



Economic Budgeting for Agroforestry Practices

by **Larry D. Godsey**, *Economist, Center for Agroforestry, University of Missouri-Columbia*

Evaluation of the economic aspects of agroforestry provides a basis for estimating financial needs and feasibility, highlights trade-offs between multiple benefits and monitors economic efficiency. The main technique used in economic analysis is budgeting.

Economic budgeting is a very flexible process. However, effective application of budgets requires an understanding of the commodity, practice or system to which it is being applied. Agroforestry poses some unique economic budgeting problems because it involves multiple enterprises with varying production cycles, such as trees, row crops, forages and/or livestock.

First, unlike most agricultural commodities, agroforestry has a “planning horizon” of greater than one season due to the tree component. A “planning horizon” is simply a time period in which all costs and revenues for a given practice are realized. For soybeans, a planning horizon may be six months to a year. For agroforestry, a simple planning horizon may be as long as 60-80 years when the timber value of trees are taken into consideration.

Unique characteristics of agroforestry

- *Long planning horizons;*
- *Irregular cost and revenue occurrences;*
- *Fixed tree component with variable crop or livestock component.*

Second, because of the long planning horizon of agroforestry practices, many of the revenues and costs do not occur at regular or predictable intervals throughout the entire planning horizon, but are irregular in occurrence.

Finally, because agroforestry practices typically incorporate a fixed tree component with a crop or livestock component, the crop or livestock component may change over time. For example, an alley cropping practice may start out as soybeans grown between rows of eastern black walnut trees, but by the time the trees are producing nuts, hay may be the crop grown between the rows

of trees because a smoother surface is required to mechanically harvest the nuts.

These three characteristics of agroforestry practices require a specific type of budgeting method that will be flexible enough to allow for variable crop and/or livestock components, as well as comprehensive enough to show annual cashflows for the entire planning horizon.

Agroforestry Budgeting

Agroforestry budgeting is a two-step process. The steps are to develop enterprise budgets and combine the enterprise budgets into a cashflow plan.

An enterprise budget is a complete, detailed listing of all the costs and revenues expected for each single enterprise, such as corn, livestock or nut and timber trees. A cashflow plan combines the details from the different enterprise budgets in the agroforestry practice and adds a time dimension. The enterprise budget provides a framework for reporting and monitoring the profitability of each enterprise, and the cashflow plan provides the information necessary to assess and forecast the economic feasibility of the agroforestry practice over time.

Developing the Enterprise Budgets

The development of an enterprise budget is a three-step process. The first step is to list all possible sources of revenue for an enterprise. For the tree component of an agroforestry practice, it is important to list not only the sources, but also list the timing of those revenues. For example, an alley cropping practice with eastern black walnut trees may receive Conservation Reserve Program (CRP) payments for the first 10 years of the planning horizon but not after that period. Income from nut production may start at year 10 or 12 and continue until the tree is harvested for wood in year 60.

The second step is to list, in detail, all possible sources of variable costs. Variable costs are those costs attributed to the productive use of resources. Variable costs can be grouped into cash and non-cash costs. Variable cash costs include payments for establishment, maintenance, harvesting and marketing. Variable non-cash costs do not require a cash outlay, but reflect



opportunity costs. Opportunity cost is simply the value of the next best alternative that is not chosen. For example, labor supplied by family members may not require a cash outlay, but could still be considered in the economic analysis.

Steps for Developing an Enterprise Budget

- List all possible sources of revenue;
- List all possible sources of variable costs (both cash and non-cash);
- List all possible sources of fixed costs (both cash and non-cash).

Reporting variable costs should include the source of the cost, the amount of the cost, and the time interval in which that cost will be incurred. For example, thinning trees may cost \$50 per acre and occur in years 21 and 25.

