FINANCIAL FEASIBILITY OF SIMULTANEOUS PRODUCTION OF PINE SAWLOGS, FORAGE, AND MEAT GOATS ON SMALL FARMS IN ALABAMA: A PRELIMINARY ANALYSIS

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ABSTRACT

Small and limited resource farmers and landowners in the Alabama Black Belt region face many challenges as they seek to make their farms and forestlands profitable, productive and environmentally sustainable. A host of problems—farmland conversion, urbanization pressures, reductions in water quality and availability, soil erosion, irregular cash flows, and increased government regulation—make managing family farms or forestland a difficult task. In response to these challenges, many farmers and landowners are considering agroforestry as an opportunity to increase land productivity and to improve their cash flows by combining income from agriculture, forestry, and animal production on the same piece of land. The objective in this paper was to conduct economic evaluations of agroforestry practices so that landowners, extension personnel, and other decision makers can correctly assess the potential of agroforestry practices among the many land-use options. The data analyzed were collected from a four year silvopastoral study conducted in the Black Belt region, on the property of the Federation of Southern Cooperatives in Epes, Alabama.

INTRODUCTION

Small scale limited resource farmers and forest landowners in the southeast U.S. are currently facing viability problems due to competition from cheap markets abroad, in addition to lack of capital for inputs, labor, and access to improved and sustainable technologies to diversify their operations. Other challenges faced by these farmers include loss of land due to urbanization and lack of appropriate technologies to increase farm productivity and profitability on small and medium sized farms, while meeting requirements for environmental and ecological sustainability. In the southeastern United States, the standard practice has been to plant and grow southern pines in "fully stocked" plantations. This production method has worked in large part because there has been a strong domestic market for pulpwood which allowed pine plantations to be commercially thinned. Unfortunately for forest landowners, the pulpwood market in the southeast is now vanishing overseas, especially to South America (Wear and Greis, 2002), making it difficult for forest landowners to generate a profit or even pay for the cost of mid-rotation thinning that are needed to maintain stand vigor, produce quality sawlogs, and reduce susceptibility to insect attacks and wildfires. Similarly, in the agricultural sector, it continues to be a struggle for limited resource and minority landowners to make a profit from conventional agriculture. The above challenges present a need to develop and evaluate environmentally sustainable strategies for increasing productivity and profitability on small scale and limited resource farmers and forest landowners in the southeast United States. Silvopasture may offer a way to address some of these issues.

Silvopasture is an agroforestry practice, which combines spatial and rotational growth of timber, forage, and livestock (Nowak, Blount, and Workman, 2008; Zinkhan and Mercer 1997). The system presents an opportunity to increase land productivity and to improve cash flow by combining income from agriculture, forestry, and animal production on the same piece of land. Silvopasture can be established either by planting trees in an improved pasture, or by thinning a tree stand and planting improved forage. Special tree arrangements in silvopastures allow for tree and forage growth, as well as for grazing livestock

(Nowak, Blount, and Workman, 2008). Benefits to the farmer include income generation while converting from crop to timber (or vice versa), improvement in water quality, wildlife habitat, and soil erosion control. In the Southeast, these systems vary from rotational grazing in pine forests or plantations, to intentional grazing under hardwoods and pecan orchards. Providing management of the three components of livestock, forage and trees, silvopasture has historically occurred as shade trees in pasture, as grazed orchards or woodlands, and as rangelands that include a managed tree or shrub component (Clason and Sharrow 2000; Robinson and Clason 1997; Williams et al. 1997).

Although in the southeastern US silvopasture has been successfully established for cattle production (Pearson 1997), combinations with goats are becoming of interest to many smallholder and limited resource farmers. Incorporating goat enterprises is an excellent strategy that offers an alternative to utilizing forage and vegetation which is otherwise "wasted". Since they are very active grazers, goats offer the potential for biological control of unwanted vegetation in pastures and forests, which reduces dependence on certain herbicides and also reduce weed and brush competition for water and nutrients with trees. Due to environmental concerns and elevated costs of other control methods such as mechanical cutting and herbicide application, the role of grazing goats as biological control agents can add to the overall profitability and sustainability of the silvopasture enterprise. Meat goat production can be appealing to smallholder and limited resource farmers because the necessary economic inputs are comparatively modest compared to, dairy cows and beef cattle, for example. In addition, goat life cycles are short which enhances cash flow, land requirements are modest, goats can be productive in a range of environments, they prefer the variety of feedstuffs found on many farms, and prices are adequate to produce a reasonable profit. Indeed, meat goat production is so attractive to limited resource farmers in the southeast because of the marked increase in ethnic populations whose diets traditionally include goat meat and other groups who use goat meat during cultural and religious events. Thus, the demand for goat meat in the US in general and the southern region in particular, is projected to continue expanding.

