FINANCIAL PERFORMANCE OF LOBLOLLY AND LONGLEAF PINE PLANTATIONS

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Abstract—The financial performance of selected management regimes for loblolly (*Pinus taeda* L.) and longleaf pine (*P. palustris* Mill.) plantations were compared for four cases, each with low- and high-site productivity levels and each evaluated using 5 and 7 percent real discount rates. In all cases, longleaf pine was considered both with and without pine straw harvesting. The analysis also examined the financial impacts of various sawtimber proportions valued as poles. With the addition of pine straw revenues, longleaf management can yield returns that are comparable to typical loblolly pine regimes (–16 to +3 percent, depending on site quality and discount rate). With as little as 25 percent of sawtimber considered poles, longleaf pine financially outperformed loblolly at all site and discount rate combinations. Results indicate that longleaf pine may be an attractive alternative for some landowners, due to both lower establishment costs and the favorable land expectation value comparisons.

INTRODUCTION

The past decade has seen significant shifts in timberland ownership, particularly in the Southern United States. Integrated forest product companies have sold many of their land assets, which have subsequently been acquired by institutional investors. The reasons behind corporate land sales are diverse, but investors are attracted to timberland for several key reasons, including strong historical risk-adjusted returns (Binkley and others 2001, Carroll 2003, Caulfield 1999), low correlation with other asset classes (Binkley and others 2001, Carroll 2003), and an apparent correlation with inflation (Clutter and others 2005). The interest in timberland investment is apparent by the inflow of capital into the sector, with approximately $2 billion invested annually over the past decade (Clutter and others 2005). Timberland investments are often made by timberland investment management organizations (TIMO), who both acquire and manage property on the behalf of institutional investors.

Many TIMOs function as closed-end funds, meaning a key aspect of TIMO management is a short-time horizon relative to integrated forest products companies. While forest product companies have traditionally held land forever, TIMOs are organized with a broader set of expected land tenures and management foci. In general, TIMOs are more focused on financial returns over the length of the investment, while forest products companies traditionally concentrated on wood supply, i.e., harvest volume, and environmental objectives (Clutter and others 2005). Many TIMOs plan to hold land for no more than 10 to 15 years (closed-end funds), but others intend to hold forest land forever. In all cases, the justification for forest management activities undertaken by TIMOs is higher returns for investors; many TIMOs focus on intensive, short-rotation silviculture but not all. With the proliferation of TIMOs and timberland investors has come differentiation, including TIMOs with an emphasis on natural regeneration, high-yield plantations to offset losses to natural forests throughout the World, or other objectives.

Along with shifts in forest ownership, the past decade has also seen increased interest in longleaf pine (*Pinus palustris* Mill.) management. Longleaf pine once dominated forests from Virginia to Texas, but overexploitation resulted in its widespread decline. In recent years, various organizations have begun encouraging longleaf plantation establishment with much of their effort directed towards private landowners whose objectives include factors such as wildlife habitat and aesthetics in addition to economics.

Little work has been done examining the economic viability of longleaf pine management on investment properties. This can be attributed to the commonly held belief that returns from longleaf management cannot compare to those from loblolly pine (*P. taeda* L.) plantations. Traditionally, longleaf has been a difficult species to plant and successfully establish (Johnson 2008). The persistent and variable grass stage translated into longer rotation lengths (Johnson 2008) and hampered planning efforts. As a result, longleaf was often relegated to poor sites, only perpetuating its reputation for slow growth (Johnson 2008). Improvements in nursery techniques and silvicultural practices, however, challenge these old assumptions (Johnson 2008), such that longleaf and loblolly plantation economics may compare more favorably than previously believed. TIMOs may be able to justify investments in longleaf pine plantations if they can show returns comparable to those from intensive loblolly pine management. This is particularly true given the higher amenity values attributed to longleaf pine.

The remainder of this paper focuses on a detailed economic comparison of longleaf and loblolly pine plantation management. Much of the literature about longleaf pine focuses on a diversity of management objectives, including wildlife and endangered species. This analysis differs in that the focus is solely on the economics of plantation management. While longleaf pine forests may provide additional wildlife or aesthetic benefits, this analysis ignores such amenity values.

