Monetary and Wildlife Benefits in a Silvopastoral System[1]

by
Amanda L. Husak and Stephen C. Grado[2]

Abstract

In many regions of the United States, agroforestry has become an important land use alternative. In the South, silvopasture, which combines spatial and temporal growth of timber and livestock, is the most common form of agroforestry. An economic analysis was undertaken to demonstrate the wildlife and economic benefits that can be accrued from a silvopastoral system in the southern United States. Wildlife-related activities as well as annual and periodic cash flows from timber and livestock sales were included in the analysis. Land expectation value, equivalent annual income, and rate of return were calculated and compared for the silvopastoral system and four traditional monocultural systems. Incorporation of a silvopastoral system increases the quantity and quality of wildlife habitat, provides greater versatility in potential outputs from the land base, and yields economic returns that are comparable to other land uses.

Introduction

In many regions of the United States, agroforestry has become an important land use alternative (Garrett 1997). In the South, silvopasture, which combines spatial and rotational growth of timber, forage, and livestock, is the most common form of agroforestry (Zinkhan and Mercer 1997).

Historical evidence suggests that Native Americans used fire to stimulate the growth of forage in forests to provide grazing for deer, elk, and buffalo (Hansbrough 1980; MacCleery 1992). Early colonists adopted this Native American practice to provide forage for domesticated livestock (Harwell and Dangerfield, Jr. 1991). The grazing of native forage in planted and natural pine stands, called "forest grazing," is still practiced to some extent across the southeastern United States and may expedite the adoption of silvopasture, or grazing of improved forage in planted pine stands (Clason 1999).

Lundgren et al. (1983) and Pearson (1991) report that the potential for forest grazing is greater in the Southeast than in any other region of comparable size in the United States. Of the 278 million acres of land area in the Southeast, approximately 38 million acres are used for crops (including harvested cropland, crop failure, and cultivated summer fallow), 9 million acres are idle, 15 million acres are used only for pasture, 19 million acres are in grassland pasture (including grasslands, non-forest pasture, and range), 43 million acres are in other uses (including marshes, open swamps, bare rock areas, urban areas, and special use areas), and 154 million acres are in forestland (excluding reserved, special use, or park land; includes forested grazing land) (USDA 1999a). Conversion of only a portion of the idle or marginal cropland available in the South to multiple-use systems like silvopasture could lead to increased social and economic benefits to landowners and biological benefits to wildlife (Pearson 1991).

Silvopastoral systems represent a form of multiple-use management in which landowners, animals, and plants enjoy multiple, diverse benefits. Although other studies by Haney, Jr. (1980), Lundgren et al. (1983), Harwell and Dangerfield, Jr. (1991), and Clason (1999) demonstrated that silvopastoral systems are economically and biologically feasible, few have discussed the benefits that wildlife add to these systems. Pearson (1991) mentioned the possibility of increased land values through hunting leases, and Grado et al. (1999) demonstrated the monetary value of wildlife to silvopastoral systems by including hunting leases in the overall management plan. The objectives of this study, then, are to demonstrate the economic benefits found in a hypothetical silvopastoral system, to compare these benefits to those of single-use management systems, and to discuss the wildlife values created by each of these systems.

Methods

System selection. A literature review was conducted to select five hypothetical land management systems in the South: silvopasture, soybeans, rice, cattle, and

[1] Approved for publication as Journal Article No. FO144 of the Forest and Wildlife Research Center, Mississippi State University.

[2] Graduate Research Assistant and Associate Professor of Forestry, respectively, Forest and Wildlife Research Center, Mississippi State University, Mississippi State, MS 39762.

a loblolly pine (*Pinus taeda*) plantation. These five systems are commonly used, and much information is readily obtainable for each (Byrd and Lewis 1983; Pearson 1991; MAFES 1999a,b,c). For each system, an average farm size of 215 acres was used which corresponds to the average farm size for the southern region (USDA 1999b). A site index of 65, base age 25 was assumed for loblolly pine for all sites and was used in studies by Pearson (1991), Harwell and Dangerfield, Jr. (1991), and Clason (1999). Regional data was taken from Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee following regional divisions suggested by Merwin (1997). Average cropland values for this area are $1557/acre (USDA 1999c). Average annual cash rents for this region are $43/acre for non-irrigated cropland, $65/acre for irrigated cropland, $16/acre for pastureland, and $18/acre for timberland (Grado 1999; USDA 1999d).

