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Natural and artificial loblolly pine regeneration and upland mixed hardwoods natural regeneration economic comparisons using three stumpage price sets

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Abstract

The objective of this paper is to address and compare growth rates and economics of natural versus artificial loblolly pine regeneration and upland mixed hardwood natural regeneration using three pine and hardwood stumpage prices. The pine and hardwood stumpage prices used here are from Timber Mart South (TM-S 1976-2013, and 2017). The reasoning for addressing natural versus artificial loblolly pine regeneration and upland hardwood natural regeneration is, in part, due to many forest landowners and land managers questioning the investment in artificial pine regeneration when natural regeneration options may exist in some pine stands and the relative value to upland mixed hardwood stands historically and as of 2017. Southeastern US and Georgia Pine and hardwood stumpage prices have change dramatically since 1976 (Figures 1 and 2). The primary financial measure of profitability used in this paper is Soil Expectation Value (SEV) also known as Bare Land Value (BLV) and Land Expectation Value (LEV) since different rotation ages are used to grow out natural loblolly and upland mixed hardwoods and planted loblolly pine. The discount rates used are 4 and 6 percent. Merchantable wood mean annual increments, gross wood dollar per acre incomes and total wood incomes over the rotation and internal rate of return (IRR) will also be presented.

Introduction

Private non-industrial forest (NIPF) landowners in the from Virginia to East Texas may question whether to site prep and plant loblolly pine (artificial regeneration) on cut-over land or naturally regenerate some of these sites. Naturally regenerated upland mixed hardwood stands are also found on many acres in the SE US and some forest landowners wish to know how cash flows and Bare Land Values compare on these hardwood sites versus naturally and artificially regenerated loblolly stands. They also question spending moderate to relatively large sums of money in site preparation, loblolly pine seedlings and planting under the current and anticipated stumpage prices and economic uncertainty. To address these questions, we used the Georgia Pine Plantation (GaPPs 4.20) growth and yield Model developed by Bailey and Zhao (1998) for artificial loblolly regeneration wood yields in a 33-year, two thin (at ages 15- and 24-years to 65 square feet basal area per acre thinning from below). Slightly modified loblolly pine natural regeneration wood yields used here were from Dangerfield and Moorhead (1997) on a 38-year rotation (seed trees cut at age 42-years with an understory of three to four year old loblolly seedlings/saplings in place). The upland mixed hardwood wood yields were from (Gingrich, Loyd, and Case 2002) on a 50 year rotation.