Despite the potential benefits for goat production in the southeast US, there is lack of information on how to profitably and sustainably raise goats in loblolly pine plantations in this region. This paper illustrates the financial feasibility of a land owner's decision of simultaneous production of pine sawlogs, forage, and meat goats as a way to increase productivity, profitability and sustainability on small and medium sized farm in the Alabama Black Belt region. In addition, the fact that a significant number of people staying on rural farms consist of an aging population, which favors a shift from cattle to smaller sized animal production due to their ease of handling presents an opportunity for diversification into new and innovative farming systems. The rest of the paper is organized as follows. First, a review of the literature followed by the assumptions used in the financial analysis is presented. Then, the study experiment, data and methods are discussed. The estimated results, sensitivity analysis and conclusions are presented in the last sections.

LITERATURE REVIEW

Definition of agroforestry

Agroforestry is a farming system that integrates crops and/or livestock with trees and shrubs. In the U.S., agroforestry is defined as an intensive land-use management system that optimizes physical, biological, ecological, economic, and social benefits from bio-physical interactions created when trees and/or shrubs are deliberately combined with crops and/or livestock (Logan, 1983; Gold et al., 2000). The resulting biological interactions provide multiple benefits, including diversified income sources, increased biological production, enhanced water quality, and improved habitat for both humans and wildlife (Beetz, 2002). Agroforestry practices in use in the U.S. include silvopasture, alleycropping, windbreaks and shelterbelts, riparian buffer strips, and forest farming. Products from an agroforestry enterprise include timber, livestock, grain crops, specialty crops, herbs and medicinal plants, mushrooms, nuts, firewood, biomass feedstocks, pinestraw mulch, honey, and fodder.

Silvopasture is an agroforestry system that incorporates timber and livestock production on the same piece of land. Trees such as hardwoods, nut trees, and pines are planted in single or multiple rows, and livestock graze between them (Beetz, 2002). One of the major reasons which have been cited against the adoption of silvopasture systems include risk of tree damage by livestock (Sharrow, 1994). However, research has shown that livestock damage to trees can be avoided by properly designing and managing silvopasture systems (Sharrow et al., 1992).

Benefits of agroforestry

Benefits of agroforestry, when compared to agricultural fields without any tree cover, include provision of shelter from wind or sun for livestock, providing wildlife habitat, controlling soil erosion, and improving soil fertility when legumes are included in the system. In addition, agroforestry practices often have a "park-like" appearance, thereby making them more socially acceptable than traditional forest plantations, especially near urban centers where land use must be sensitive to visual appeal. Since agroforestry systems promote higher biodiversity, they may require little pesticide or fertilizer use, thereby making them more environmentally sustainable compared to traditional agricultural and forestry practices. With good grazing management, for example, herbicides and mowing may become unnecessary. Increased tree growth in silvopasture agroforestry compared to traditionally managed forests has been reported (Sharrow, 1994). This has often been attributed to reduced competition between trees and other ground vegetation for soil moisture (Doescher, et al., 1989).

Agroforestry systems have a better potential to sequester carbon compared to traditional monocrop agricultural land-use systems. Terrestrial ecosystems can store carbon in the form of above ground living biomass, decomposing litter, and roots in the soil (Schlesinger, 1995; Six et al., 2002; Cambardella et al., 2005). In addition, woody biomass and soil are large sinks for sequestering atmospheric carbon, with biomass carbon being transferred to above ground forest litter before entering the soil as organic matter in various stages of decomposition. According to Davis and Condron (2002), afforestation of grasslands provides an opportunity for partial mitigation of increasing CO_2 levels in the atmosphere through carbon fixation in the form of plant biomass.