METHODOLOGY

Selected Cases

The financial performance of selected loblolly and longleaf pine plantation management regimes were compared for

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Table 1—Selected case/species combinations

Case	Species	Site index	Discount rate	Straw harvest
		feet	*percent*	
1	Loblolly (LP)	60	5	No
	Longleaf (LL)	85	5	No
	Longleaf (LL-S)	85	5	Yes
2	Loblolly (LP)	60	7	No
	Longleaf (LL)	85	7	No
	Longleaf (LL-S)	85	7	Yes
3	Loblolly (LP)	80	5	No
	Longleaf (LL)	110	5	No
	Longleaf (LL-S)	110	5	Yes
4	Loblolly (LP)	80	7	No
	Longleaf (LL)	110	7	No
	Longleaf (LL-S)	110	7	Yes

four cases, outlined in table 1. Loblolly and longleaf pine plantations were projected with low- and high-site productivity levels. For the comparison, the loblolly pine site index values (base age 25 years) were converted to equivalent site index values for longleaf pine (base age 50 years). Discounted cashflows were generated using 5 and 7 percent real discount rates. In all cases, longleaf pine was considered both with and without pine straw harvesting. Pine straw harvesting can add substantially to overall returns from a given rotation (Johnson 2008), making its inclusion an important consideration.

Management Regimes

Management regimes were selected from a reduced set of acceptable alternatives, which were constrained by management intensity and treatment timing. Reforestation activities follow those commonly used in loblolly and longleaf pine on suitable sites in South Carolina. Planting density and first-year survival were assumed to be identical for both species. Midrotation treatment timings were restricted to ranges considered biologically reasonable and commercially feasible, with management intensities based on commonly implemented rates. The regimes that maximized land expectation value (LEV) for each site/discount rate combination were chosen for further analysis. LEV is the present value per acre of the projected costs and revenues from an infinite series of identical rotations starting from bare ground, and may also be referred to as bare land value or soil expectation value.

Loblolly Pine—Loblolly pine plantations were projected using the Forest Nutrition Cooperative Decision Support System (LobDSS) (Amateis and others 2005). LobDSS interfaces with FASTLOB2, a whole stand growth-and-yield model developed by the Loblolly Pine Growth and Yield Research Cooperative at Virginia Tech. This model provides options for evaluating thinning and/or midrotation fertilization treatments (Amateis and others 2001). The effects of site conditions, site preparation, and first-year silvicultural treatments on loblolly pine plantation survival and growth are also modeled.

The LobDSS optimization routine was used for evaluating the impacts of midrotation fertilization and thinning timing and rotation length on economic valuation. Searches were constrained to one thinning treatment between ages 12 and 20 years, with a midrotation fertilization 1 year postthin. The thinning treatment removed every fifth row combined with thinning from below to 75 square feet per acre residual basal area. Thinned plantations were fertilized with urea at a rate of 200 pounds of nitrogen per acre.

Longleaf Pine—The FORSim Longleaf Pine Growth Simulator (LPGS) was used for projecting longleaf pine plantations (FORSight Resources 2007a, 2007b). LPGS serves as an interface to the longleaf pine growth engine, a stand-level model that simulates longleaf pine survival and growth, including the ability to simulate up to five thinning treatments during stand development.

Longleaf pine management regimes with either one or two thinning treatments were considered. Two thinning regimes, common in the generally longer longleaf rotations, were included in this analysis. The first thin was a 1-in-5 row per thin from below combination to 80 square feet per acre residual basal area. The second thin was from below to 70

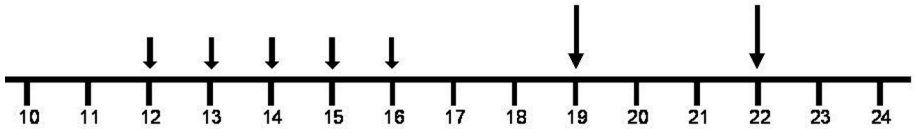

Figure 1—Time line illustration of a typical pine straw-raking cycle. Short arrows indicate enhancement activities and longer arrows indicate pine straw rakings.

square feet per acre residual basal area. The operational window for the first thin was between ages 15 and 30 years, and a second thin was considered after age 19 years. A minimum 4 years was required between thinning entries. The final harvest was allowed no earlier than 4 years after the final thinning treatment. Based on the level of site preparation, the number of years for the plantation to emerge from the grass stage and reach breast height (4.5 feet) was set at 3 years.