The third and final step to preparing an enterprise budget is to list all fixed costs. Fixed costs are typically those costs that are attributed to resource ownership. In other words, fixed costs occur regardless of any productive activity being attempted. Fixed cash costs usually include property taxes, insurance, interest on intermediate or long-term debt, and lease agreements. Fixed non-cash costs are important when developing an investment analysis, because these costs have significant influence on taxes. However, these costs are difficult to determine. Depreciation and land costs are the two main areas of fixed non-cash costs. Fixed costs may not change as often as the revenues and variable costs. In fact, any changes may be predictable, such as a 2 percent increase in property taxes every year. When reporting fixed costs, be sure and note the source, the amount and the estimated changes that will occur in the original amount.

Appendix A gives questions to consider for each step in enterprise budgeting. Appendix C is an example of an enterprise budget for an alley cropping practice using eastern black walnut. The enterprise budget reports all costs and revenues on a per acre basis. Species and spacing are clearly described so this budget will not be confused with other types of agroforestry practices.

From Enterprise Budgets to Cashflow Plans

Once enterprise budgets are created, a cashflow plan for the agroforestry practice can be developed. It is important to understand that an agroforestry practice may include more than one enterprise. For example, a well-established alley cropping practice may combine a tree enterprise with a hay and livestock enterprise. As mentioned earlier, often the tree enterprise is fixed while the crop or livestock enterprises vary over time.

Cashflow planning has two major characteristics that benefit agroforestry economic analysis:

- *Allows for multiple enterprises to be considered;*
- *Incorporates a time dimension.*

Using a cashflow plan in conjunction with enterprise budgets can simplify the process of economic analysis by allowing the enterprise budgets to reflect the detailed information and let the cashflow plans use minimal data to provide the analysis. Appendix B has questions to aid in cashflow planning while Appendix D is an example of a cashflow plan for an alley cropping practice that uses eastern black walnut along with bluegrass and white clover hay.

Common Indicators of Economic Performance

There are several common indicators used to analyze an agroforestry practice for economic performance. Supplementing these common economic indicators with some very basic indicators of economic performance can help both producers and

Examples of Agroforestry Revenues, Variable Costs and Fixed Costs

Revenues

Cost-share and CRP payments, nuts, biomass, grafted seedling sales, hunting rights, scionwood and cuttings, nature walks, timber (sawlogs, veneer logs, etc.), seedlings

Variable costs

Cash costs

Establishment: Site preparation (mechanical/chemical), seedlings, planting (labor and equipment), watering, staking

Maintenance: Fertilization, pest and disease control, grafting, thinning, pruning

Harvesting: Nut harvest, timber harvest

Marketing: Advertising, packaging, transportation

Non-cash costs

Family labor

Fixed costs

Cash costs

Property taxes, insurance, interest payments (intermediate debt), lease agreements, land - interest (Option 1)

Non-cash costs

Depreciation, land - opportunity cost (Option 2)

economists understand the economic performance of agroforestry practices.

A common economic analysis technique known as net present value (NPV) analysis can be conducted given the information provided in a good cashflow plan. Net present value is simply all future net income streams from the practice discounted to reflect their current or present value. Appendix E shows the formula for the calculation of NPV. This indicator is useful only as a basis for comparison. The net present value of the agroforestry practice can be compared to the net present value of other alternatives, such as a soybean monoculture, to see which practice is the most economically profitable. Assuming each practice is discounted using the same period of time and the same discount rate, the highest NPV would indicate the best alternative.

Common economic indicators

- *Net Present Value (NPV)*;
- *Internal Rate of Return (IRR)*;
- *Annual Equivalent Value (AEV)*.

The internal rate of return (IRR) is another common indicator of economic performance. The internal rate of return is the rate at which an investment is expected to grow. For example, a savings account pays 3 percent per year; therefore, an investor who puts money in a savings account is expecting to earn 3 percent on that investment. If an agroforestry practice has an IRR of 6 percent, then a rational investor would choose the agroforestry practice over the savings account earning 3 percent. However, the internal rate of return does not always capture the uncertainty of returns over time. Using the savings account example, an investor is assured that the money put into a saving account is relatively risk free; however, investment in agroforestry practices may face uncertainties that were not predicted or planned. Appendix E shows the calculations for deriving the IRR.

