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Rates of return on silvicultural practices

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RATES OF RETURN ON SILVICULTURAL PRACTICES. Steven H. Bullard and Bob L. Karr, Department of Forestry, Mississippi Agricultural and Forestry Experiment Station, P. O. Drawer FR, Mississippi State, MS 39762.

ABSTRACT

Anticipated rates of return can help landowners and forest managers evaluate hardwood control and many other stand treatments. A simple microcomputer model is discussed which displays rates of return for specific stand treatment conditions. The program can be used before or after taxes and with or without inflation. The model displays rates of return for ranges of silvicultural treatment costs and expected harvest value increases, thus providing information for evaluating treatments where growth responses or future prices are difficult to estimate.

INTRODUCTION

Forest managers consider many factors when selecting silvicultural treatments for individual stands. Decisions are influenced by the needs of each stand, the knowledge and experience of the decision-maker, available funds, environmental factors and, in many cases, by the expected rate of return for treatment alternatives.

Many biological and economic factors influence expected rates of return from stand treatments. Biological factors include the species grown, site quality, and expected growth responses from treatment alternatives. Economic factors include the discount rate, and current and anticipated costs and prices. Expected rates of return are therefore most accurate when estimated for specific stands and specific landowners. We discuss an approach for estimating economic rates of return for silvicultural treatments. We use chemical vegetation control as an example, but the methods and computer model can be applied to other silvicultural practices.

RATE OF RETURN

The rate of return (ROR) on an investment is often referred to as the internal rate of return or simply as the return on investment. It is the average rate of invested capital growth, or the interest rate which equates the discounted value of all revenues and benefits with the discounted value of all costs. Other popular economic criteria also compare discounted values: present net value (PNV) is the present value of revenues minus the present value of costs and the benefit/cost ratio (B/C) of an investment is the present value of revenues divided by the present value of costs. Each criterion yields the same answer to: "Is this particular investment profitable?" (Canada and White 1980). That is, if the rate of return for a particular investment exceeds the cost of capital, then PNV is positive and B/C is greater than 1.

We discuss ROR for evaluating the profitability of silvicultural treatments since most forest managers and landowners are more familiar with this concept (Cubbage and Redmond 1985), and since descriptive results are equivalent to other criteria. We do not recommend ROR for ranking competing investments, however (see Bullard 1985).

For investments with a single cost and a single revenue, ROR is very easy to determine. The basic formula for compound interest applied to single sums of money is:

$$V_n = V_0(1 + i)^n \qquad (1)$$

where

V_n = a value in year n,

V_0 = a value in year 0,

i = the interest rate, and

n = the number of years.

Equation (1) can be written in terms of "i", or the ROR, and applied to silvicultural treatment costs that result in added revenue when a stand is harvested:

$$ROR = [\Delta FHV/C]^{1/(r - t)} - 1 \qquad (2)$$

where

ROR = rate of return on the silvicultural treatment,

ΔFHV = the change in final harvest value due to the treatment,

C = cost of the treatment,

r = rotation age or year of final harvest, and

t = year the treatment is applied.

Equation (2) can be solved for any silvicultural treatment where costs and anticipated changes in final harvest values are known. In many cases, however, these values are not known, and it may be more useful to observe the ROR for ranges of costs or final harvest effects. Computer program FAST (Financial Analysis of Silvicultural Treatments) presents such information. The BASIC program is a simple application of equation (2), and is available from the authors for IBM-PC compatible microcomputers.

The following example shows output from the model, and presents several ways of using the rate of return information.

RATE OF RETURN FOR HARDWOOD CONTROL

Computer program FAST requires three inputs:

1. the year of treatment,

2. the year of final harvest, and

3. an estimate of what the final harvest value would have been <u>without</u> treatment.

The program calculates rates of return for treatment costs of \$10, \$20, . . . , \$150, and for increases in final harvest value of 5, 10, . . . , 100 percent. Rates of return for each combination are presented in one of two tables; final harvest value increases from 5 to 50 percent, or from 55 to 100 percent.

To demonstrate the information provided by FAST, we assume a common silvicultural treatment for southern pine plantations: chemical spraying to control hardwood competition. We assume the stand is treated in year 1, and that final harvest will occur at age 25. Computer program HDWD (Burkhart and Sprinz 1984, Burkhart 1985) was used to estimate final harvest yields without treatment. HDWD predicts stand and stock tables for unthinned loblolly pine plantations, for different levels of hardwood competition. Without treatment, we assumed the stand would have 30 percent hardwood basal area.

With 680 trees planted per acre, HDWD predicts 2158.5 cubic feet as the total loblolly pine volume at age 25 (site index 60, base age 25, 30 percent hardwood basal area). We assumed a constant price of 15 cents per cubic foot, and final harvest value without treatment was \$323.78.

Output from FAST is presented in Table 1, for treatments in year 1, final harvest in year 25, and a final harvest value without treatment of \$323.78. The output can be used in three ways:

1. If you know the rate of return you would like to earn, and the probable increase in final harvest value due to a particular silvicultural treatment -- find the appropriate percentage value increase column and read the rates of return listed until you find a rate close to what you would like to earn. The associated cost (in the left-most column) is the maximum amount that could be spent on the silvicultural treatment (and expect to earn a favorable rate of return).