Silvopasture – timber component. Initial conditions were selected in light of real-world examples by Lundgren et al. (1983), Harwell and Dangerfield, Jr. (1991), Clason (1999), and Grado et al. (1999) where loblolly pine was planted at a density of 454 trees per acre on a 4′x 8′x 20′ spacing and maintained on a 30-year sawtimber rotation. Commercial thinnings to a residual basal area of 70 ft^2 were conducted at age 15, 20, and 25 to improve the growth and value of the stand (Nebeker et al. 1985). Final harvest occurred in year 30. Due to difficulties in modeling the typical spacing for silvopastoral systems, an initial stocking of 908 trees per acre was used to simulate the competition between trees, and thinning volumes were halved for ages 15 and 20 to reflect typical yields from silvopasture. Timber yields per acre were estimated using WINYIELD (Hepp 1994). Yields were: 8.46 cords of pulpwood at age 15; 3.69 cords of pulpwood at age 20; 6.35 cords of chip ‘n’ saw at age 25; and 5.27 cords of chip ‘n’ saw and 4.78 thousand board feet (MBF) Doyle of sawtimber at age 30. Prescribed burning was used annually from ages four to 30 to reduce fire hazards and plant competition, kill brush, improve access, and stimulate forage growth (Grado et al. 1999). Residual trees were pruned following thinnings to reduce tree taper and increase volume (Valenti 1986). Timber prices used were: $390/MBF Doyle for sawtimber; $85/cord for chip ‘n’ saw; and $25/cord for pulpwood (Daniels 1999). For consistency, timber prices were assumed to remain constant throughout the rotation.

Silvopasture – cattle component. Byrd and Lewis (1983), Clason (1999), and Pearson (1991) have shown that the introduction of cattle to silvopastoral systems has no negative effect on timber growth if introduction occurs after trees reach a height of 18 inches. Cattle will be introduced to the system in year two to allow time for forage and tree establishment (Pearson 1991; Grado et al. 1999). In a previous study, Lundgren et al. (1983) used a stocking rate of one cow or bull per 1.5 acres for cattle that remained on site only during the grazing season and that produced no calves. This analysis assumed that calves will be produced each year, thus the initial stocking rate was reduced to one cow or bull per three acres. Reducing the initial stocking rate permits the herd to grow as calves are produced. Assuming that one bull can service 25 to 30 cows, the 215-acre site initially supported 72 cows and three bulls (Pearson 1991). The annual calving rate was assumed to be 92% or 66 calves, which increases the herd to 138 total cows and calves and three bulls, or a stocking rate of one animal per 1.5 acres (Lundgren et al. 1983; Pearson 1991). Calves were sold in their second year since two-year old steers and heifers, weighing 1000 pounds, yield higher prices ($708/head) than yearling calves weighing 500 pounds ($489/head) (USDA 1999e). Cows were purchased for $500/head and sold in 10 years at $350/head (USDA 1999e). Bulls were purchased for $1000/head and sold in five years at $580/head (USDA 1999e). Generally, cows produce for 10 to 12 years, and bulls produce for five years (Pearson 1991). For consistency, cattle prices were held constant throughout the rotation.

Silvopasture – forage component. A permanent summer grass mixture composed of bahiagrass (*Paspalum notatum*), bermudagrass (*Cynodon dactylon*), dallisgrass (*Paspalum dilatatum*), and other mixed grasses and Mount Barker clover (*Trifolium subterraneum*) were planted, fertilized, and maintained annually beginning in year one. The summer grass mixture was established by seeding at a planting rate of 35-40 lbs/acre; clover was established at a planting rate of 15-20 lbs/acre (SCS 1994). Fertilizer was applied at rates of 500 lbs/acre of 13-13-13 NPK at establishment; 200 lbs/acre of ammonium nitrate, 100 lbs/acre of phosphate, and 100 lbs/acre of potash were applied annually for maintenance (SCS 1994; MAFES 1999b).

Silvopasture – monetary considerations. Annual maintenance costs, which include land rent in years zero to 30, and fertilizer, herbicide, seed, soil testing, labor, diesel fuel, and repair and maintenance to tractors and implements were incurred in years one to 30 (Grado et al. 1999; MAFES 1999b). Revenues from the sale of steers and heifers occurred in years three to 30. Prescribed burning costs and hunting lease revenues were incurred in years four to 30 (Dubois et al. 1997; Jones et al. 1998). Delaying prescribed burning and hunting leases until year four reduces the chance of tree damage and results in more suitable habitat for game species (Byrd and Lewis 1983; Hazel 1990; Pearson 1991). Annual costs and revenues involved in the silvopasture system were reported in *Table 1*.

Table 1. Annual Costs and Revenues for a Silvopastoral System (1999 Dollars).

