

AGRICULTURAL GUIDE

Published by the University of Missouri-Columbia Extension Division

Timber

NOV 05 1984

Determining the profitability of timber stand improvement investments

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You can increase the financial return from a tract (stand) of Missouri forest land by improving tree quality and woodland composition. Timber Stand Improvement (TSI) includes a broad range of practices: site preparation, thinning, release, pruning, and vine and weed removal. Guide 5150, "Increasing Woodland Products Through Timber Stand Improvement" provides information about these TSI practices.

Because Missouri woodland owners most commonly practice thinning, this guide sheet is restricted to that TSI practice. But the information applies to any practice option you are considering.

Deciding to invest in Timber Stand Improvement (TSI) practices to improve the productivity of your woodlands is sometimes difficult. These practices cost now, but you won't benefit from the increased growth and quality of the remaining stand until you sell the timber sometime in the future. Making wise TSI investment decisions depends not only upon the success of the practice but also on costs, number of years between thinning and harvest, future product values, alternative investment opportunities, government cost-sharing assistance, and income tax provisions. Planning a TSI practice is not so difficult if you consider those factors affecting its economic success.

TSI costs

Typical costs include paying for an evaluation of your woodlands, marking stand boundaries, designating trees to be saved or removed, removing or killing designated trees, and carrying charges.

Carrying charges are costs of holding the TSI investment over time. For example, assume that you borrowed money to pay for the TSI operation and did not repay the loan until the timber was sold. Then, the carrying charge is the interest charge for using the borrowed money. Obviously, if you can shorten the investment period, total interest accumulation is reduced.

TSI benefits

With TSI, the goal is concentrating diameter growth on the higher-valued vigorously growing trees. Economic benefits from thinning are increased stand quality through tree improvement and faster diameter growth on the remaining crop trees. These economic benefits may also reduce the investment period.

The key to calculating TSI benefits is an accurate estimation of the increased growth and product quality that will result from TSI practice application. That means you need to compare anticipated product yields with and without the treatment.

Investment analysis

To analyze TSI benefits, we have calculated the internal rate of return (IRR) earned on the TSI investment. IRR is the average interest rate earned on a cost(s) during the life of an investment. For evaluating a TSI investment, IRR is the interest rate you need for the sum of the treatment cost plus accumulated *interest* charges to just equal the net benefits from TSI. Calculating IRR yields the interest rate you would obtain from the TSI investment, much the same as a savings account or similar investment.

Only consider those costs and revenues that directly relate to the TSI practice. So ignore past costs (land purchase, site preparation, planting, or any other management practices). The benefit you want to measure is the difference in value between untreated and treated stands.

Note: This is not the same as the difference between present stand value and future stand value.

Use current stumpage prices to estimate the value of the net growth of timber you can attribute to TSI. Doing the estimation this way counters the influence of inflation, which could overshadow the true economic effect of TSI. Prices will not actually stay the same through time, but this procedure yields a measure of investment performance

known as a *real interest rate*. Real interest rate expresses the annual percentage at which the TSI investment increases over and above the percent of inflation.

The effects of federal cost sharing complicates your analysis of a TSI investment. The following example illustrates calculation of the IRR on a TSI investment both with and without government cost sharing. You can see that cost sharing substantially increases the return you receive on your TSI investment through a reduction in early out-of-pocket costs. It has the effect of reducing the amount of money borrowed for a long period of time.

Evaluating a TSI investment

Technical advice can be obtained from a local office of the Missouri Department of Conservation or a consulting forester.

Step 1. Calculate present stand conditions (per acre). Assume that a 40-year-old stand of black and scarlet oaks has a basal area¹ of about 110 square feet per acre. The site index² for black oak is 70. The stand will be harvested at an age of 60 years.

Step 2. Calculate future stand conditions (per acre). To determine merchantable volume, measure trees as 16-foot sawlogs up to an 8-inch top. Estimate cordwood volume from the top material. The assistance of a professional forester can be invaluable at this point.

Step 2a. Calculate future stand conditions without TSI. You can expect merchantable volume (per acre) to be 8,444 board feet of sawtimber and 5.5 cords of cordwood at a harvest age of 60 years.