Another common indicator of economic performance that can be derived from a cashflow plan in the annual equivalent value (AEV). The annual equivalent value is an estimate of a level income stream that would have the same net present value as the actual income streams. Actual income streams for agroforestry practices may be positive one year and negative another; however, with the annual equivalent value, a level income estimate is established. The annual equivalent value can be used to compare alternative practices with the agroforestry practice to determine which practice has the highest expected income potential.

Supplemental Economic Indicators

All three of the common indicators can be used to evaluate the economic success of agroforestry practices. However, there are easier ways to help evaluate the economic feasibility of agroforestry practices without the complicated discounting equations.

Using a cashflow budget, three supplemental economic indicators can be derived:

- 1) *Frequency of negative cashflow;*
- 2) *Duration of negative cashflow;*
- 3) *Magnitude of positive and negative cashflows.*

The frequency of negative cashflow is simply determining the number of years in a planning horizon in which a practice will have a net loss. For many landowners, a practice that appears to be economically profitable according to a NPV analysis in the long run, may not be feasible due to several periods of net loss. Similar to frequency, duration of negative cashflow reflects the length of time that the practice returns a negative cashflow, or net loss. While frequency would describe a practice as having negative cashflow four out of 15 years, duration may indicate that three of those four years occurred consecutively. A landowner may not be concerned about having a negative cashflow occasionally. However, a continuous net loss may make a practice undesirable and infeasible.

The magnitude of positive and negative cashflow reflects the range of fluctuations that occur from year to year and throughout the planning horizon in net income. For example, one practice may have a very large net loss the first two years for startup costs, followed by several years of small net incomes. Over the long run, this practice may have a positive internal rate of return, but the periods of large net losses may make the practice infeasible. On the other hand, expected large net income in the future may make periods of small net losses tolerable.

The three supplemental indicators of frequency, duration and magnitude require no special training in finance or math and may have more influence on the decision process. The common indicators of net present value, internal rate of return and annual equivalent value are still important to help compare the agroforestry alternative to other possible alternatives. Using both types of economic indicators can help “fine tune” the economic analysis and aid in the decision process.

There are many other benefits to agroforestry besides those measured by economics. Environmental and social benefits may also have value to the decision maker. These benefits are often difficult to quantify. With economic analysis, these benefits can be considered in light of financial considerations.

Reassessment

Economic analysis is not meant to be – nor is it designed to be – a one-time activity. Economic analysis is designed to be a road map for a dynamic and living system. Reassessment takes the information gathered in the economic analysis and combines it with other information to change the original goals or fine tune the design so that it is more successful at meeting those goals. Reassessment is the continuous loop that helps redefine goals, adjust designs and modify indicators. Economic analysis is just one part of the reassessment loop.

Additional Resources

Training Manual for Applied Agroforestry Practices, University of Missouri Center for Agroforestry, 2006 Edition

Garrett, H.E. (ed.). 2008. North American Agroforestry: An Integrated Science and Practice. 2nd Edition. American Society of Agronomy, Inc., Madison, WI.

Black Walnut Financial Model, available on the University of Missouri Center for Agroforestry Web site at <http://www.centerforagroforestry.org/profit/walnutfinancialmodel.asp>

Appendix A Agroforestry Enterprise Budgeting (Steps 1-4)

Step 1: Define the Enterprise

1. What practice is it? (alley cropping, silvopasture, riparian forest buffer, windbreak, forest farming)
2. What species? (common or scientific name)
3. What spacing? (30' x 30', 20' x 40', etc.)
4. What is the price basis? (\$/acre, \$/tree, \$/year, etc.)