2. If you know the cost of a particular treatment and the rate of return you would like to earn -- read across the appropriate cost row until the minimum rate of return is reached. The final harvest value must increase by the percentage amount of the column heading if the investment is to earn the minimum ROR.

3. If you know the cost and the probable increase in final harvest value for a given treatment -- read the ROR from the appropriate column and row.

For the hardwood control example, we can estimate a realistic cost of application, and if we have a minimum acceptable ROR, we can use Table 1 to obtain the necessary percentage change in final harvest value (as in paragraph (2) above). If we're spending $70 per acre on pine release, for example, and want to earn at least 6 percent on our investments, final harvest values for our assumed stand will have to increase 85-90 percent as a result of hardwood control.

Program HDWD can also be used to estimate percentage increases in final harvest values. If we assume, for example, that with hardwood control only 5 percent of the stand's basal area at final harvest is hardwood, the projected yield results in a final harvest value of $589.53, an increase of 82 percent. The yield program can thus be used to estimate percentage increases in harvest value due to hardwood control measures early in the life of a stand, and rates of return or maximum acceptable costs can be estimated.

DISCUSSION

ROR information from FAST is intended to help forest managers or landowners evaluate silvicultural alternatives for existing stands of any age. With existing stands, costs incurred in prior years should be considered "sunk costs". Silvicultural treatments considered for such stands should therefore be evaluated with regard to their own costs and benefits. Prescribed burning, fertilization, timber stand improvement, or other silvicultural practices can be evaluated separately or in combination, but should not be influenced by costs in previous years.

On private lands, an aspect of silvicultural treatments that can be very important when considering their profitability is federal income taxes. For tax purposes, treatment costs are either expensed (deducted from income in the year they occur) or capitalized (deducted over a period of years or when timber is sold). Tax regulations vary according to the type of silvicultural treatment and the intended purpose. Siegel (1984) provides an excellent discussion of federal tax treatment of the costs of silvicultural practices in young pine stands. Computer program FAST displays after-tax rates of return, of course, if after-tax cost and final harvest values are used.

Inflation can also influence the estimated ROR for silvicultural treatments. If inflation is included in final harvest values, inflated ROR's are displayed by FAST. If inflation is not included, real ROR's result. Silvicultural treatment decisions should either be based on real terms or on inflated terms. If we expect the ROR for timber stand improvement to be at least as high as rates currently paid on bank accounts, for example, then final harvest values should either be increased to reflect inflation, or the bank account rate should be changed to a real alternative rate of return (see Gregerson 1975). For pre-tax analyses, inflation has no effect on treatment decisions if it is properly accounted for. After-tax analyses, however, should include inflation if treatment costs are capitalized. Current tax law does not allow such costs to be indexed to reflect inflation, and the resulting "equity erosion" is ignored if inflation is entirely omitted.

Many variables influence rates of return expected from silvicultural practices. Some factors are related to the particular stand and treatment being considered, and some are related to the economic assumptions most relevant to the decision-maker. ROR information is therefore highly specific, and generalizations are often of limited use. Our example of evaluating hardwood control demonstrates the type of information that can be obtained for specific treatments. Although nonfinancial considerations also influence most silvicultural treatment decisions, many forest managers can greatly benefit from rate of return or other economic information for evaluating stand management alternatives.

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Table 1. Rates of return for the hardwood control example.

Treatment Cost ($/acre)	Percentage Value Increase in Year 25 Which Can Be Attributed to the Silvicultural Treatment in Year 1									
	55	60	65	70	75	80	85	90	95	100
	percent									
10	12.7	13.2	13.5	13.9	14.2	14.5	14.8	15.1	15.3	15.6
20	9.5	9.9	10.3	10.6	11.0	11.3	11.5	11.8	12.1	12.3
30	7.7	8.1	8.5	8.8	9.1	9.4	9.7	9.9	10.2	10.4
40	6.4	6.8	7.2	7.5	7.8	8.1	8.4	8.6	8.9	9.1
50	5.4	5.8	6.2	6.5	6.8	7.1	7.4	7.6	7.9	8.1
60	4.6	5.0	5.4	5.7	6.0	6.3	6.6	6.8	7.0	7.3
70	4.0	4.3	4.7	5.0	5.3	5.6	5.9	6.1	6.4	6.6
80	3.4	3.8	4.1	4.4	4.7	5.0	5.3	5.5	5.8	6.0
90	2.9	3.3	3.6	3.9	4.2	4.5	4.8	5.0	5.3	5.5
100	2.4	2.8	3.1	3.5	3.8	4.0	4.3	4.6	4.8	5.0
110	2.0	2.4	2.7	3.1	3.4	3.6	3.9	4.1	4.4	4.6
120	1.7	2.0	2.4	2.7	3.0	3.3	3.5	3.8	4.0	4.2
130	1.3	1.7	2.0	2.3	2.6	2.9	3.2	3.4	3.7	3.9
140	1.0	1.4	1.7	2.0	2.3	2.6	2.9	3.1	3.3	3.6
150	0.7	1.1	1.4	1.7	2.0	2.3	2.6	2.8	3.0	3.3