Using a value of \$50 per thousand board feet (m.b.f.) for sawtimber and \$4 per cord for cordwood, determine the future value per acre for the material removed from an untreated stand at final harvest.

In this example, the final harvest value from an untreated stand at age 60 years is \$444.20.

| Product | Volume | Stumpage price | Value |
|--------------|---------------|----------------|--------------------|
| Sawtimber | 8,444 b.f./a. | \$50/m.b.f. | \$422.20/a. |
| Cordwood | 5.5 cords/a. | \$ 4/cord | \$ 22.00/a. |
| Total | | | \$444.20/a. |

Step 2b. Calculate the cost of thinning. TSI costs include both fixed and variable costs. In the example, management and overhead costs of the thinning practice are fixed at \$6.00 per acre. Actual TSI costs vary per acre according to the amount of material removed or deadened, method of control (mechanical or chemical), distance traveled, size of area treated and the prevailing wage rate. Assume that these costs are \$24.00 per acre. So the total cost is \$30.00 per acre.

Step 2c. Calculate future stand conditions with TSI. Merchantable volume (per acre) increases at a faster rate in the treated stand because of thinning. In the example, thinning reduced the 110-square-foot basal area per acre of the 40-year-old stand to 70-square-foot basal area per acre.

¹Square feet of area occupied by all the tree trunks on an acre measured 4.5 feet above the ground.

²Typical tree height at age 50 years.

Thus, you could expect a different mix of sawtimber and cordwood volumes than in an untreated stand at final harvest. Furthermore, you might expect a slightly higher sawtimber price because of quality. Sawtimber price for the treated stand is 10 percent higher to reflect higher quality material.

Using a value of \$55 per thousand board feet for sawtimber and \$4 per cord for cordwood, determine the future value per acre for the material removed from a treated stand at final harvest.

In this example, the final harvest value from a treated stand at age 60 years is \$571.03 per acre. Note that the harvest age for both untreated and treated stand conditions is the same—60 years—to make a valid comparison.

| Product | Volume | Stumpage price | Value |
|--------------|----------------|----------------|--------------------|
| Sawtimber | 10,186 b.f./a. | \$55/m.b.f. | \$560.23/a. |
| Cordwood | 2.7 cords/a. | \$ 4/cord | \$ 10.80/a. |
| Total | | | \$571.03/a. |

Step 2d. Calculate net gain from TSI. The difference in final harvest values between the treated and untreated stand conditions represents the net gain from TSI. In the example, this gain is

| | Final harvest value |
|--------------------------|---------------------|
| With TSI | \$571.03 |
| Without TSI | \$444.20 |
| Net gain from TSI | \$126.83 |

Step 3. Compute the rate of return on the TSI investment without cost-sharing. The TSI investment is like a savings account. For example, suppose you invest \$30.00 per acre (TSI cost) at compound interest in a savings institution. In 20 years, you withdraw the principal and interest and receive \$126.83 per acre (gain from TSI). The question is: **At what interest rate were your funds invested?**

Posed another way, look at the TSI investment as if it were borrowed money. Suppose you borrow the \$30.00 per acre to conduct TSI and 20 years later repay \$126.83 per acre. **At what interest rate were the funds borrowed?**

You can easily determine the rate of return by calculating a valuation factor. Then, find an approximation of this factor in the accompanying table for determining the rate of return.

- To calculate the valuation factor, divide the net gain from TSI by the investment cost.

$$\text{Valuation factor} = \frac{\text{Net gain from TSI}}{\text{Investment cost}} = \frac{\$126.83}{\$ 30.00} = 4.23$$

The valuation factor is 4.23.