In addition to thinning treatments, longleaf pine management regimes with and without pine straw-raking cycles were examined. A pine straw-raking cycle included a 4-year enhancement period followed by a series of rakings (see fig. 1). The operational window for cycle commencement was limited to biologically feasible age ranges; ages 12 to 15 years for the first cycle and 23 to 32 years for the second. Thinning activities were not allowed during a raking cycle, and cycles could not commence until 2 years postthin.

Financial Analysis

Harvest volumes were merchandized using the product specifications shown in table 2. All harvested volumes were measured in tons. Site preparation, planting, and midrotation treatments are outlined in table 3, including treatment timing, application rate, and associated cost. All site preparation and planting activities are assumed to occur during the same year. Net revenues from longleaf pine straw harvest are based on typical contracts with local straw producers. Product prices and management costs used in the analysis were limited to those values available from published, verifiable sources.

LEV and present net worth (PNW) for the first rotation were calculated for each selected management regime using both 5 and 7 percent real discount rates. Because loblolly and longleaf rotation lengths differ, LEV provides the only means for directly comparing results. PNW provides a means for analyzing cashflows over the short term. Product prices and treatment costs and revenues were applied as outlined in tables 2 and 3. In all cases, activities were assumed to occur at the start of each year, i.e., January 1.

RESULTS

Selected Regimes

Table 4 shows the chosen regime for each case. The associated PNW for the first rotation and LEV are shown in table 5. Harvest removals for each case are reported in table 6. The percent-product recovery from all harvest operations and cumulative PNW over stand age by case/species combination are shown in figures 2, 3, and 4, respectively. Species-level results are analyzed in the following sections.

Table 2—Product specifications and stumpage prices

Product	Min. d.b.h.	Top diameter inside bark	Price
	---------- *inches* ----------		*dollars per ton*
Pulpwood	5	3	8.05
Chip-n-saw	9	5	18.98
Sawtimber	12	8	36.82

Loblolly Pine

Discount rate had no effect on thinning age but did result in an earlier final harvest (table 4). A comparison of case 1 to case 3 (and case 2 to case 4) indicates that reductions in both thinning and final harvest ages were associated with higher site. Figures 2 and 3 reveal that changes in site quality had little influence on product proportions removed from stands; sawable volume (sawtimber and chip-n-saw) is about 65 percent in all cases. However, with a 5-percent discount rate, the optimum rotation produced about 50 percent sawtimber, while only 35 percent sawtimber is produced using a 7-percent discount rate. The lowest ($212.75 per acre) and highest ($1,179.70 per acre) LEVs were associated with cases 2 and 3, respectively.

Longleaf Pine without Pine Straw

In all cases, regimes for longleaf pine plantations without pine straw harvests incorporated a single thinning treatment, and although the longleaf final harvests occurred slightly later than in loblolly, the economic rotations were shorter than those typically associated with longleaf management. This is expected since this study considers only economic factors and does not consider the amenity values that are often an important consideration elsewhere.

As with loblolly plantations, site quality was the driving factor behind thinning age. On the poorer site, longleaf plantations produced no sawtimber, but on the higher site sawtimber yield increased to 26 to 35 percent of total removal volume. As was the case for loblolly, total sawable volume (sawtimber and chip-n-saw) was about 65 percent in all cases. The lowest

Table 3—Costs and revenues for loblolly and longleaf pine treatment regimes

Description	Value
	dollars per acre
Loblolly pine	
Chemical hardwood control (CHEM) @ establishment	100.00
Hand plant @ 622 TPA with 95 percent first-year survival	81.10[a]
Herbaceous weed control (HWC) @ year 1	57.50
Establishment fertilization with 250 pounds DAP per acre @ year 1	47.50
Midrotation fertilization with urea @ 200 pounds nitrogen per acre	47.50
Longleaf pine	
Chemical hardwood control (CHEM) @ establishment	100.00
Broadcast burn @ establishment	15.00[b]
Hand plant @ 622 TPA with 95 percent first-year survival	102.87[a]
Pine straw harvest net revenue per raking	150.00[c]
Annual costs/revenue	
Management fee costs	5.00
Hunting lease revenues	7.00

TPA = trees per acre; DAP = diammonium phosphate.

[a] Hand planting—Georgia Forestry Commission (2008) and seedling cost—South Carolina Forestry Commission (2008).

[b] South Carolina Forestry Commission (2008).

[c] North Carolina Cooperative Extension Service (1995).