Year	*Activity*	*Cost ($/acre)*	*Revenue ($/acre)*
0 to 30	Land Rent	16.00	
1 to 30	Management	150.48	
2 to 30	Supplemental Feed	20.00	
2 to 30	Animal Maintenance	5.00	
3 to 30	Steer/Heifer Sales		217.34
4 to 30	Prescribed Burning	13.58	
4 to 30	Hunting Leases		6.89

Periodic costs and revenues incurred in a silvopasture operation include site preparation, planting, and fertilizer costs in year 0. Total site preparation/establishment costs include minimal site preparation and planting costs of $13.58 per acre and $32.51 per acre, respectively (Dubois et al. 1997) and a seedling cost of $22.00 per 500 (SCFC 1998). Cattle costs were converted to a per acre basis by dividing the purchase price for cows or bulls by the number of acres and multiplying this by 72 for cows and three for bulls. Steer and heifer prices were converted to a per acre basis by multiplying the number of calves produced each year (66) by the sale price ($708/head) and dividing this by the total number of acres in the tract (215). Cattle revenues were obtained by reducing the initial purchase price by 75% for cows and 58% for bulls; this percentage reduction in price represents the value depreciation of cattle (Pearson 1991). Thinning revenues were obtained by multiplying the estimated yields by the timber prices. Pruning costs were estimated at $0.17 per tree and reflected the actual cost to the landowner for pruning their own trees (Grado et al. 1999). Per acre periodic costs and revenues for the silvopasture treatment were itemized in *Table 2*.

Table 2. Periodic Costs and Revenues for a Silvopastoral System (1999 Dollars).

Year	*Activity*	*Cost ($/acre)*	*Revenue ($/acre)*
0	Establishment	68.09	
2, 12, 22	Cow Purchase	167.44	
2, 12, 22	Cow Sales		117.21
Every 5 Years	Bull Purchase	13.95	
Every 5 Years	Bull Sales		8.09
15	Thinning		211.50
15	Pruning	38.18	
20	Thinning		92.25
20	Pruning	23.61	
25	Thinning		539.75
25	Pruning	16.17	
30	Harvest		2312.15

Soybeans. Soybeans were planted annually at a rate of 40 pounds/acre and yielded 36 bushels/acre (MAFES 1999a). Phosphorus (46% P205) and Potash (60% K20) fertilizers, Apron®XL fungicide, Roundup®Ultra 4SL herbicide, and Larvin®3.2 insecticide were applied to stimulate growth and protect against fungus, weeds, and insects (MAFES 1999a). Soybean prices remained constant at $4.56/bushel (USDA 1999e).

Soybeans – monetary considerations. Total annual costs for soybean production were $112/acre. Total annual revenues were $164/acre. Annual land rent was $43/acre. All costs and revenues involved in soybean production were itemized in *Table 3*.

Table 3. Costs and Revenues for Soybean Production (1999 Dollars).

Income	***Cost ($/acre)***	***Revenue ($/acre)***
Total Income		164.16
Annual Expenses		
Custom Spray	0.26	
Fertilizers	17.01	
Fungicides	0.57	
Herbicides	14.97	
Insecticides	0.77	
Seed/Plants	20.80	
Custom Harvest/Haul	4.80	
Operator Labor	4.71	
Hand Labor	1.12	
Unallocated Labor	4.24	
Diesel Fuel	3.08	
Repair and Maintenance	11.55	
Interest on Operator Capital	2.91	
Land Rent	43.00	
Total Annual Expenses	86.82	
Total Fixed Expenses	25.59	
Total Expenses	112.41	

Rice. Rice was planted annually at a rate of 90 pounds/acre and yielded 144 bushels/acre (MAFES 1999c). Solid urea (46% N) fertilizer, and Propanil®4E, Ordram®15-G, and Grandstand® herbicides were applied to stimulate growth and protect against weeds (MAFES 1999c). Rice prices were assumed to remain constant at $2.93/bushel (MAFES 1999c).

Rice – monetary considerations. Total annual costs were $429/acre. Total annual revenues were $422/acre. Annual land rent was $65/acre. All costs and revenues involved in rice production were itemized in *Table 4.*

Table 4. Costs and Revenues for Rice Production (1999 Dollars).