Step 2: Estimate Revenues¹

1. What are all of the possible sources of revenue? (incentives, nuts, scionwood, etc.)
2. When are these revenues going to be earned? (years 1-10, after 10, after 60, etc.)

Step 3: Estimate Variable Costs (Operating Costs)

1. What are the costs to establish the practice? (site preparation, planting, etc.)
2. What are the costs to maintain the practice? (chemicals, grafting, thinning, etc.)
3. What will it cost to harvest? (nuts, timber, etc.)
4. What will it cost to market the products? (advertising, trans-

portation, spoilage, etc.)

5. Are there any variable non-cash costs?
6. When and how often will these costs occur?

Step 4: Estimate Fixed Costs (Ownership Costs)

1. What proportion of the property taxes can be attributed to the tree portion? (10 percent per acre in trees = 10 percent of per acre property tax)
2. What proportion of the property insurance bill can be attributed to the tree portion? (using machinery 10 percent of the time on trees = 10 percent of the per acre insurance bill)
3. Is there any interest being paid on capital? (interest on machinery debt, building debt, etc.)
4. What does it cost to own the land?² (current rental rates, interest payments on land, etc.)
5. Is there any capital that must be depreciated? (machinery, buildings, roads, etc.)
6. When and how often will these costs occur?

*1 When developing enterprise budgets for the tree component of an agroforestry practice, be sure to consider all possible sources of income.
2 The easiest method is the market cash rental method.*

Appendix B Agroforestry Cashflow Planning (Steps 1-6)

Step 1: Define the Practice

1. What practice is it? (alley cropping, silvopasture, riparian forest buffer, windbreak, forest farming)
2. What are the enterprises that make up the practice? (tree enterprise, crop and/or livestock enterprise)
3. Do the enterprise budgets match the practice? (spacing, species, trees per acre, etc.)
4. What price basis best represents all enterprises? (\$/acre, \$/bushel, \$/year)
5. What is the planning horizon for this practice? (10 years, 50 years, etc.)

Step 2: Calculate Annual Revenues

1. What are the total revenues each year for the tree enterprise? (year 1 = \$100, year 2 = \$50, etc.)
2. What are the total revenues each year for the crop or livestock component?¹ (year 1 = \$100, year 2 = \$50, etc.)
3. What are the total revenues each year for the tree, crop and/or livestock enterprises? (combine the annual tree and crop/livestock revenues)

Step 3: Calculate Annual Variable Costs

1. What are the total variable costs each year for the tree enterprise? (year 1 = -\$75, year 2 = -\$50, etc.)
2. What are the total variable costs each year for the crop or livestock component? (year 1 = -\$100, year 2 = -\$25, etc.)
3. What are the total variable costs each year for the tree, crop and/or livestock enterprises? (combine the annual tree and crop/livestock variable costs)

Step 4: Calculate Annual Fixed Costs

1. What are the total fixed costs each year for the tree enter-

prise? (year 1 = -\$15, year 2 = -\$15, etc.)

2. What are the total fixed costs each year for the crop or livestock component? (year 1 = -\$25, year 2 = -\$25, etc.)
3. What are the total fixed costs each year for the tree, crop and/or livestock enterprises?² (combine the annual tree, crop and/or livestock fixed costs)

Step 5: Calculate Net Income for Each Year

1. Total Revenues - Total Variable Costs - Total Fixed Costs = Net Income

Step 6: Analyze the Results

1. What is the net present value (NPV) of the calculated annual net incomes?
2. What is the internal rate of return (IRR) of the calculated annual net incomes?
3. What level payment (annuity) would have the same net present value at the same discount rate used above?³
4. What is the frequency of negative income occurrences (3 out of 10 years, 7 out of 10 years, etc.)
5. What is the duration of the negative incomes occurrences? (3 years in a row, 5 years in a row, etc.)
6. What is the magnitude of the negative income? (how large is the income deficit⁴, how large is the deficit compared to expected future incomes, etc.)