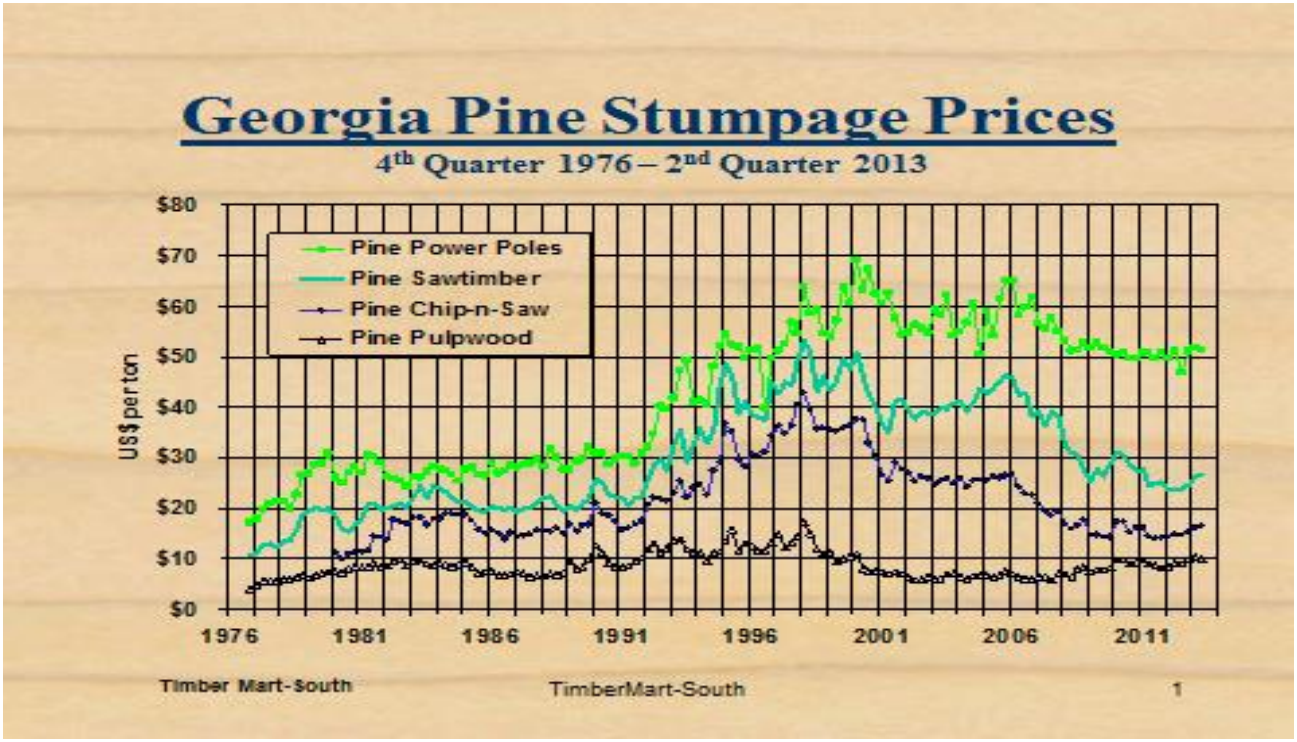

Figure 1. Georgia state-wide average pine stumpage prices from 4th quarter 1976 through 2nd quarter 2013 by product class