Income	***Cost ($/acre)***	***Revenue ($/acre)***
Total Income		421.92
Annual Costs		
Custom Spray	12.80	
Gin/Dry	53.60	
Fertilizers	34.80	
Herbicides	61.92	
Irrigation Supplies	0.25	
Seed/Plants	28.35	
Custom Fertilizer/Lime	16.40	
Custom Harvest/Haul	13.40	
Operator Labor	8.66	
Hand Labor	6.91	
Irrigation Labor	6.91	
Unallocated Labor	8.66	
Diesel Fuel	0.64	
Repair and Maintenance	30.42	
Interest on Operator Capital	8.74	
Land Rent	65.00	
Total Annual Costs	357.46	
Total Costs	71.65	
Total Costs	429.11	

Cattle. Cattle production was simulated using the combined information for the cattle and forage components for the silvopastoral system. A permanent summer grass mixture, along with clover, was established in year zero, and cattle were introduced in year one. Stocking rates, purchase and sale prices for cattle, and land rent, as well as forage establishment and maintenance requirements, remained the same as for silvopasture.

Cattle – monetary considerations. Annual costs and revenues for cattle production include land rent in years zero to 30, forage and establishment and maintenance in years one to 30, and animal supplements and maintenance and steer and heifer sales in years two to 30. Periodic costs and revenues include cow and bull sales and purchase at 10 and five-year increments, respectively. Costs and revenues for cattle production were itemized in *Table 5*.

Table 5. Annual and Periodic Costs for Cattle Production (1999 Dollars).

Year	*Activity*	*Cost ($/acre)*	*Revenue ($/acre)*
0 to 30	Land Rent	16.00	
0 to 30	Forage Est/Misc	150.48	
1 to 30	Supplements	20.00	
1 to 30	Animal Maint.	5.00	
2 to 30	Str/Hfer Sales		217.34
1,11,21	Cow Purchase	167.44	
11,21,30	Cow Sales		117.21
1,6,11,16,21,26	Bull Purchase	13.95	
6,11,16,21,26,30	Bull Sales		8.09

Pine plantation management. Using a plantation design described by Harwell and Dangerfield, Jr. (1991) for use in the South, loblolly pine was planted at a density of 605 trees per acre in year zero and maintained on a 35-year sawtimber rotation. A pre-commercial thinning was conducted in year 10. Commercial thinnings to a residual basal area of 70 ft^2 were conducted at ages 15 and 25 (Harwell and Dangerfield, Jr. 1991). Final harvest occurred in year 35. Timber yields were estimated using WINYIELD (Hepp 1994). Yields per acre were 13.71 cords of pulpwood at age 15; 14.77 cords of chip ‘n’ saw at age 25; and 9.34 MBF Doyle of sawtimber at age 35. Timber prices remained the same as for silvopasture.

Monetary considerations – pine plantation. Total establishment costs for the pine plantation included site preparation and planting costs of $13.58/acre and $30.25/acre, respectively (Dubois et al. 1997), and seedling costs of $22.00 per 500 (SCFC 1998). Other costs included: land rent at $18/acre, herbicide at $50/acre, pre-commercial thinning at $65/acre, and prescribed burning at $14/acre (Dubois et al. 1997). Costs and revenues incurred in the pine plantation system are listed in *Table 6*.

Using the costs and revenues for the silvopasture, soybeans, rice, cattle, and pine plantation systems and real, before tax interest rates of 5, 7, and 9%, Land Expectation Values (LEV), Equivalent Annual Incomes (EAI), and Rates of Return (ROR) were calculated for each. Wildlife benefits for each system were taken from the literature.

Table 6. Costs and Revenues for a Pine Plantation (1999 Dollars).

Year	Activity	Cost ($/acre)	Revenue ($/acre)
0 to 30	Land Rent	18.00	
0	Site Prep/Establishment	70.45	
1	Herbicide	50.00	
10	Pre-commercial Thinning	64.47	
15	Prescribed Burning	13.58	
15	Thinning Revenue		342.75
25	Thinning Revenue		1,255.45
35	Final Harvest		3,642.60

