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Richard T. Straight
Iowa State University

David W. Countryman
Iowa State University

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Forest Returns: An Interactive Computer System for Economic Analysis of Alternative Forest Land Uses¹

RICHARD T. STRAIGHT AND DAVID W. COUNTRYMAN

Department of Forestry, Iowa State University, Ames, Iowa 50011

FOREST RETURNS is an interactive computer program developed at Iowa State University and designed to aid landowners in making economic comparisons of land use alternatives. The program calculates benefit-cost ratio, present net worth, realizable rate of return, and cash-flow listing of the cost-revenue stream of four land use types: timber, Christmas trees, row crop, and pasture. Each land use type is analyzed by a separate section of the program which asks the user for information on the estimated costs and revenues specific to the land use being analyzed. Currently, FOREST RETURNS is written in Apple Business BASIC V1.1 for Apple III computers, but the program could be adapted for use with several similar microcomputer systems. This report describes the logic and operations of FOREST RETURNS.

INDEX DESCRIPTORS: Forestry, Economic Analysis, Computers.

INTRODUCTION

Among the factors leading to the clearing of forest lands in Iowa are misconceptions of the productivity potential of forest lands and the lack of experience of private landowners with trees as a crop (Kelley, 1980). Forest economics has shown that often landowners cannot plant seedlings, wait for the crop to mature, and realize an attractive return on their investment, but this typically is not the problem facing many Iowa landowners. Many private nonindustrial forest landowners must decide how best to manage the existing stands of timber instead of whether or not to plant trees versus doing some other project.

Economic criteria such as present net worth, internal rate of return, and benefit-cost ratio are commonly used to choose among alternative land uses. These calculations can be difficult and tedious to perform if the cash-flow stream under analysis is longer than a few years, especially when several alternatives are under consideration. Also, when calculations are being done by hand the chance of making an error increases with the number of calculations.

However, with the growing interest in and use of microcomputer systems, small businesses and individuals are finding that calculations and information storage can be made faster and more efficient. Use of the computer by businesses and individuals allows the user to do what people do best; that is, think and make decisions, while the computer does what it does best; that is, fast, repetitive, efficient calculations and accurate long-term storage of information.

This study was undertaken to develop an interactive program to aid individuals who have access to a computer system in making and comparing economic analyses of land-use operations. The current program is written in Apple Business BASIC V1.1 and could be modified to operate on other presently available microcomputer systems.

RESULTS

"FOREST RETURNS" was developed as an interactive, stand-alone computer program. Questions used to acquire information from the user and information needed by the user to operate the program are written as clearly and concisely as possible to avoid the need of a user's manual.

The user is asked to determine the timing and value of costs and revenues for the land use operation under analysis. These costs and revenues are then stored in a matrix. After all data for a particular land

use are in the matrix, the calculations are made, and the information is presented to the user.

The program consists of eight major sections: I) Introduction, II) Control, III) Row Crop, IV) Pasture, V) Christmas Trees, VI) Timber, VII) Calculations and Output, and VIII) Subroutines (Figure 1).

I. Introduction

The Introduction section of the program is a series of print statements that contain: (1) a brief statement of the purpose of the program, and (2) a few guidelines for entering information into the program.

II. Control

The Control section of the program has three major functions: (1) establish the value of the land parcel under analysis, (2) establish the length of the analysis period, and (3) to act as a directory of the possible land-use analyses.

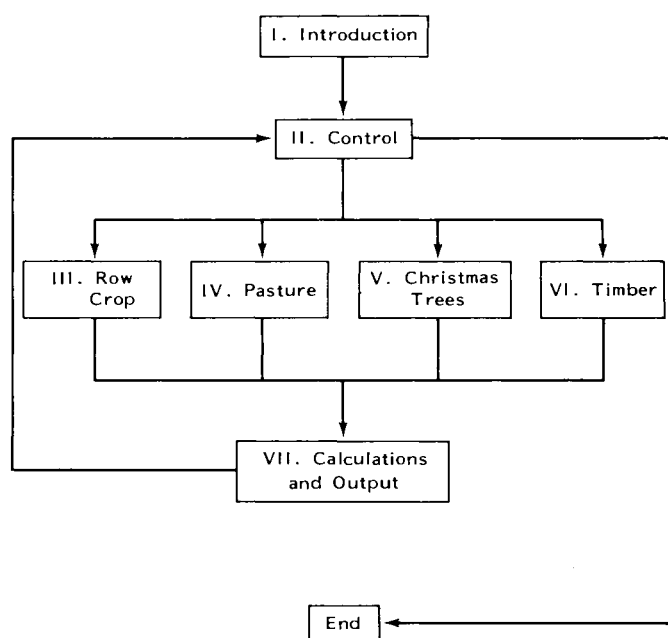


Figure 1. Conceptual flowchart of the major sections within the computer program FOREST RETURNS.