*1 Crop and livestock enterprise budgets can be developed using similar enterprise budgeting methods as the tree component.
2 The total fixed costs for any practice should not exceed the amount that would be expected if all the assets set idle. If there is a difference, that difference would be a variable cost.
3 This is often called the annual equivalent value (AEV).
4 Deficit – a situation when expenses are greater than revenues.*

Agroforestry Cashflow Plan

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Revenues											
Tree: Eastern Black Walnut	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$255.00
Crop: Hay	\$-	\$-	\$-	\$-	\$-	\$-	\$-	\$-	\$-	\$-	\$120.00
Total revenues:	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$62.00	\$375.00
Variable Costs											
Tree: Eastern Black Walnut	\$650.50	\$19.10	\$19.10	\$26.70	\$26.70	\$26.70	\$44.50	\$44.50	\$44.50	\$44.50	\$202.00
Crop: Hay	\$34.50	\$30.00	\$30.00	\$44.50	\$30.00	\$30.00	\$30.00	\$44.50	\$30.00	\$30.00	\$60.00
Total Variable Costs:	\$685.00	\$49.10	\$49.10	\$71.20	\$56.70	\$56.70	\$74.50	\$89.00	\$74.50	\$74.50	\$262.00
Fixed Costs											
Tree: Eastern Black Walnut	\$11.00	\$11.00	\$11.00	\$11.00	\$11.00	\$11.00	\$11.00	\$11.00	\$11.00	\$11.00	\$26.00
Crop: Hay	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00
Total Fixed Costs:	\$45.00	\$45.00	\$45.00	\$45.00	\$45.00	\$45.00	\$45.00	\$45.00	\$45.00	\$45.00	\$60.00
Net Income/(loss)	\$(668.00)	\$(32.10)	\$(32.10)	\$(54.20)	\$(39.70)	\$(39.70)	\$(57.50)	\$(72.00)	\$(57.50)	\$(57.50)	\$53.00
NPV @ 10%	(\$449.04)										
Internal Rate of Return	6.432%										
Annual Equivalent Value	\$45.72										

Practice: Alley Cropping
Species: Black Walnut
Crop: Hay

Price Basis: \$/acre/year
Spacing: 30x30

Agroforestry Cashflow Plan

	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21
Revenues										
Tree: Eastern Black Walnut	\$263.00	\$271.00	\$279.00	\$287.00	\$296.00	\$305.00	\$314.00	\$323.00	\$333.00	\$343.00
Crop: Hay	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00
Total revenues:	\$383.00	\$391.00	\$399.00	\$407.00	\$416.00	\$425.00	\$434.00	\$443.00	\$453.00	\$463.00
Variable Costs										
Tree: Eastern Black Walnut	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00
Crop: Hay	\$64.50	\$60.00	\$60.00	\$60.00	\$64.50	\$60.00	\$60.00	\$60.00	\$64.50	\$60.00
Total Variable Costs:	\$266.50	\$262.00	\$262.00	\$262.00	\$266.50	\$262.00	\$262.00	\$262.00	\$266.50	\$262.00
Fixed Costs										
Tree: Eastern Black Walnut	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00
Crop: Hay	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00
Total Fixed Costs:	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00
Net Income/(loss)	\$56.50	\$69.00	\$77.00	\$85.00	\$89.50	\$103.00	\$112.00	\$121.00	\$126.50	\$141.00

Practice: Alley Cropping
Species: Black Walnut
Crop: Hay

Price Basis: \$/acre/year
Spacing: 30x30

Agroforestry Cashflow Plan

	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Year 31
Revenues										
Tree: Eastern Black Walnut	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00
Crop: Hay	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00
Total revenues:	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00
Variable Costs										
Tree: Eastern Black Walnut	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00
Crop: Hay	\$60.00	\$60.00	\$64.50	\$60.00	\$60.00	\$60.00	\$64.50	\$60.00	\$60.00	\$60.00
Total Variable Costs:	\$262.00	\$262.00	\$266.50	\$262.00	\$262.00	\$262.00	\$266.50	\$262.00	\$262.00	\$262.00
Fixed Costs										
Tree: Eastern Black Walnut	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00
Crop: Hay	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00
Total Fixed Costs:	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00
Net Income/(loss)	\$141.00	\$141.00	\$136.50	\$141.00	\$141.00	\$141.00	\$136.50	\$141.00	\$141.00	\$141.00