- Turning to the table and looking in the left-hand column, **first** find the period of time over which you would hold the TSI investment. In this example, the period is 20 years.
- Reading across the columns along the 20-year line, find an approximation of the valuation factor. You'll find it between 3.87 and 4.66.
- At the tops of these two columns, you should find interest rates of 7 and 8 percent. Thus, you can expect the annual rate of return on these TSI investments to be about 7.5 percent per year. Remember that this procedure calculates the *real* rate of return which is above the rate of inflation. So if inflation averaged 4 percent annually

Valuation factors for determining the return on an investment.

| Length of investment (years) | Percent of interest | | | | | | | | | | | | | | | |
|---------------------------------|---------------------|------|------|------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|--------|--------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 20 |
| 1 | 1.01 | 1.02 | 1.03 | 1.04 | 1.05 | 1.06 | 1.07 | 1.08 | 1.09 | 1.10 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.2 |
| 2 | 1.02 | 1.04 | 1.06 | 1.08 | 1.10 | 1.12 | 1.14 | 1.17 | 1.19 | 1.21 | 1.2 | 1.3 | 1.3 | 1.3 | 1.3 | 1.4 |
| 3 | 1.03 | 1.06 | 1.09 | 1.12 | 1.16 | 1.19 | 1.23 | 1.26 | 1.30 | 1.33 | 1.4 | 1.4 | 1.4 | 1.5 | 1.5 | 1.7 |
| 4 | 1.04 | 1.08 | 1.13 | 1.17 | 1.22 | 1.26 | 1.31 | 1.36 | 1.41 | 1.46 | 1.5 | 1.6 | 1.6 | 1.7 | 1.7 | 2.1 |
| 5 | 1.05 | 1.10 | 1.16 | 1.22 | 1.28 | 1.34 | 1.40 | 1.47 | 1.54 | 1.61 | 1.7 | 1.8 | 1.8 | 1.9 | 2.0 | 2.5 |
| 6 | 1.06 | 1.13 | 1.19 | 1.27 | 1.34 | 1.42 | 1.50 | 1.59 | 1.68 | 1.77 | 1.9 | 2.0 | 2.1 | 2.2 | 2.3 | 3.0 |
| 7 | 1.07 | 1.15 | 1.23 | 1.32 | 1.41 | 1.50 | 1.61 | 1.71 | 1.83 | 1.95 | 2.1 | 2.2 | 2.4 | 2.5 | 2.7 | 3.6 |
| 8 | 1.08 | 1.17 | 1.27 | 1.37 | 1.48 | 1.59 | 1.72 | 1.85 | 1.99 | 2.14 | 2.3 | 2.5 | 2.7 | 2.9 | 3.1 | 4.3 |
| 9 | 1.09 | 1.20 | 1.30 | 1.42 | 1.55 | 1.69 | 1.83 | 2.00 | 2.17 | 2.36 | 2.6 | 2.8 | 3.0 | 3.3 | 3.5 | 5.2 |
| 10 | 1.10 | 1.22 | 1.34 | 1.48 | 1.63 | 1.79 | 1.97 | 2.16 | 2.37 | 2.59 | 2.8 | 3.1 | 3.4 | 3.7 | 4.0 | 6.2 |
| 11 | 1.12 | 1.24 | 1.38 | 1.54 | 1.71 | 1.90 | 2.10 | 2.33 | 2.58 | 2.85 | 3.2 | 3.5 | 3.8 | 4.2 | 4.7 | 7.4 |
| 12 | 1.13 | 1.27 | 1.43 | 1.60 | 1.80 | 2.01 | 2.25 | 2.52 | 2.81 | 3.14 | 3.5 | 3.9 | 4.3 | 4.8 | 5.4 | 8.9 |
| 13 | 1.14 | 1.29 | 1.47 | 1.67 | 1.89 | 2.13 | 2.41 | 2.72 | 3.07 | 3.45 | 3.9 | 4.4 | 4.9 | 5.5 | 6.2 | 10.7 |
| 14 | 1.15 | 1.32 | 1.51 | 1.73 | 1.98 | 2.26 | 2.58 | 2.94 | 3.34 | 3.80 | 4.3 | 4.9 | 5.5 | 6.3 | 7.1 | 12.8 |