Carbon sequestration is now a recognized important environmental benefit of afforestation (Vesterdal et al., 2002). Unlike conventionally-tilled agricultural systems which are net sources of both nitrogen and carbon emissions (Davidson and Ackerman, 1993; Cambardella and Elliot, 1994), grasslands, young forests and agroforests (Maikhuri et al., 2000; Kaur et al., 2000) generally accumulate organic matter. After the ratification of the Kyoto Protocol in 1990, afforestation of former arable land has been acknowledged as a land-use change that contributes to the mitigation of increasing atmospheric CO_2 concentrations (IPCC, 2000). Reports by Johnson (1992) suggest that reversion of former agricultural land to forests usually results in substantial increases in soil C. Estimates by Bouwman and Leemans (1995) assume that 50 Mg C ha^{-1} would be sequestered in afforested soils in 30 years. In Puerto Rico, soil organic C increased by 0.8 to 4.0 Mg C ha^{-1} yr^{-1} during secondary forest succession on land previously cultivated for 100 to 300 years (Lugo and Sanchez, 1986). Agroforestry offers the greatest potential for C sequestration in both forest and agricultural soils. Silvopastoral systems which combine managed pastures with forest trees and livestock can accrete more C and N than sole pasture or timber plantations because they may produce more total annual biomass and have both forest and grassland nutrient cycling patterns active (Paul et al., 2002; Sharrow and Ismail, 2003).

Grazing also enhances nutrient cycling and reduces commercial fertilizer costs; the animals remove few nutrients, and their waste is a valuable nutrient input for the trees. Well-managed grazing will increase organic matter and improve soil physical, chemical, and biological properties. Converting some of the land use in the southeastern U.S. into agroforestry land-use systems will provide biomass needed to supply carbon to the soil which will improve soil organic matter. Soil organic matter is in a way an indicator of soil fertility based on the fact that it improves soil physical, chemical, and biological properties that affect vital ecosystem processes of soils (Hopmans, et al., 2005).

METHODS

Study Design

In May 2006, a silvopasture experiment study was established on a six hectare loblolly pine stand in the “Black Belt” region, on the property of the Federation of Southern Cooperatives[1] in Epes, Alabama. The 8-year-old loblolly pine stand was thinned by removing 75 percent of the trees (from 600 to 200 trees per acre), so that a goat silvopasture research site could be established. Paddocks were fenced out and treatments consisting of 0, 4, and 8 goats per acre stocking rates and an enhanced soil management treatment with 6 goats per acre were established (Table 1).

Table 1. List of treatments

Treatment	Description
T1	Control (existing vegetation without grazing)
T2	Existing vegetation + low stocking rate (LOW) – 4 goats/ac
T3	Existing vegetation + browse enhancement (EHP) – 6 goats/ac
T4	Existing vegetation + high stocking rate (HI) – 8 goats/ac

Study Assumptions

The silvopasture investment returns presented in this preliminary analysis are based on the following management assumptions:

1. The financial projections that serve as the foundation for the cost-share analyses utilize a Southern loblolly pine plantation. The plantation grown is located on average quality land in the Alabama Black Belt region. The site index—measure of soil productivity—of the timberland is 60 feet at a base age of 25. This means that the dominant trees will be 60 feet tall when they reach 25 years of age. This is a typical site index for loblolly pines in the southeast US.

[1] The Federation is comprised of over 100 black farmer cooperatives located in the Southeast.

2. In this analysis, it is assumed that the landowner was interested in growing trees for large sawtimber. The analysis is based on a forest management regime that utilizes two thinning prior to the final harvest. The first thinning is performed in year 8, the earliest feasible point in this rotation. This timing is due to harvesting limitations that require the thinning to produce a minimum of 26 tons (~10 cords) of fiber per acre to ensure an economically viable logging operation. The second thinning is conducted in year 17, and the final tree harvest occurs at an optimal rotation length of 30 years. This rotation length maximizes the plantation's financial return under the current management regime.
3. Harvest volume information was obtained from the growth and yield model. This model predicts cord and International 1/4 MBF (thousand board feet) volumes that were subsequently converted to tons. The cordwood volumes were converted to tons using a conversion factor of 2.68 tons per standard pine pulpwood cord. The sawtimber volumes were converted to tons using 6 tons per thousand board feet. Weight measurements are used due to prevalence in current markets and to ensure data consistency. The conversions were also necessary to standardize data for entry into the forest finance spreadsheet.
4. A silvopasture finance spreadsheet is used to calculate Net Present Value (NPV), Net Benefit Investment Ratio (NBIR), Benefit-Cost Ratio (BCR), Annualized Income (AI), and Internal Rate of Return (IRR) decision criteria. The spreadsheet utilizes prices, costs, discount rate (except for IRR), harvest volumes, and/or rotation length to solve for the decision criteria.
5. The discount rate is 6% nominal (or 2.4% real—net of inflation). This represents the anticipated return from an alternative investment, such as long-term CD's, bonds, or stocks.
6. Animal values—the price paid for live animal is $1.40 per pound. This price represents the average of Texas prices reported over a five-period (2001-2005).
7. Goat harvest occurs at an optimal rotation period of six month, meaning that the farmer produces two animal rotations per year. It is also assumed that the animal operation has a high stocking rate of 8 goats per acre.