Practice: Alley Cropping
Species: Black Walnut
Crop: Hay

Price Basis: \$/acre/year
Spacing: 30x30

Agroforestry Cashflow Plan

	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49	Year 50	Year 51	Year 52
Revenues										
Tree: Eastern Black Walnut	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00
Crop: Hay	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00
Total revenues:	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00
Variable Costs										
Tree: Eastern Black Walnut	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00
Crop: Hay	\$60.00	\$64.50	\$60.00	\$60.00	\$60.00	\$64.50	\$60.00	\$60.00	\$60.00	\$64.50
Total Variable Costs:	\$262.00	\$266.50	\$262.00	\$262.00	\$262.00	\$266.50	\$262.00	\$262.00	\$262.00	\$266.50
Fixed Costs										
Tree: Eastern Black Walnut	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00
Crop: Hay	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00
Total Fixed Costs:	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00
Net Income/(loss)	\$141.00	\$136.50	\$141.00	\$141.00	\$141.00	\$136.50	\$141.00	\$141.00	\$141.00	\$136.50

Practice: Alley Cropping
Species: Black Walnut
Crop: Hay

Price Basis: \$/acre/year
Spacing: 30x30

Agroforestry Cashflow Plan

	Year 53	Year 54	Year 55	Year 56	Year 57	Year 58	Year 59	Year 60
Revenues								
Tree: Eastern Black Walnut	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$343.00	\$1,343.00
Crop: Hay	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00	\$120.00
Total revenues:	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$463.00	\$1,463.00
Variable Costs								
Tree: Eastern Black Walnut	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00	\$202.00
Crop: Hay	\$60.00	\$60.00	\$60.00	\$64.50	\$60.00	\$60.00	\$60.00	\$64.50
Total Variable Costs:	\$262.00	\$262.00	\$262.00	\$266.50	\$262.00	\$262.00	\$262.00	\$266.50
Fixed Costs								
Tree: Eastern Black Walnut	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00	\$26.00
Crop: Hay	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00	\$34.00
Total Fixed Costs:	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00
Net Income/(loss)	\$141.00	\$141.00	\$141.00	\$136.50	\$141.00	\$141.00	\$141.00	\$1,136.50

Practice: Alley Cropping
Species: Black Walnut
Crop: Hay

Price Basis: \$/acre/year
Spacing: 30x30

Appendix E: Calculations

Net Present Value (NPV) is an estimate of the current value of all future incomes from an investment. To determine net present value, future net incomes or net losses, called cashflows, must be discounted to reflect the fact that a dollar today will purchase more than a dollar in the future.

$$NPV = cashflow_0 + cashflow_1 \left[\frac{1}{(1+i)^1} \right] + cashflow_2 \left[\frac{1}{(1+i)^2} \right] + \dots + cashflow_n \left[\frac{1}{(1+i)^n} \right]$$

Where:

NPV = Net Present Value

cashflow_n = net income or net loss for the year “n,” for example *cashflow₁* is the net income from the first full year of production.

i = discount rate, or the opportunity cost of investing. For example, the dollars could have been invested in the stock market with an expected return of 14 percent instead of being invested in an agroforestry practice, therefore, the opportunity cost of the agroforestry practice would be 14 percent.

n = number of years included in the budget.