| 15 | 1.16 | 1.35 | 1.56 | 1.80 | 2.08 | 2.40 | 2.76 | 3.17 | 3.64 | 4.18 | 4.8 | 5.5 | 6.3 | 7.1 | 8.1 | 15.4 |
| 16 | 1.17 | 1.37 | 1.60 | 1.87 | 2.18 | 2.54 | 2.95 | 3.43 | 3.97 | 4.59 | 5.3 | 6.1 | 7.1 | 8.1 | 9.4 | 18.5 |
| 17 | 1.18 | 1.40 | 1.65 | 1.95 | 2.29 | 2.69 | 3.16 | 3.70 | 4.33 | 5.05 | 5.9 | 6.9 | 8.0 | 9.3 | 10.8 | 22.2 |
| 18 | 1.20 | 1.43 | 1.70 | 2.03 | 2.41 | 2.85 | 3.38 | 4.00 | 4.72 | 5.56 | 6.5 | 7.7 | 9.0 | 10.6 | 12.4 | 26.6 |
| 19 | 1.21 | 1.46 | 1.75 | 2.11 | 2.53 | 3.03 | 3.62 | 4.32 | 5.14 | 6.12 | 7.3 | 8.6 | 10.2 | 12.1 | 14.2 | 31.9 |
| 20 | 1.22 | 1.49 | 1.81 | 2.19 | 2.65 | 3.21 | 3.87 | 4.66 | 5.60 | 6.73 | 8.1 | 9.6 | 11.5 | 13.7 | 16.4 | 38.3 |
| 21 | 1.23 | 1.52 | 1.86 | 2.28 | 2.79 | 3.40 | 4.14 | 5.03 | 6.11 | 7.40 | 8.9 | 10.8 | 13.0 | 15.7 | 18.8 | 46.0 |
| 22 | 1.24 | 1.55 | 1.92 | 2.37 | 2.93 | 3.60 | 4.43 | 5.44 | 6.66 | 8.14 | 9.9 | 12.1 | 14.7 | 17.9 | 21.6 | 55.2 |
| 23 | 1.26 | 1.58 | 1.97 | 2.46 | 3.07 | 3.82 | 4.74 | 5.87 | 7.26 | 8.95 | 11.0 | 13.6 | 16.6 | 20.4 | 24.9 | 66.2 |
| 24 | 1.27 | 1.61 | 2.03 | 2.56 | 3.23 | 4.05 | 5.07 | 6.34 | 7.91 | 9.85 | 12.2 | 15.2 | 18.8 | 23.2 | 28.6 | 79.5 |
| 25 | 1.28 | 1.64 | 2.09 | 2.67 | 3.39 | 4.29 | 5.43 | 6.85 | 8.62 | 10.83 | 13.6 | 17.0 | 21.2 | 26.5 | 32.9 | 95.4 |
| 26 | 1.30 | 1.67 | 2.16 | 2.77 | 3.56 | 4.55 | 5.81 | 7.40 | 9.40 | 11.92 | 15.1 | 19.0 | 24.0 | 30.2 | 37.9 | 114.5 |
| 27 | 1.31 | 1.71 | 2.22 | 2.88 | 3.73 | 4.82 | 6.21 | 7.99 | 10.25 | 13.11 | 16.7 | 21.3 | 27.1 | 34.4 | 43.5 | 137.4 |
| 28 | 1.32 | 1.74 | 2.29 | 3.00 | 3.92 | 5.11 | 6.65 | 8.63 | 11.17 | 13.42 | 18.6 | 23.9 | 30.6 | 39.2 | 50.1 | 164.8 |
| 29 | 1.33 | 1.78 | 2.36 | 3.12 | 4.12 | 5.42 | 7.11 | 9.32 | 12.17 | 15.86 | 20.6 | 26.7 | 34.6 | 44.7 | 57.6 | 197.8 |
| 30 | 1.35 | 1.81 | 2.43 | 3.24 | 4.32 | 5.74 | 7.61 | 10.06 | 13.27 | 17.45 | 22.9 | 30.0 | 39.1 | 51.0 | 66.2 | 237.4 |
| 35 | 1.42 | 2.00 | 2.81 | 3.95 | 5.52 | 7.69 | 10.68 | 14.79 | 20.41 | 28.10 | 38.6 | 52.8 | 72.1 | 98.1 | 133.2 | 590.7 |
| 40 | 1.49 | 2.21 | 3.26 | 4.80 | 7.04 | 10.29 | 14.97 | 21.72 | 31.41 | 45.26 | 65.0 | 93.1 | 132.8 | 188.9 | 267.9 | 1469.8 |
| 45 | 1.56 | 2.44 | 3.78 | 5.84 | 8.99 | 13.76 | 21.00 | 31.92 | 48.33 | 72.89 | 109.5 | 164.0 | 244.6 | 363.7 | 538.8 | 3657.3 |
| 50 | 1.64 | 2.69 | 4.38 | 7.11 | 11.47 | 18.42 | 29.46 | 46.90 | 74.36 | 117.39 | 184.6 | 289.0 | 450.7 | 700.2 | 1083.7 | 9100.4 |

during the 20-year investment period, the rate of return for comparative purposes would be the sum $7.5 + 4.0 = 11.5$ percent. This figure is called the *nominal* rate of return. This rate would be comparable to a savings or investment institution.