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III. Row Crop

The Row Crop section is designed as a general format for entering costs and revenues of row-cropping systems into the cost-revenue matrix. The program is set up to enter yearly costs and revenues for single- or multiple-crop rotations along with periodic and one-time costs.

The user can choose between single- and multiple-year crop rotations. The multiple-crop rotation option asks the user for the length of the crop rotation and then asks the user for the expected costs and revenues for each year of the crop rotation. The program provides a list of suggested costs for consideration but does not provide specific values for the costs since these costs vary so much from operation to operation and from year to year. The value of a program such as FOREST RETURNS is that a manager can use production costs and revenues specific to an individual operation; however, average rates (Edwards, 1983) may also be entered. The single-crop option asks the user for the costs and revenues associated with the single-crop rotation. This option allows the user to insert costs and revenues associated with other crops. For example, if the user decides on a continuous corn rotation, the program will let the user insert other crops periodically or in individual years.

Once the annual production costs and revenues have been entered into the program, the user may enter other anticipated costs into the program. These other costs may be entered as periodic costs (e.g., periodic liming) or as one-time costs (e.g., terracing).

IV. Pasture

The Pasture section of the program begins by asking the user for annual and periodic costs associated with managing a pastured parcel of land. The program then asks the user for anticipated periodic revenues and revenues that may occur only once.

The Pasture section allows the user to periodically plant row crops, instead of pasture, whenever desired. When another crop is planted, the costs and revenues associated with the pasture are replaced by the costs and revenues associated with the row crop. The program also allows the user to reseed the pasture in the fall after the row crop is harvested.

V. Christmas Trees

In the Christmas Trees section of the program, costs and revenues are put into one of three categories: (1) annual, (2) periodic, and (3) one-time. The user is responsible for determining the source of the cost such as planting, shearing, herbicides, and harvesting. The program does provide a list of sample costs which may occur as annual, periodic, or one-time costs; the user should realize that these lists are only samples and not an operation schedule for a Christmas tree production operation. Possible operation schedules and costs may be found in "Christmas Tree Production in Iowa" (Wray and Countryman, 1979).

Because of the relatively long time period (i.e., 7-10 years between planting and marketing of Christmas trees), the user may wish to plant only a fraction of the land to Christmas trees for each of several years to provide a more uniform flow of income. However, if this type of schedule is undertaken, the user is responsible for keeping track of the costs and revenues of the multiple operations that may be used during the early stages of the development of the Christmas tree operation.

VI. Timber

The Timber section of the program is designed to analyze single, annual, and regular harvests of fuelwood, sawlogs, or both fuelwood and sawlogs.

Costs and revenues needed for this section of the program would be included in a timber management plan. Landowners may contact their District Forester for help in preparing a timber management

plan, if they do not already have one.

This section also includes the option to make calculations for determining allowable cut by using von Mantel's formula:

$$\text{Allowable cut} = 2(Gs)/R,$$

where:

Gs = volume of growing stock,

R = rotation age, in years.

This formula was chosen because it requires relatively little information to make an allowable cut determination.

VII. Calculations and Output

Several economic indices were chosen for inclusion in the final output. Benefit cost ratio (B/C) and present net worth (PNW) (de Neufville and Stafford, 1971) were chosen because of their common use and relative ease of calculation. Realizable rate of return (RRR) (Schallau and Wirth, 1980) was chosen instead of the more common internal rate of return for several reasons. First, internal rate of return assumes that the rate at which net cash flows can be reinvested is equal to the rate of return from the project being analyzed. For many landowners, this is not the case. When the reinvestment opportunities of the landowners are less than the rate of return from the project, internal rate of return yields a rate that is unrealistically large. However, realizable rate of return allows the user to analyze reinvesting the net cash flows at the expected reinvestment rate. Internal rate of return also is calculated by a repetitive method, which requires a longer program and more computer time and space to operate.