8. The goat enterprise was introduced in the silvopasture production system in the 7th year, when the trees are mature to minimize potential tree damage from animals.

Financial Analysis

The paper analyzes preliminary economic and financial data collected from this on-going experiment. Specifically, the analysis focuses on the financial feasibility of silvopasture production system comprising of existing vegetation with 8 goats per acre (T4 in Table 1). The analysis is based on enterprise budgets developed using data collected from the experiment and several secondary sources. Enterprise budgets provide a representation of estimates of specific inputs and outflows associated with silvopasture production system. These estimates include profits in the form of cash receipts (revenues) and costs associated with production cycles pertinent to silvopasture production system. The enterprise budgets are then translated into cash flow plans. The cash flow plan provides the information necessary to assess and forecast the economic feasibility of the silvopasture practice over time. It contains all costs and benefits accruing from the project over its economic lifetime. The economic lifetime is the period over which outlays and revenues are considered in the financial evaluation. In this study, the lifetime of the project is assumed to be thirty-years.

The financial performance indicators used are discussed below but first, the central feature of financial assessments is that one needs to compare costs and benefits accruing in different time periods. The link across time periods over the project lifetime is provided by the discount rate. Its correct value in financial analyses must reflect the cost of capital to the implementer of the project. If the implementer is a net borrower (the most typical case) then the market borrowing rate provides the basis for determining the discount rate. In this study, benefits include all revenues arising from the sale of goats and tree products while costs embrace all expenditures (capital and operating) required for the silvopasture production system. The main cost categories include fixed capital costs (building and equipment), working capital, and operating costs (labor, material). The cost and benefits ensuing in different time periods are made comparable by using a discount rate. Since all benefits and costs are counted at market prices, real discount rate is used, which is derived from the nominal market interest rate and the expected rate of inflation (assumed to be 3.5%) as follows:

$$DR_r = \frac{(1+DR_n)}{(1+INFR)} - 1$$

where, DR_r and DR_n are the real and nominal discount rates, respectively, INFR is the inflation rate.

To project the long term costs and benefits of the silvopasture production system, the Net Present Value (NPV) analysis is conducted using information from the cash flow plan. The use of the NPV method in analyzing investments has been well documented (Degregori, et al., 2000). It is defined as the sum of the present values of the annual cash flows minus the initial investment. The annual cash flows are the net benefits (revenues minus costs) generated from the investment during the production cycle. These cash flows are discounted or adjusted by incorporating the uncertainty and time value of money. The formula for calculating the NPV is as follows:

$$NPV = \sum_{t=0}^{n} \frac{(B_t - C_t)}{(1+r)^t}$$

where, B_t are project benefits in period t, C_t are project costs in period t, r is the appropriate financial discount rate, and n is the number of years for which the project will operate. The basic decision rule based on NPV is that silvopasture production system should be implemented if NPV is greater than or equal to zero.

To examine the highest possible rate of return from the silvopasture production system, an Internal Rate of Return (IRR), which is the discount rate at which NPV of the enterprise becomes zero (Campbell 2003:44) is computed. A negative IRR means that costs are greater than benefits (profits) and therefore not a feasible alternative. The operating formula of calculating IRR is,

$$IRR = LDR + DTDR * \frac{NPV_L}{ADPV}$$

Where, LDR = Lower discount rate, DTDR = Difference between the two discount rate, NPV_L =Present value of cash flow at the lower discount rate, and ADPV = Absolute difference between the present value of cash flow at the two discount rates. Other measures utilized to examine the financial feasibility of the silvopasture production system include the following:

Net benefit investment ratio

The net benefit investment ratio (NBIR) is the most sensible indicator to guide decisions under conditions when the total financial requirements of feasible projects with positive NPVs exceed the available investment funds. This indicator relates the present value of the project's net benefits to the present value of the required investment costs. The indicator is calculated as:

$$NBIR\ (N/K)\ ratio = \frac{\sum_{t=1}^{t=n} \frac{N_t}{(1+i)^t}}{\sum_{t=1}^{t=n} \frac{K_t}{(1+i)^t}}$$

NBIR = Net benefit-investment ratio, N_t = Incremental net benefit in each year after stream has turned positive, K_t = Incremental net benefit in initial years when stream is negative, t = Project life. The basic decision rule using NBIR is that all projects are worth implementing for which this ratio is greater than unity.