Table 4—Silvicultural treatment regimes by case/species

Case (discount rate)	Species	#1 Straw cycle[a]	#1 Thin/fert age	#2 Straw cycle[a]	#2 Thin/fert age	Final harvest
		years				
1	Loblolly (LP)	—	15/16	—	—	35
(5 percent)	Longleaf (LL)	—	25/—	—	—	33
	Longleaf (LL-S)	12	23/—	25	38/—	52
2	Loblolly (LP)	—	15/16	—	—	28
(7 percent)	Longleaf (LL)	—	25/—	—	—	33
	Longleaf (LL-S)	12	23/—	25	38/—	52
3	Loblolly (LP)	—	12/13	—	—	29
(5 percent)	Longleaf (LL)	—	23/—	—	—	32
	Longleaf (LL-S)	12	23/—	25	38/—	42
4	Loblolly (LP)	—	12/13	—	—	24
(7 percent)	Longleaf (LL)	—	23/—	—	—	27
	Longleaf (LL-S)	12	23/—	—	—	27

— = not applicable; Thin/fert = thinning and fertilization.

[a] Indicates age at which pine straw cycle begins.

Table 5—Present net worth and land expectation value by case/species

Case (discount rate)	Species	Present net worth (1st rotation)	Land expectation value
		---------- *dollars per acre* ----------	
1	Loblolly (LP)	501.93	610.64
(5 percent)	Longleaf (LL)	245.23	307.83
	Longleaf (LL-S)	548.02	592.91
2	Loblolly (LP)	182.75	212.75
(7 percent)	Longleaf (LL)	49.25	53.37
	Longleaf (LL-S)	174.82	178.11
3	Loblolly (LP)	895.10	1,179.70
(5 percent)	Longleaf (LL)	765.82	966.69
	Longleaf (LL-S)	968.24	1,109.14
4	Loblolly (LP)	469.74	582.60
(7 percent)	Longleaf (LL)	385.42	456.96
	Longleaf (LL-S)	503.31	597.46

Table 6—Thinning and final harvest volume removals by case/species

Case (discount rate)	Species	1st thin	2nd thin	Final harvest	Total
		---------- *tons per acre* ----------			
1	Loblolly (LP)	25.80	—	132.30	158.10
(5 percent)	Longleaf (LL)	27.27	—	108.08	135.35
	Longleaf (LL-S)	15.43	55.23	120.21	190.88
2	Loblolly (LP)	25.80	—	104.40	130.20
(7 percent)	Longleaf (LL)	27.27	—	108.08	135.35
	Longleaf (LL-S)	15.43	55.23	120.21	190.88
3	Loblolly (LP)	31.90	—	158.30	190.20
(5 percent)	Longleaf (LL)	64.13	—	135.78	199.91
	Longleaf (LL-S)	56.16	51.50	126.04	233.70
4	Loblolly (LP)	31.90	—	135.10	167.00
(7 percent)	Longleaf (LL)	64.13	—	116.84	180.97
	Longleaf (LL-S)	56.16	—	116.64	172.80

— = not applicable.