The Calculations and Output section of the program carries out the actual calculations needed to determine benefit-cost ratio, present net worth, and realizable rate of return. This section also formats the printed output for the user (Tables 1 and 2). The individual costs and revenues are discounted or compounded, as needed, at a rate equal to the user's long-term borrowing rate considering the user's anticipated long-term inflation rate (Gregerson, 1975). This method is used because (1) all costs and revenues are assumed to be constant dollars, (2) for comparison purposes, it is assumed the effects of inflation will be similar for all items and thus not alter the relative ranking of alternatives, and (3) the purpose of this economic comparison is to compare the returns due to the management system used and not to the increase in land value due to inflation or changing land use (e.g., housing property versus agricultural property).

VIII. Subroutines

The Subroutines section contains 10 subroutines. These subroutines exist because they are used several times during the operation of the program. They were formulated as subroutines instead of repeating these lines of the program and thus wasting computer space.

Table 1. Sample printout of benefit-cost ratio, present net worth, and realizable rate of return.

With a borrowing rate of 10%, an inflation rate of 5%, and a real cost of capital of 4.76%	
discounted costs =	\$3,476.22
discounted revenues =	\$3,694.60
benefit-cost ratio (B/C) =	1.063
present net worth (PNW) =	\$ 218.38
realizable rate of return =	5.643%
Realizable rate of return exceeds the real cost of capital by 0.881%	

Table 2. Sample printout of the cash-flow listing.

YEAR	COSTS	REVENUES	ACCUMULATED NEW CASH FLOW
1	50.00	122.00	72.00
2	200.00	122.00	6.00 -
3	50.00	122.00	66.00
4	50.00	122.00	138.00
5	50.00	147.00	235.00
6	50.00	147.00	332.00
7	200.00	247.00	379.00
8	200.00	543.00	722.00
9	200.00	543.00	1,065.00
10	200.00	879.00	1,744.00

These subroutines are listed as A through K.

- A. *Row crop cost*: This subroutine prints for the user a list of costs that should be considered by the user when determining the production cost of most rowcrop operations.
- B. *Yes-no edit*: This subroutine checks the user's yes and no responses for errors in typing.
- C. *Periodic costs*: This subroutine asks the user for the timing and amount of periodic costs and enters those costs into the proper locations in the cost-revenue matrix.
- D. *One-time cost*: Subroutine D asks the user for the value of costs that occur as one-time costs and not as annual or periodic costs. It also asks for the timing of these one-time costs.
- E. *Revenue*: Subroutine E asks the user for the value of revenues that occur as one-time revenues and not as periodic or annual revenues. The program also asks the user for the year of the analysis period in which the revenue occurs.
- F. *Periodic revenue*: This subroutine allows the user to enter revenues that occur at regular intervals.
- G. *New revenue*: Subroutine G allows the user to enter a different value for a periodic revenue in special instances within the program.
- H. *Growing stock I*: This subroutine asks the user for the value of growing stock in the Christmas Trees (Section V) and Timber (Section VI) sections of the program. This separation of the value of the growing stock on the land and the value of the land allows the program to calculate the increase or decrease in value of the growing stock due to management.
- J. *Growing stock II*: Subroutine J asks the user for the value of growing stock at the end of the analysis period for both Sections V and VI.
- K. *Changes*: This subroutine allows the user to correct errors or change values previously entered into the cost-revenue matrix. By allowing the user to change data, the user may compare the effects of price and cost changes on the ranking of land use options.

DISCUSSION

FOREST RETURNS was developed to help individuals compare economic returns from land management and land-use alternatives. The land use alternatives represented within the program are management systems that are likely to be considered by landowners. The purpose of this program is to compare the returns to the management system used and not the change in value of the land due to a land-use change. The program also was not designed as a complete economic analysis system for estate planning or business accounting.

By making the program interactive, several benefits are realized. First, the user is less likely to be stifled by the tedious task of entering data onto punch cards in a specified format. An interactive program appears to the user to be more personal and more familiar because it asks questions and gives more information in an easily understood

manner. Second, mistakes can be identified easily and changed as the information is being entered. And third, an interactive program provides for faster results by avoiding the time needed to send data cards to the computer, retrieve the results, and correct the necessary data cards for additional runs of the program. The desired changes can be made and results obtained within one session, if the program is interactive.