Silvopasture - wildlife species associations. Wildlife habitat and species associations for the silvopasture system were taken from Benyus (1989), Terres (1991), Brown (1997), AOU (1998), Turcotte and Watts (1999), and Yarrow and Yarrow (1999) and are arranged by successional stage. In the first five years after establishment, the silvopasture system will likely resemble an old-field or pasture and would be utilized by many wildlife species. The grass will attract grazers like white-tailed deer (*Odocoileus virginianus*) and provide nesting cover for ground-nesting birds like northern bobwhite (*Colinus virginianus*), horned lark (*Eremophila alpestris*), and eastern meadowlark (*Sturnella magna*). Flowering plants along field edges will attract insects that in turn attract perching birds like eastern bluebird (*Sialia sialis*), loggerhead shrike (*Lanius ludovicianus*), northern flicker (*Colaptes auratus*), and eastern kingbird (*Tyrannus tyrannus*). Loose soil will attract burrowers and rodents such as southeastern shrew (*Sorex longirostris*), eastern mole (*Scalopus aquaticus*), hispid cotton rat (*Sigmodon hispidus*), and gold field mouse (*Peromyscus polionotus*). Other wildlife species such as eastern fence lizard (*Sceloporus undulatus*), eastern hognose snake (*Heterodon platyrhinos*), eastern cottontail (*Sylvilagus floridanus*), eastern garter snake (*Thamnophis sertalis sertalis),* eastern wild turkey (*Meleagris gallopavo*), and red-tailed hawk (*Buteo jamaicensis*) will use open grass or pastureland.

As the pines grow to the small sapling stage, other wildlife species will be able to use the habitat. Birds like Carolina wren (*Thryothorus ludovicianus*), mourning dove (*Zenaida macroura*), and song sparrow (*Melospiza melodia*) will be attracted in this stage. Other possible visitors include striped skunk (*Mephitis mephitis*), eastern coachwhip (*Masticophis flagellum flagellum*), eastern box turtle (*Terrapene carolina*), and five-lined skink (*Eumeces fasciatus*).

As the pines proceed to pole and sawtimber size, frequent burning of the stand will provide easier travel for wildlife, expose pine seeds for food, and provide dusting areas for songbirds. The trees in the silvopasture system will attract bark-insect feeding birds like downy woodpecker (*Picoides pubescens*), brown-headed nuthatch (*Sitta pusilla*), and white-breasted nuthatch (*Sitta carolinensis*). The trees will also provide cover for birds like white-eyed vireo (*Vireo griseus*), pine warbler (*Dendroica pinus*), and yellow-throated warbler (*Dendroica dominica*). Mammals like cotton mouse (*Peromyscus gossypinus*), raccoon (*Procyon lotor*), nine-banded armadillo (*Dasypus novemcinctus*), Virginia opossum (*Didelphis virginiana*), and fox squirrel (*Sciurus niger*) will also be present.

As demonstrated by these species associations, silvopasture systems, due to their inherent diversity, provide nesting and breeding areas, food, and cover for numerous wildlife species throughout the rotation. Succession of the habitat from pasture to tree cover attracts different species at different times in the rotation and provides the landowner with a chance to view wildlife and incorporate hunting leases for some of the species that are attracted. In a silvopastoral setting, hunting lease rates and bare land value will increase as habitat quality increases. The species richness of silvopastoral systems also makes them very attractive to other wildlife enthusiasts.

Soybeans – wildlife species associations. Although soybean fields do not provide the structure and cover of a forest landscape, they do provide food and shelter for wildlife species like eastern wild turkey, northern bobwhite, white-tailed deer, and eastern cottontail (Walter 1990; SCS 1994). Rodents and burrowers will also be attracted to soybean fields, which will in turn attract avian predators like red-tailed hawk, American kestrel (*Falco sparverius*), and northern harrier (*Circus cyaneus*) (Benyus 1989; Jahn and Schenck 1991).

Rice – wildlife species associations. Rice fields often attract migratory waterfowl and other birds such as snow goose (*Chen caerulescens*), Canada goose (*Branta canadensis*), great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), and roseate spoonbill (*Ajala ajala*) (Walter 1990; Turcotte and Watts 1999; Yarrow and Yarrow 1999).

Cattle production – wildlife species associations. Pastureland attracts birds like cattle egret (*Bubulcus ibis*), brown headed cowbird (*Molothrus ater*), horned lark, and northern bobwhite as well as mammals, rodents, and reptiles like white-tailed deer, eastern cottontail, hispid cotton rat, gold field mouse, eastern hognose snake, and eastern garter snake (Benyus 1989; Yarrow and Yarrow 1999).

*Pine plantation – wildlife species associations***.** Studies by Joyce et al. (1990) and Morrison (1992) have investigated the abundance and diversity of wildlife species in forests managed for timber production. Even-aged management, such as that used in pine plantations, will attract both breeding and non-breeding birds throughout the rotation (Morrison 1992). As in the silvopasture system, eastern wild turkey and white-tailed deer will use pine plantations at various ages during the rotation. Cavity-nesting and bark-insect feeding birds, songbirds, and mammals listed for the silvopasture system in late successional stages will also be found in pine plantations (Benyus 1989; Terres 1991; Turcotte and Watts 1999; Yarrow and Yarrow 1999).