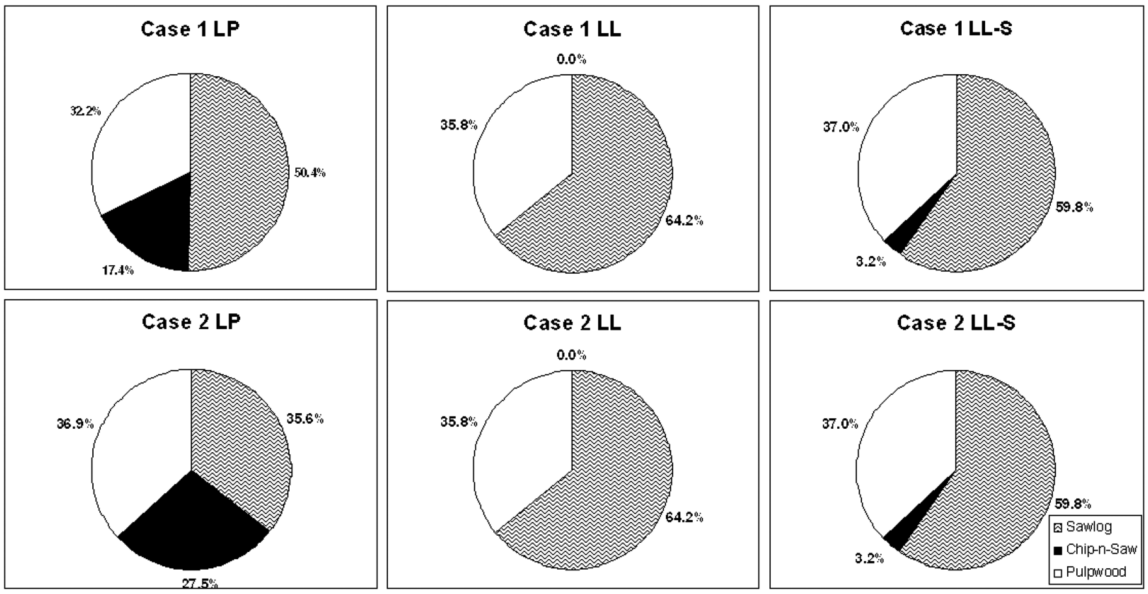

Figure 2—Percent product recovery, cases 1 and 2 (all species and regimes).

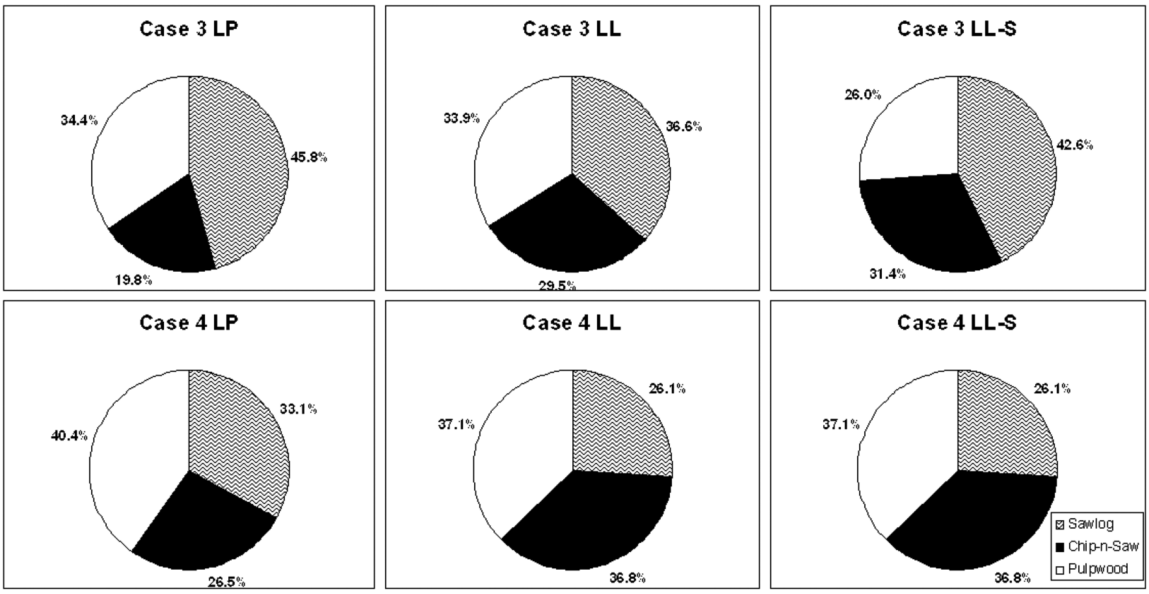

Figure 3—Percent product recovery, cases 3 and 4 (all species and regimes).

($53.37 per acre) and highest ($966.69 per acre) LEVs were associated with cases 2 and 3, respectively (table 5).

Longleaf Pine with Pine Straw

For all cases, adding pine straw harvests greatly improved the financial performance of longleaf pine plantations. Management regimes included two thins and two pine straw-raking cycles in all cases except case 4. The first pine straw-raking cycle began at the earliest feasible age in all cases, indicating the importance of early revenues to overall net present worth. Regimes were identical for the first three cases, indicating that pine straw revenues dominated the economic impacts of site and discount rate. The carrying costs of holding the stand long enough to produce a second thin and straw raking exceeded the increased revenues attributed to the longer rotation with the higher discount rate used in case 4. Site quality had the largest impact on product recovery percentages. Virtually all of the sawable material produced on the low site was sawtimber, with a more

