since the landowner took a 10% tax credit, he/she has to reduce the amortizable basis by 50% of the tax credit. This can be accomplished by multiplying the basis by 0.95. He/she is allowed 1/14 of the deduction immediately because he/she incurred the expense at the end of the tax year. The landowner's marginal income tax rate is 28%; therefore, when his/her income is reduced by $339.29 (since 1/14 × 0.95 × $5000 = $339.29), his/her income tax is reduced by 28% of that amount (or $95.00).

The present value column of Table 3 discounts cost sharing and tax savings at the 10% interest rate. The total of the present value column gives the present value of the cost-sharing and tax savings, $6471.25 in our example. This means the effective reforestation cost was $3528.75.

FORVAL does this entire calculation, for beginning or end of year. It is a realistic introduction to the tax implications of a complex natural resource investment problem. Problems of this type are discussed in more detail in Bullard and Straka (1985).

Depletion Allowance (DA)

For federal income tax purposes, expenditures of a forest owner are classified as capital expenditures or ordinary expenditures. That is, all expenditures are either capitalized or expensed.

Expenditures that are expensed are deducted in full in the year incurred. Generally, if the benefits resulting from an expenditure occur in the current tax year, the expenditure is expensed. Examples of expensed costs are tools of a short life (usually 1 yr or less), salaries, travel, and property taxes.

Expenditures that are capitalized are deducted in three ways: (i) for *non-wasting* assets like land, costs are deducted when the asset is sold; (ii) for *wasting* assets like equipment and structures, costs are deducted over the useful life of the asset through depreciation; (iii) and for certain resource-based assets like timber and oil, costs are deducted as the asset is sold or used (depleted). FORVAL performs the calculations to establish the depletion allowance for timber investments.

Capitalization is the process of recording an expenditure in a capital account, instead of deducting the expenditure from ordinary income in the year incurred. The dollar value in any capital account represents the total investment for that capital asset. The purchase price of a capital asset (including related acquisition costs) is called the *original cost basis* of the asset. The original basis may increase as capital improvements are made, or decrease as allowances for depletion or depreciation are claimed. Once adjustments are made to the original basis, the basis is referred to as the *adjusted basis*.

Depletion is the recovery of the basis in timber that is cut and sold. That is, depletion is the amount of the original timber investment that the landowner is allowed to expense against timber sale revenue. Volume and value are added to the merchantable timber subaccount when young growth and plantations become merchantable; volume and value are subtracted from the merchantable timber account by cutting (also, growth and mortality are taken into account). Depletion occurs when an owner cuts timber and recovers part of the capitalized book value (basis) of the timber.

Table 4. The depletion allowance subroutine.

Part I. The request for data (with user responses entered):
For clearcuts, enter 1.0 for 100%.
for 33%, enter 0.33, etc.
_____0.50
How much money is generated by the timber sale?
$_____250 000.00
What is the landowners approximate marginal tax rate?
Enter 0.25 for 25%, etc. _____0.33
What is the current basis for depletion?
$_____100 000.00

Part II. The output (automatic after last response):
The landowner has a basis for depletion of $100 000.00
50% of the timber is cut and a total income of $250 000.00 is generated.
The after-tax value of timber sale income is $184 000.00
The new or adjusted basis for depletion is $50 000.00

Part III. Detailed computations are available on request:
Would you like to see how the above calculations were made?
Enter Y or N. _____ Y
The amount to deduct form timber sale income (in determining taxes) is the depletion allowance: the depletion allowance is the depletion rate multiplied by the volume cut, or the percentage of timber cut multiplied by the basis for depletion.
Depletion allowance = (Percentage cut) × (Basis)
(0.500) × (100 000.00) = $50 000.00
The amount of tax = (Tax rate) × (Income − Depletion allowance)
In the present case, the amount of tax is:
(0.330) × (250 000.00 − 50 000.00) = $66 000.00,
and the after-tax value of timber sale income is:
Income × Tax = 250 000.00 − 66 000.00 = $184 000.00
The new or adjusted basis for depletion is:
(Former basis for depletion) − (Depletion allowance)
100 000.00 − 50 000.00 = $50 000.00

The balance of the merchantable timber subaccount (the original basis of the timber minus the value of timber cut in the past) is the *adjusted basis*. The *depletion rate* is the dollar amount the owner is allowed to deduct *per unit* of timber cut. It is defined as:

$$\text{Depletion rate} = \frac{\text{Adjusted basis}}{\text{Total timber volume (before harvest)}}$$

The *depletion allowance* is the *total* capitalized value the owner is allowed to recover for a particular timber sale. It is based on the proportion of timber actually cut. It is defined as:

$$\text{Depletion allowance} = \text{Depletion rate} \times \text{Total volume cut}$$

This option reports the depletion allowance, the adjusted basis for depletion, and the after-tax value of the revenue from a timber sale. The user inputs the percentage of standing timber removed, the timber revenue generated, the landowner's marginal tax rate, and the current basis for depletion. Upon request, the program will output the detailed calculations used to derive the depletion allowance.

Consider a timber sale that produces $250 000 of revenue. The timber owner has a marginal tax rate of 33%. The basis of the timber is $100 000. Half of the timber is removed from the tract. The DA option shows that the after-tax value of the timber sale revenue is $184 000 and the adjusted basis for depletion is now $50 000. Table 4 illustrates the information requested by FORVAL and the detailed computations provided by the program.

SOFTWARE SPECIFICATIONS

FORVAL is available for Data General Computers using the Advanced Operating System with Virtual Storage and for IBM PC-compatible computers. It is a compiled FORTRAN 77 program consisting of eight files requiring 210 Kbytes of disk space. It requires MS-DOS version 2.x or later and a minimum of 64 K RAM. The program does not require a math coprocessor, but can utilize one if present to speed calculations. Output is to the monitor only, which can be either monochrome or color CGA or higher resolution. Printer output is possible through the Print Screen key. A user's manual is self-contained and available by requesting detailed instructions at the program's beginning. A 4-page summary of program procedures and sample calculations is also available (Bullard et al., 1987). FORVAL is public domain software and will be supplied free upon receipt of a formatted diskette. Users are encouraged to make this software available to interested persons and may alter the source code as desired. Send requests to the junior author at the address on the first page of this article.

SUMMARY

FORVAL is an interactive computer software package that evaluates the economic efficiency of typical forestry investments. It includes all standard decision criteria and allows for income tax treatments of timber income. Other programs exist to perform these standard calculations. The advantage of FORVAL is that it is set up specifically for forestry investments and performs after-tax calculations. An instructional advantage is that additional detail supports most calculations and is available if the user requests. FORVAL is a convenient teaching tool that students will find very user-friendly.

REFERENCES

Bullard, S.H., T.A. Monaghan, and T.J. Straka. 1986. Introduction to forest valuation and investment analysis. Mississippi Coop. Ext. Serv. Publ. 1546.

Bullard, S.H., and T.J. Straka. 1985. What is your "effective" rate of reforestation cost? Forest Farmer 45(1):16–17.

Bullard, S.H., T.J. Straka, and T.G. Matney. 1987. FORVAL: A computer program for forest valuation. Mississippi Agric. and For. Exp. Stn. Res. Rep. 12(3).■