Results and Discussion

LEV's, EAI's, and ROR's for all five systems are reported in *Table 7*. At 5%, the LEV of $1241 and EAI of $62 was greatest for the silvopasture system, followed closely by the pine plantation and rice production. At 7% and 9%, rice production yields the highest LEV's of $884 and $700 and EAI's of $62 and $63. At all interest rates, cattle production had the lowest LEV's and EAI's. These values indicate that, at low interest rates like 5%, the preferred uses for the land are silvopasture, pine plantations, or rice production. At higher interest rates like 7% and 9%, rice or soybean production is the preferred land use. In this analysis, cattle production is consistently the least preferred land use.

Although LEV's and EAI's consistently give the same ranking for potential investments**,** EAI is often included to compare forestry and agricultural investments (Bullard and Straka 1998). Equivalent Annual Incomes represent the net present value (i.e., all revenues minus all costs discounted to the present) of an investment expressed as an annual amount (Bullard and Straka 1998). EAI's for these systems follow the same trend as the LEV's.

Although ROR's should not be used for ranking purposes, they provide some idea of the average rate of interest earned on capital over the lives of these investments. For this analysis, ROR's were 14.6% for silvopasture, 5.3% for soybeans, -3.3% for rice, 12.9% for cattle, and 13.4% for pine plantation, respectively. The negative ROR for rice can be attributed to the high annual rent required for rice production, which creates negative annual returns on the investment.

Table 7. LEV's, EAI's, and ROR's for All Production Systems (1999 Dollars).

System	***Interest Rate (%)***	***LEV ($/acre)***	***EAI ($/acre)***	***ROR (%)***
Silvopasture	5	1240.93	62.05	14.6
	7	630.28	44.12	14.6
	9	325.51	29.30	14.6
Soybeans	5	1087.38	49.31	5.3
	7	791.49	48.39	5.3
	9	627.11	47.50	5.3
Rice	5	1214.01	55.06	-3.3
	7	883.67	54.03	-3.3
	9	700.14	53.04	-3.3
Cattle	5	443.38	22.17	12.9
	7	303.31	21.23	12.9
	9	220.87	19.88	12.9
Pine	5	1232.85	61.64	13.4
Plantation	7	572.66	40.09	13.4
	9	262.25	23.60	13.4

To demonstrate wildife benefits accrued from the incorporation of hunting leases into silvopasture systems, LEV's, EAI's, and percentage increase in LEV's and EAI's were calculated using lease values of $3, $4, $5, $6, $7, and $8 and are reported in *Table 8* (Yarrow and Yarrow 1999).

As expected, LEV and EAI are greater at all interest rates for all values when the hunting lease is included in the analysis. At 5%, differences range from $130 and 11.9% at $7 to $190 and 16.9% at $10; at 7%, the range is $95 and 16.3% to $140 and 23.3%; and, at 9%, the range is $75 and 23.1% to $107 and 33.0%. The LEV's and EAI's in this analysis reflect monetary differences between incorporating or not incorporating hunting leases into a silvopastoral system. However, one could also infer that these values reflect the wildlife value of this production system and illustrate the provision of wildlife benefits to the landowner with very little effort directed towards creating wildlife habitat.

Conclusions

Agroforestry is gaining acceptance by landowners across the United States. Studies have shown that the adoption of these systems is both economically and biologically feasible. Results from this study illustrate the monetary benefits that can be gained in silvopasture systems.

At low interest rates, silvopasture yields slightly higher LEV's and EAI's than pine plantations or rice production. These higher values can be attributed to annual and periodic revenues attained from production of multiple outputs throughout the rotation. Thus, silvopasture has the potential to offer an economically attractive and comparable alternative to single-use systems. In addition, the literature review suggests that silvopasture provides both quantity and quality of wildlife habitat that cannot be found in the other systems used in this analysis. Throughout the rotation, different wildlife species are attracted by various successional stages, thereby providing the landowner with greater opportunities for incorporating wildlife-related activities. On average, silvopastoral systems incorporating wildlife leases yield 5.1 to 26.4% more value per acre than conventional silvopasture. Monocultural systems also offer fee hunting opportunities, but the average returns may be less than what can be received from silvopastoral systems.

Table 8. Wildife Benefits with a Hunting Lease for a Silvopastoral System (1999 Dollars).