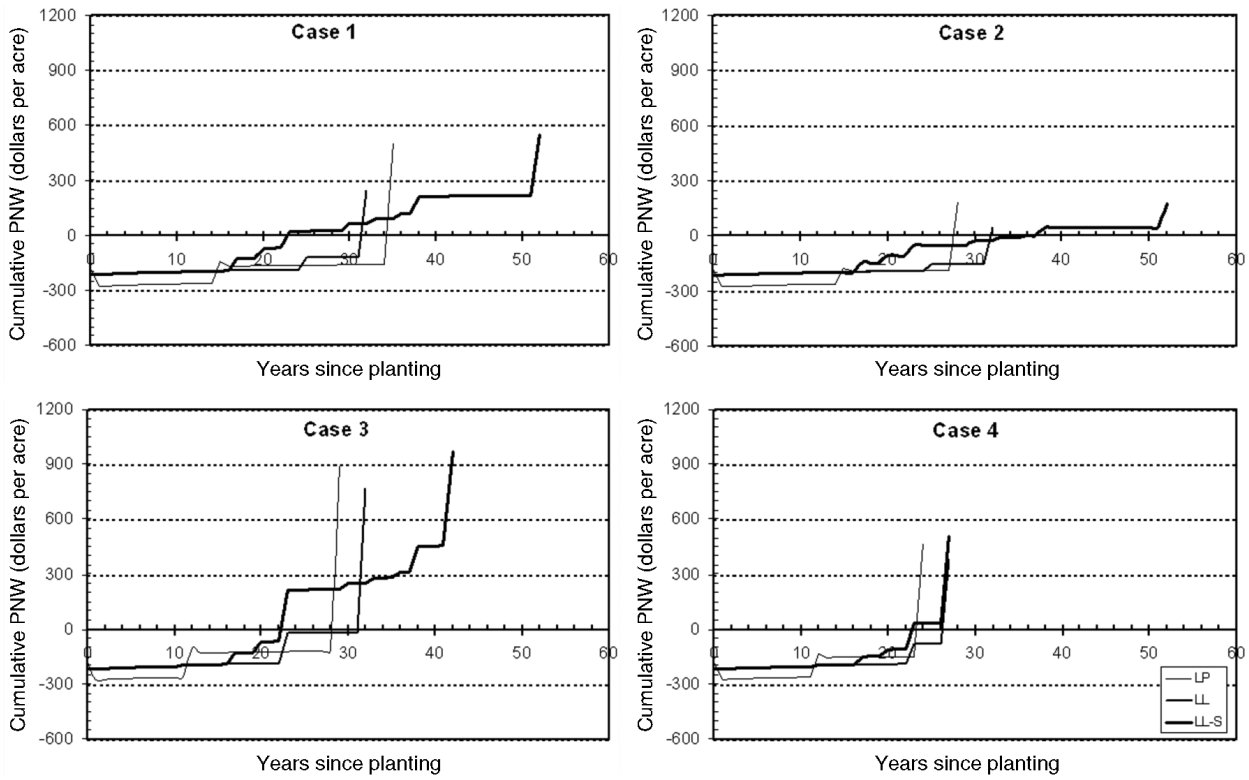

Figure 4—Cumulative present net worth by stand age for cases 1 through 4.

even breakdown among products on the high site. On the high site, more sawable wood (sawtimber and chip-n-saw) was produced than either loblolly or longleaf without pine straw raking (75 percent sawable compared to 65 percent). Minimum ($178.11 per acre) and maximum ($1,109.14 per acre) LEVs were associated with cases 2 and 3, respectively (table 5).

Species Comparison

The addition of pine straw raking to longleaf pine management regimes resulted in improved financial results (13 to 70 percent higher than without pine straw raking) that compared favorably with the loblolly pine management regimes (table 5). The loblolly regimes produced LEV values 3 to 16 percent higher than longleaf in all cases except case 4, where longleaf exceeded the corresponding loblolly LEV by 2.6 percent.

An examination of the cashflows in figure 4 reveals that the cumulative PNW (dollar per acre) from loblolly pine plantations remained negative until the final harvest in all cases. However, pine straw harvests yield positive cashflows earlier in the rotation, especially for longleaf pine plantations on lower sites and evaluated using lower discount rates. In terms of product recovery percentages, longleaf pine plantations with pine straw harvests and longer rotations produced a higher percentage of sawable wood compared to short rotations for loblolly pine plantations (figs. 2 and 3).