Benefit-cost ratio

The benefit-cost ratio (BCR) is the oldest among the project performance indicators. It was widely used in the past but its popularity faded due to problems associated with it. The BCR is defined as the ratio of the present value of all benefits to the present value of the total costs, both counted over the project's entire lifetime:

$$BCR = \frac{\sum_{t=0}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+r)^t}}$$

The project should be implemented if its BCR is above or equal to 1, in other words: if the discounted benefits at least compensate for the discounted costs. There is an obvious link between the BCR and the IRR indicators. At the acceptability limit (BCR=1), the discount rate used in BCR is equal to the project's IRR. This implies that if the limited resource farmer can obtain loans at a real interest rate lower than the IRR, the BCR will be greater than 1 and thus the project will be worth implementing according to both criteria.

Annualized Income (AI)

Annualized income indicates the annual return of the investment on the basis of the discounted value for the life span of the program. The current study used the following formula for calculating the annualized income of the program:

$$D = \frac{r(NPV)(1+r)^t}{(1+r)^t - 1}$$

Where, D=Annualized income, r=discount rate, t=Lifespan of the project

Finally, sensitivity analysis is conducted to assess the risks or likelihood of financial failure. It provides more specific and strategically useful information than profit margin. Sensitivity can most easily be measured as the percentage change in a cost, value or parameter required to reduce net revenue to zero, or reduce returns to land, labor and capital to unacceptable levels. The likelihood or risk of such changes taking place can then be assessed. In this study, two variables that carry considerable uncertainty for silvopasture production system are sales prices (for both animals and tree products) and the discount factor. The sensitivity analysis for price changes was carried out at 4% and 8% and 10% rates.

RESULTS

First, the itemized costs incurred were in the form of transplantation cost, maintenance cost, labor, seed/seedling cost, etc. In the last year (30th year) only maintenance cost were borne and was $50 for the tree enterprise and $620.43 for the goat enterprise for a total of $670.43 in the last year (Table 2). On the other hand, the benefits are the value of the goats sold each year and the revenue from the timber products (Pulpwood, Chip-N-Saws and Sawtimber) sold during the 30th year, estimated at approximately $2,853 (Table 3).

Table 2. Estimated cost for silvopasture production system combining trees and meat goats

Year	OPERATION	Comments	Cost/Acre
0	Management plan	By professional	$65.00
0	Site Preparation	Scrub (to clear)	$300.00
0	Fencing	5-strand barbed wire(installed)	$1,290.00
0	Planting	Actual plants & planting	$400.00
2,4,6	Pruning	Form pruning	$600.00
5, 10	Thinning	Noncommercial	$85.00
Annual	Miscellaneous	Maintenance	$50.00
Annual	Variable cost	Animal cost plus other input costs	$1028.26
Annual	Fixed costs	Interest cost, equipment, etc	$212.60

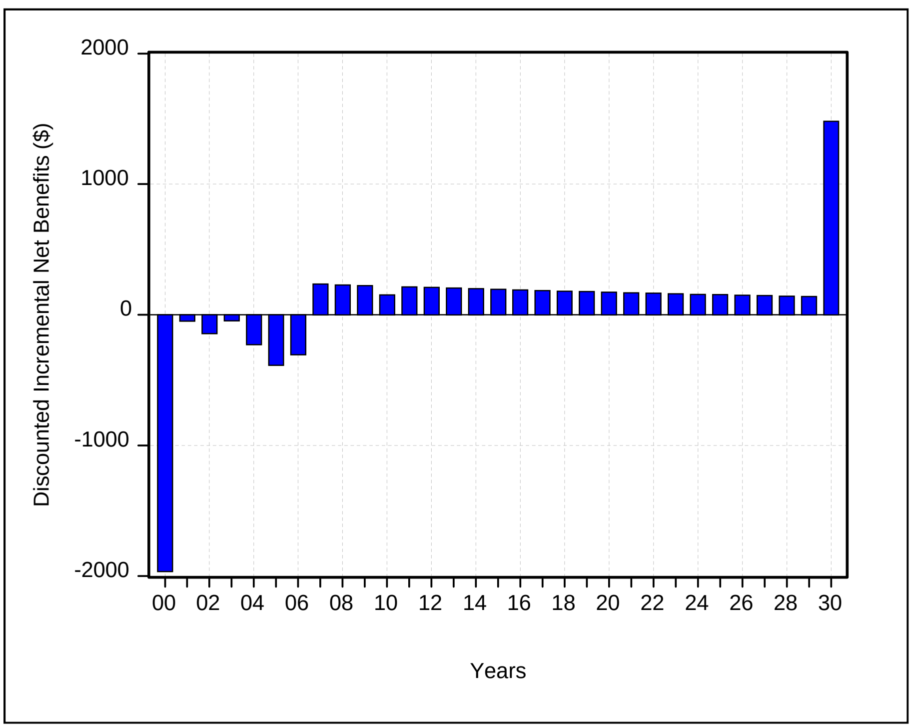
Table 3. Estimated Revenues from the sale of timber products and meat goats