Step 4. Compute the rate of return on the TSI investment with cost-sharing. Federal sharing of TSI costs is available through the Forestry Incentives Program (FIP) administered by the USDA Agricultural Stabilization and Conservation Service (ASCS). Offices are located in most Missouri counties. As previously indicated, the rate of return on qualified practices that are applied with shared costs is substantially greater than without cost-sharing.

"Improving a stand of forest trees - FIP 2," as used in the example, is a qualified practice. The federal government has commonly paid about 65 percent of the cost of deadening or removing the unwanted trees to increase timber growth or improve timber quality, if the landholding is greater than 10 acres but not larger than 1,000 acres. For the example, with 65 percent cost-sharing, the government will pay $\$30.00 \times .65 = \19.50 per acre for applying the TSI practice.

• Computing the rate of return with cost-sharing assistance is the same as without cost-sharing, except in the way you calculate the valuation factor. With cost-sharing assistance, your TSI cost should be reduced by the amount of government cost-share. Thus, the adjusted investment cost would be $\$30.00 - \$19.50 = \$10.50$. Calculate the valuation factor as before, but use the adjusted investment cost. The net gain from TSI has not changed.

$$\text{Valuation factor} = \frac{\$126.83}{\$10.50} = 12.08$$

- Find the 20-year investment period in the table.
- Reading across the columns along the 20-year line, find an approximation of the valuation factor. In this instance, you will find it between 11.5 and 13.7.
- At the tops of the two columns, you should find interest rates of 13 and 14 percent. The annual rate of return earned on this TSI investment is near 13.5 percent per year. As in the previous example, this procedure yields the *real* rate of return which does not include inflation. So you need to add the average rate of inflation over the life of the investment to this rate for estimating the *nominal* rate ($13.5 + 4.0 = 17.5$ percent).

Step 5. TSI investment decision. When you're deciding whether to invest in a TSI practice, compare the estimated rate of return from the TSI investment to the rate of return from alternate investment opportunities. Use the *nominal* rate of return from the TSI investment for comparative purposes because most returns from alternate investments are expressed as a *nominal* rate.

Actually, deciding is easy. Your decision involves selecting the investment alternative yielding the greatest return. The estimated *nominal* rate of return computed in the example of TSI investment without cost-sharing (Step 3) was approximately 11.5 percent. Therefore, if an investment alternative (for example, some utility stocks) return greater than 11.5 percent, then you might reject the TSI investment in favor of the alternative. However, the estimated *nominal* rate of return for the TSI investment with cost-sharing (Step 4) would be near 17 percent. Thus, if 65 percent cost-sharing were available and the practice qualified, your best economic interest would be to invest in the TSI practice.

Summary

Become informed about woodland management and income tax treatment of woodland costs and income, so you'll make a sound decision. Guide 740 "Maintaining Woodland Tax Records" and Guide 750 "Capital Gains Taxation of Woodland Income" explain the income tax benefits of woodland management. Also, USDA Forest Service Agriculture Handbook 596 "A Guide to Federal Income Tax for Timber Owners" covers the details of reporting timber sale receipts and expenditures when you file your Federal income tax return.

This investment analysis gives you and your forester a way of economically evaluating the use of a TSI program. Wildlife habitat enhancement, tree planting, and timber harvesting as well as TSI practices may all be part of an overall management plan. Often, a timber sale, in the form of an improvement cut, can accomplish many goals of your TSI program and also provide you with income. As in other businesses, timber management requires a long-term commitment rather than short-term gains from premature liquidation of resources.

Economically analyzing your TSI investments can help you make sound decisions leading to improved timber management and better wood products for everyone's use.