Internal Rate of Return (IRR) uses the same equation as net present value; however, instead of solving for the NPV, an arbitrary NPV of \$0 is assumed. The discount rate becomes the unknown variable in the equation. The “*i*” now represents the rate at which all discounted cashflow will equal zero. Or, in other words, the rate at which future incomes will return the initial investment (*cashflow₀*).

$$0 = cashflow_0 + cashflow_1 \left[\frac{1}{(1+i)^1} \right] + cashflow_2 \left[\frac{1}{(1+i)^2} \right] + \dots + cashflow_n \left[\frac{1}{(1+i)^n} \right]$$

Since *cashflow₀* is not affected by the variability of the discount factor, it is moved to the other side of the equation.

$$- cashflow_0 = cashflow_1 \left[\frac{1}{(1+i)^1} \right] + cashflow_2 \left[\frac{1}{(1+i)^2} \right] + \dots + cashflow_n \left[\frac{1}{(1+i)^n} \right]$$

Annual Equivalent Value (AEV) modifies the equation used in the other two indicators. The AEV calculates an annuity (or an annual set payment) that would give the equivalent net present value at the same discount rate. The equation used in the NPV calculation assumes varying cashflows for each year. The AEV equation assumes that the cashflow is the same each year; therefore, the equation can be modified as follows:

$$NPV = Cashflow \left[\sum_{t=1}^n \frac{1}{(1+i)^t} \right]$$

To calculate the AEV using this equation, the *NPV*, *n*, and *i* must be known. The *cashflow* is the annual equivalent value that is being calculated. The above equation can be manipulated as follows:

$$Cashflow = \left[\frac{NPV}{\sum_{t=1}^n \frac{1}{(1+i)^t}} \right]$$

Although this looks like a difficult equation, the summation portion (annuity discount factor) of the equation can be simplified as follows:

$$\sum_{t=1}^n \frac{1}{(1+i)^t} = \frac{1}{i} - \frac{1}{i(1+i)^n}$$

To show how this equation works, let's assume that we have budgeted for an agroforestry practice using the enterprise and cashflow plans described in this paper. Assuming that the opportunity cost of investing in this practice is 8 percent and the planning horizon is 50 years, we calculated that the $NPV_{(8\%, 50)}$ is \$1,200. To calculate the AEV, all we need to do is estimate the annuity discount factor shown above and divide that factor into the NPV.

$$\frac{1}{.08} - \frac{1}{.08(1+.08)^{50}} \rightarrow 12.5 - \frac{1}{.08(46.902)} \rightarrow 12.5 - \frac{1}{3.752} \rightarrow 12.5 - 0.2665 \rightarrow \underline{12.233}$$

$$Cashflow = \frac{NPV}{12.233} \rightarrow \frac{\$1,200}{12.233} = \underline{\$98.00}$$

This indicates that the series of cashflows expected with this practice have the same net present value as an annuity that pays \$98 per year. This does not, however, reflect the variability of those cashflows or the time it takes to start generating positive cashflows.

Most spreadsheet programs have these equations programmed in. However, it is good to understand what the equation is doing and what the indicator is telling you. Misinterpreted financial indicators can lead to bad decisions.



**Produced by the
University of Missouri Center for Agroforestry**

Gene Garrett, Ph.D., Director
203 ABNR Columbia, MO 65211

Technology Transfer and Outreach Unit

Michael Gold, Ph.D., Associate Director
Larry D. Godsey, Economist
Dusty Walter, Technical Training Specialist
Julie Rhoads, Events Coordinator
Michelle Hall, Sr. Information Specialist

For more information, visit www.centerforagroforestry.org
(573) 884-2874; umca@missouri.edu



This work was funded through the University of Missouri Center for Agroforestry under cooperative agreements 58-6227-5-029, 58-6227-2-008 and 58-6227-5-028 with the United States Dept. of Agriculture (USDA) Agricultural Research Service. Special recognition is given to the USDA, ARS, Dale Bumpers Small Farms Research Center, Booneville, Ark. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the USDA.