Sivopasture Products	Quantity/acre	Price/unit	Gross Revenue Per Acre
Pulpwood	25.3 tons	$12.78	$323.33
Chip-N-Saws	23.6 tons	$22.50	$531.00
Sawtimber	56.3 tons	$35.50	$1,998.65
Goats*	8 live animals	$98	$1,568.00

* The average weight of the animals is estimated at 70 pounds and the average price per pound of a live goat is $1.40. Assuming two production cycles in a year

Turning to the cash flow plan, the enterprise budgets that generated data for the cash flow plan used a nominal discount rate of 6% which was later converted to a real discount rate of 2.4 to adjust for the assumed 3.5% inflation. The discounted incremental net benefits using the 2.4% real discount rate are presented in Figure 1. The trend in the figure indicates that the cash flows from 1 to 6 years were negative but turned positive starting in year 7.

Figure 1. Discounted Incremental Net Benefits



The financial feasibility of the silvopasture production system based on the five indicators discussed above suggests that the BCR is 1.108 at full cost basis (Table 4). The NPV, IRR, NBIR and AI are $2,502, 5.99%, 1.8 and $107, respectively, clearly indicating the viability of the silvopasture production system in the Alabama Black Belt region under the specified assumptions and following the five decision criteria.

Table 4: Financial Analysis of Silvopasture Production System

Indicators	2.4% Real Discount Rates (Nominal rates, 6%)	Decision
Benefit-Cost Ratio (BCR)	1.108	Accept
Net Present Value (NPV) $/acre	$2502	Accept
Net Benefit- Investment Ratio (NBIR)	1.8	Accept
Annualized Income (AI) $/acre	$107	Accept
Internal Rate of Return (IRR)	5.99%	

Sensitivity Analysis

Sensitivity analysis was carried out for examining the sensitivity to the discount rate. Three nominal discount rates: 5%, 8% and 10% were used to recalculate the NPV, BCR, IRR, BIR and AI. Table 5 shows the result of sensitivity analysis at different real discount rates.

Table 5: Sensitivity Analysis at Different Discount Rates

Indicators	Real Discount Rates (Nominal rates)			
	1.4% (5%)	2.4% (6%)	4.3% (8%)	6.3% (10%)
Benefit-Cost Ratio (BCR)	1.139	1.108	1.049	0.985
Net Present Value (NPV) $/acre	$3723.33	$2502.17	$870.76	$-208.98
Internal Rate of Return (IRR)	6.04%	5.99%	5.91%	6.57%
Net Benefit- Investment Ratio (NBIR)	2.17	1.80	1.29	0.93
Annualized Income (AI) $/acre	$81.50	$107.01	$122.48	$109.55

CONCLUSIONS

Throughout the southeast US, non-industrial private forestland owners hold millions of acres of valuable timberland. These individuals manage their forestland for a variety of objectives, including income, recreation, wildlife management and other activities. This paper conducted economic evaluations of agroforestry practices so that landowners, extension personnel, and other decision makers can correctly assess the potential of agroforestry practices among the many land-use options. The data analyzed are preliminary data collected from an ongoing silvopastoral study conducted in the Alabama Black Belt region, on the property of the Federation of Southern Cooperatives in Epes, Alabama. The preliminary economic and financial feasibility results indicate that the silvopasture production system is a financial feasible investment for the limited resource farmers in the region. The net present value model suggested that an investment in this system would be considered acceptable because the net present value at 6 percent nominal interest rate is positive, or greater than zero. This was also the case when the cost of capital was assumed at 5 percent and 8 percent under sensitivity analysis. In summary, the current economic situation of the small farm sector make the simultaneous production of pine sawlogs, forage, and meat goats on small farms a financially sound alternative enterprise for producers in the region.

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