	Lease ($/acre)	*Int. Rate (%)*	*LEV ($/acre)*	*EAI ($/acre)*	*% Diff. B/tw Options*
Silvopasture		5	1103.41	55.17	
(w/o lease)		7	584.39	40.91	
		9	325.27	29.27	
Silvopasture	3	5	1159.52	57.98	5.1
(with lease)		7	625.23	43.77	7.0
		9	357.49	32.17	9.9
	4	5	1178.22	58.91	6.8
		7	638.85	44.72	9.3
		9	368.23	33.14	13.2
	5	5	1196.93	59.85	8.5
		7	652.46	45.67	11.6
		9	378.97	34.11	16.5
	6	5	1215.63	60.78	10.2
		7	666.08	46.63	14.0
		9	389.70	35.07	19.8
	7	5	1234.33	61.72	11.9
		7	679.69	47.58	16.3
		9	400.44	36.04	23.1
	8	5	1253.03	62.65	13.6
		7	693.31	48.53	18.6
		9	411.18	37.01	26.4

Although revenues from hunting leases do not represent a major source of income, the net return to landowners for having and maintaining wildlife habitat is higher than without the incorporation of leases. As stated earlier, the actual financial gain from including hunting leases can be viewed as the expected monetary gain to the landowner for maintaining quality habitat.

In conclusion, silvopasture stands as an environmentally and economically feasible multiple land use system with great potential for application in the South. Silvopasture compares favorably to other land use systems and provides additional benefits made possible by the diversity and productivity of the system. Although excluded from this study, other opportunities for supplementing income, such as pine straw harvest and floriculture, exist and may be incorporated into silvopastoral systems. Government subsidized programs like the Conservation Reserve Program (CRP) and the Wildlife Habitat Incentives Program (WHIP), which promote sustainable use and management, can provide additional incentives to landowners for creating wildlife habitat (McKenzie 1997).

As technological advances in the implementation and maintenance of agroforestry systems are introduced, widespread adoption of silvopasture may become as commonplace as other land use systems today. This study serves as a methodology for observing these systems and providing landowners with information on the potential monetary and wildlife benefits produced.

Literature Cited

American Ornithologists' Union (AOU). 1998. Check-list of North American Birds. 7th ed. Washington, D.C.: American Ornithologists' Union, 829pp.

Benyus, J.M. 1989. The Field Guide to Wildlife Habitats of the Eastern United States. New York: Simon and Schuster, 336pp.

Brown, L.N. 1997. A Guide to the Mammals of the Southeastern United States. Knoxville: University of Tennessee Press, 236pp.

Bullard, S.H. and T.J. Straka. 1998. Basic Concepts in Forest Valuation and Investment Analysis, Ed. 2.1. Preceda Education and Training, Auburn, AL, 251pp.

Byrd, N.A. and C. E. Lewis. 1983. Managing pine trees and bahiagrass for timber and cattle production. USDA Forest Service, Southern Region, General Report R8-GR 2, 9pp.

Clason T.R. 1999. Silvopastoral practices sustain timber and forage production in commercial loblolly pine plantations of northwest Louisiana, USA. Agroforestry Systems 44:293-303.

Daniels R. 1999. Mississippi timber price report. Mississippi State, MS: Mississippi State University, Extension Service.

Dubois M.R., K. McNabb, and T. J. Straka. 1997. Costs and cost trends for forestry practices in the South. Forest Landowner Manual Edition 56(2):7-13.

Garrett H.E.G. 1997. Agroforestry: An integrated land-use management system for production and farmland conservation. USDA SCS 68-3A7S-3-134, 57pp.

Grado S.C., C.H. Hovermale, and D.G. St. Louis. 1999. A financial analysis of a silvopasture system in south Mississippi. Agroforestry Systems (In press).

Haney, H.L., Jr. 1980. Economics of integrated cattle-timber land use. Proc. Southern Forest Range and Pasture Symposium, New Orleans, Louisiana, March.

Hansbrough, T. 1980. Integrated use of the southern forest range: A sociological perspective. Proc. Southern Forest Range and Pasture Symposium, New Orleans, Louisiana, March.

Harwell, R.L. and C.W. Dangerfield, Jr. 1991. Multiple use on marginal land: A case for cattle and loblolly pine. The Forestry Chronicle 67:249-253.

Hazel, R.B. 1990. Timber and wildlife. Landowner's handbook for managing southern pines. Cooperative Extension Service and USDA Forest Service, Southern Region, 2pp.

Hepp, T.E. 1994. WINYIELD 1.0, A Windows-based Forest Growth, Yield, and Financial Analysis Tool for Southern Forests. Norris, TN: Tennessee Valley Authority.

Jahn, L.R. and E.W. Schenck. 1991. What sustainable agriculture means for fish and wildlife. Journal of Soil and Water Conservation 46:251-255.