FOREST RETURNS provides a cash flow listing and calculates present net worth, benefit-cost ratio, and realizable rate of return in an attempt to meet a variety of user information needs. A cash-flow listing is important to many landowners because a good return 5 or 10 years hence may mean nothing if the landowner need endure a 4-year period of large costs, without appreciable income. Present net worth is the difference between the sum of the discounted revenues and the sum of the discounted costs. A project with a present net worth greater than 0 has a rate of return greater than the cost of capital. Benefit-cost ratio is the ratio of the sum of the discounted revenues over the sum of the discounted costs and any project with a benefit-cost ratio greater than 1.0 has a rate of return greater than the cost of capital. Realizable rate of return is made up of two parts. One is the return from the project and the other is the return due to the reinvestment rate. A project may appear to be acceptable, even though the project has a low rate of return because the reinvestment rate carries the project. Thus, the realizable rate of return value must be compared with the reinvestment rate.

To assist the user in making more beneficial comparisons, the subroutine for making changes and corrections was developed. This subroutine allows the user to alter costs and revenues and then see the effects that these changes have on indices and cash flow. In this manner, the user can decide which factors are most important and have the most effect on the outcome of the land use or management alternative being analyzed.

FOREST RETURNS has the basic elements needed for making economic comparisons of land management and land-use alternatives. There are, however, changes and modifications that could be made that could help the user.

The program could be made to explicitly deal with tax considerations. Long-term investment such as timber and Christmas trees may allow the user to take advantage of several tax options. Long-term capital gains treatment of timber and Christmas tree income (Wray, 1980) and the capitalizing of certain production costs (Forest Industries Committee on Timber Valuation and Taxation, 1981) could well change the comparative ranking of the user's land-use options. Tax considerations must currently be taken into account off-line as costs and revenues are developed.

The addition of a growth model to work within the Timber section of the program may also improve the program. A growth model would assist the user in keeping track of the volume of standing timber in each age or size class. Such an addition also could improve the precision of management by timber managers by providing accurate calculations instead of estimates of expected growth based on the "average" timber tract. A growth model also could cut down on off-line calculations by the user. However, a growth model would use general average growth rates for certain timber types (thus, restricting the use of the program to only those timber types) or would require more specific growth information from the user concerning their specific woodlands than many users would have available (thus, prohibiting many users from using the program).

FOREST RETURNS could be broken down into several smaller programs, each analyzing a single land use. The smaller programs could contain only the specific sections of the current program that are relevant to a specific land use. These smaller programs could then operate on microcomputers with limited storage capacity.

FOREST RETURNS is written in sections, so it could be changed by rewriting a section at a time if desired. Thus, as sections of the

program are improved, changes can be added without rewriting the entire program.

An example of how FOREST RETURNS may be applied in a land management situation is as follows. Suppose a landowner has a tract of timberland as part of his farming operation. This landowner might wish to consider clearing the land and converting it to agricultural uses (i.e., pasture or rowcrops); or clearing the land and planting Christmas trees; or maintaining the present forest cover and managing for sawlogs and fuelwood production. This is certainly not an exhaustive list, but it includes many of the most obvious alternatives that might be considered.

FOREST RETURNS would provide a means for the landowner to analyze costs and revenues expected from that specific land management operation to compare the alternatives on a rational economic basis in addition to information based on contemporary management patterns of others. The landowners may wish to compare all possible options or any combination. Since the calculations can be made very rapidly once the landowner compiles the expected costs and revenues, several variations of each alternative could be compared to determine the effect of changes in prices, interest rates, market conditions, and timing of practices. This sensitivity analysis would also highlight the factors to which each alternative is most sensitive, thus, providing some indication of risks involved in each alternative. By comparing the values for present net worth, benefit-cost ratio, realizable rate of return, and cash flow resulting from this set of analyses, the landowner may choose the alternative that is best for that specific operation, based on economic criteria.

In summary, FOREST RETURNS is an interactive computer program that is dependent upon the user bringing certain skills and information into the man-machine union. The user must have the ability to think and interpret the results while the machine does the repetitious calculations accurately and rapidly. This computer program does not make decisions for the user, it only aids the user by generating economic information based on user inputs concerning alternatives being considered.

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