Research reported at Auburn University indicates greater pole production in 39-year-old longleaf stands (72 percent) than in loblolly pine stands (<8 percent) of the same age. Figure 5 illustrates the impacts of pole production on LEVs using the management regimes for LL-S in table 4. With as little as 25 percent of the sawtimber volume classified as poles, longleaf pine with straw raking financially outperforms loblolly at all site index and discount rate combinations. Note that the regimes outlined in table 4 may produce suboptimal LEVs when pole production is considered. As a result, the comparison may be even more favorable than indicated in figure 5.

DISCUSSION

Results indicate that longleaf pine regimes that do not incorporate pine straw raking yield financial results that are inferior to those from intensive loblolly management. With the addition of pine straw revenues, however, longleaf management can yield returns that are comparable to typical loblolly pine regimes (–16 to +3 percent, depending on site quality and discount rate). In fact, longleaf pine plantations with pine straw harvests produced greater LEVs than loblolly plantations on lands with higher site index (80 and 110 feet for loblolly pine and longleaf pine, respectively) when using the higher discount rate (7 percent). Other longleaf pine management regimes produced lower but comparable financial performance. Furthermore, figure 5 indicates that there may be additional upside potential for longleaf when pole production is considered.

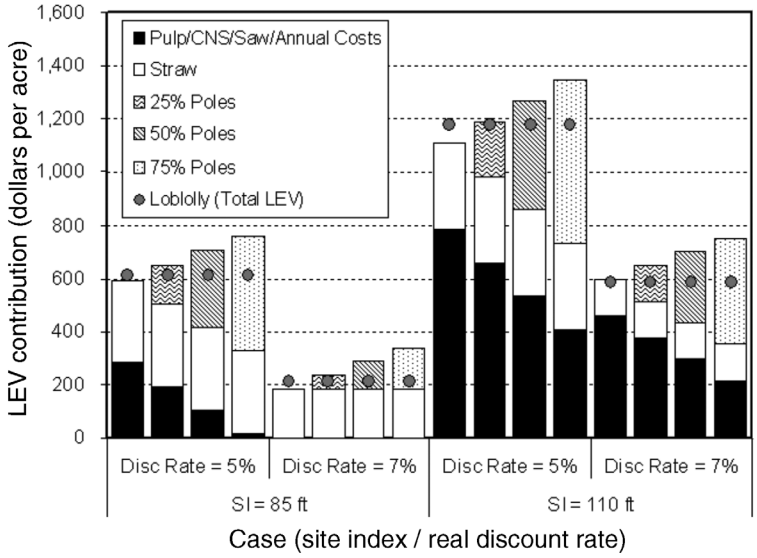

Figure 5—Land expectation value (LEV) for longleaf pine plantations with varying proportions of sawtimber considered eligible for poles.

It should be noted that LobDSS downgrades a portion of loblolly sawtimber trees into the pulpwood class, a behavior absent from LPGS. This may have caused an elevated sawtimber proportion in the longleaf product recovery. In addition, while this study assumes equal seedling survival between longleaf and loblolly pine, longleaf seedling survival may in fact be lower.

Several factors seem to indicate that longleaf may perform even better than indicated in this analysis. Citing a report by John Guthrie and Son's, Inc., Johnson (2008) points to evidence that average timber sale prices were 10 to 20 percent higher when species composition was primarily longleaf pine. Given that longleaf regimes consistently produce higher total yield (table 6), this may lead to even more favorable comparisons between the species. A longleaf price premium was not included in this analysis due to a lack of widespread, documented evidence that such a premium exists. In addition, some authors have indicated that current site preparation practices may reduce time to leave grass stage below the 3 years used in this paper (Johnson 2008). Reducing the length of time spent in the grass stage shortens the overall rotation length with commensurate improvements in PNW and LEV.

At lower discount rates longleaf pine regimes with pine straw raking provided positive cashflows sooner than loblolly (figs. 3 and 4). In all cases, however, positive cashflows were not achieved with any regime until after age 23. This result is noteworthy because this may be longer than the land tenure of closed-end funded TIMO ownerships. Because there is likely to be little to no direct return on reforestation investments under these short land tenures, a logical consequence may be the minimization of reforestation expenses. Thus, longleaf pine may be a more attractive alternative, given the 25-percent lower initial investment ($217 per acre vs. $286 per acre for loblolly) and the favorable LEV comparison.

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