Jones W.D., I.A. Munn, J.C. Jones, and S.C. Grado. 1998. A survey to determine fee hunting and wildlife management activities by private non-industrial landowners in Mississippi. Proc. Ann. Conf. of Southeast Assoc. Fish and Wildlife Agencies 52:(In press).

Joyce, L.A., C.H. Flather, P.A. Flebbe, T.W. Hoekstra, and S.J. Ursic. 1990. Integrating forage, wildlife, water, and fish projections with timber projections at the regional level: A case study in Southern United States. Environmental Management 14:489-500.

Lundgren, G.K., J.R. Connor, and H.A. Pearson. 1983. An economic analysis of forest grazing on four timber management situations. Southern Journal of Applied Forestry 7:119-124.

MacCleery, D.W. 1992. American Forests: A History of Resiliency and Recovery. Durham, N.C: USDA Forest Service, Forest History Society, 59 pp.

McKenzie, D.F. 1997. A Wildlife Manager's Field Guide to the Farm Bill. Washington, D.C.: Wildlife Management Institute, 1101 14th St, N.W., Suite 801, 44pp.

Merwin, M.L. 1997. The Status, Opportunities, and Needs for Agroforestry in the United States. Association for Temperate Agroforestry, Columbia, Missouri, 41pp.

Mississippi Agricultural and Forestry Experiment Station (MAFES). 1999a. Soybeans 2000 planning budgets. Agricultural Economics Report 107. Mississippi State, MS: Mississippi State University.

Mississippi Agricultural and Forestry Experiment Station (MAFES). 1999b. Forage 1999 planning budgets. Agricultural Economics Report 105. Mississippi State, MS: Mississippi State University.

Mississippi Agricultural and Forestry Experiment Station (MAFES). 1999c. Rice 2000 planning budgets. Agricultural Economics Report 108. Mississippi State, MS: Mississippi State University.

Morrison, M.L. 1992. Bird abundance in forests managed for timber and wildlife resources. Biological Conservation 60:127-134.

Nebeker, T.E., J.D. Hodges, B.K. Karr, and D.M. Moehring. 1985. Thinning practices in southern pines – with pest management recommendations. USDA, Forest Service, Technical Bulletin 1703, 36pp.

Pearson, H.A. 1991. Silvopasture: forest grazing and agroforestry in the southern coastal plain. In: Henderson DR (ed) Proceedings: Mid-South conference on Agroforestry Practices and Policies, pp 25-42. West Memphis, AR Nov 28-29, 1990. Winrock International Institute for Agricultural Development.

Soil Conservation Service (SCS). 1994. Mississippi Planting Guide for Wildlife Food Plots, Livestock, Erosion control, and Beautification. Jackson: Soil Conservation Service, 65pp.

South Carolina Forestry Commission (SCFC). 1998. South Carolina Forestry Commission price guide for tree seedlings, equipment, and services. South Carolina Forestry Commission, 4pp.

Terres, J.K. 1991. The Audobon Society Encyclopedia of North American Birds. New Jersey: Wings Books.

Turcotte, W.H. and D.L. Watts. 1999. Birds of Mississippi. Jackson: University Press of Mississippi.

United States Department of Agriculture (USDA) (1999a) Agricultural statistics. USDA National Agricultural Statistics Service, Economic Research Division. US Government Printing Office, Washington D.C.

United States Department of Agriculture (USDA) (1999b) Farms and land in farms. USDA National Agricultural Statistics Service, Economic Research Division. US Government Printing Office, Washington D.C.

United States Department of Agriculture (USDA) (1999c) Agricultural land values. USDA National Agricultural Statistics Service, Economic Research Division. US Government Printing Office, Washington D.C.

United States Department of Agriculture (USDA) (1999d) Agricultural cash rents. USDA National Agricultural Statistics Service, Economic Research Division. US Government Printing Office, Washington D.C.

United States Department of Agriculture (USDA) (1999e) Agricultural prices. USDA National Agricultural Statistics Service, Economic Research Division. US Government Printing Office, Washington D.C.

Valenti, M.A. 1986. A comparison of the effects of one-step and two-step pruning on loblolly pine stem form. Southern Journal of Applied Forestry 10:215-253.

Walter, J. 1990. What is farming without the beasts? Successful Farming 88(2):25-38.

Yarrow, G.K. and D.T. Yarrow. 1999. Managing Wildlife. Birmingham, AL: Sweetwater Press, 588pp.

Zinkhan, C.F. and D.E. Mercer. 1997. An assessment of agroforestry systems in the southern USA. Agroforestry Systems 35: 303-321.