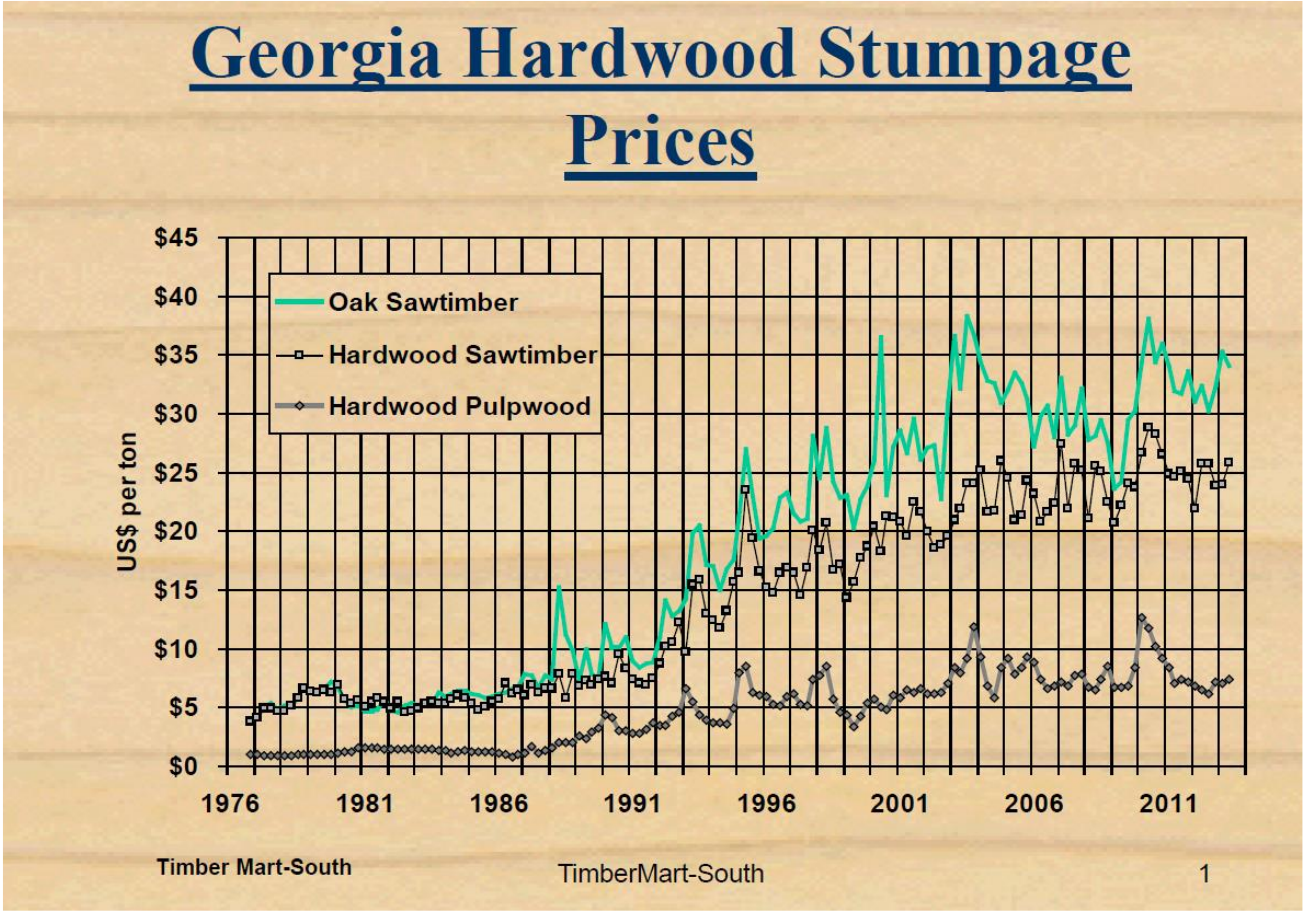

Figure 2. Georgia state-wide average hardwood stumpage prices from 4th quarter 1976 through 2nd quarter 2013 by product class (TM-S)

Financial Calculations

Soil expectation value (SEV) is also known as bare land value (BLV) or land expectation value (LEV). SEV is the present value of an infinite series of identical rotations calculated at some discount rate. Put another way, SEV uses the present value of a perpetual periodic series formula to calculate the present value of an infinite series of identical rotations (Bullard and Straka 1993). At a given discount rate various species' rotation ages can be compared with the highest SEV being the most attractive and the lowest SEV being least attractive. SEVs were calculated using the Biomass Green Weight Estimation and Financial Analysis Tool (Love, 2011) and checked for accuracy using FORVAL online (Bullard and others. 2001) and an excel spreadsheet developed by Li and Dickens (2017). Gross wood revenues per acre are straightforward economic calculations of adding up all thinning and clear-cut sale incomes for a total revenue per acre. The gross wood revenue for each loblolly or upland mixed hardwood scenario is calculated with no discounting of costs or returns back to time zero or compounding forward costs and returns to the end of the rotation.

The rate or return (ROR) for a given scenario is the rate of compound interest that is earned by costs invested. ROR is the average rate of appreciation during the life of the project (Bullard and Straka 1993). ROR is calculated by finding the compound interest rate that is equal to the total present value of costs with the total present value of revenues; the interest rate where Net Present Value is equal to zero. ROR is also known as Internal Rate of Return (IRR) and Return on Investment (ROI). Rate of Returns were calculated using the Biomass Green Weight Estimation and Financial Analysis Tool (Love,

2011) and checked for accuracy using FORVAL online (Bullard and others. 2001) and an excel spreadsheet created by Li and Dickens (2017 personal communication).

Gross wood revenues and Rate or Return are useful when comparing scenarios of the same time duration (rotation age). A shortcoming of gross wood revenue values is that they lack the time value of money. Some of the shortcomings of Rate or Return values are: (1) they lack scale (how large or small investments amounts are returning or losing for each scenario) and (2) due to the mathematics to calculate ROR, intermediate costs and returns are assumed to be re-invested at the ROR interest rate calculated which may not be achievable in real-world scenarios.

Methodology

Assumptions

The artificial loblolly pine regeneration scenario (chemical site preparation, a site prep burn, buying quality genetically improved seedlings and planting) rotation age was set at 33-years. Two commercial (income) thinnings at ages 15- and 24-years to a residual basal area of 65 square feet removing the smaller diameter trees (thinning from below) were used in the GaPPS model with a mean annual merchantable wood (plus bark) increment (MAI) of 5.85 tons/acre/year (Table 1).

The natural loblolly pine regeneration scenario (a site prep burn only to prepare the seed bed for the remaining 10 to 15 co-dominant and dominant trees per acre to seed the site in, hence natural regeneration) had a pre-commercial thinning at age 7-years, commercial thinnings at age 28- and 38-years (back to best 10 – 15 trees per acre), and the seed tree cut at age 42-years with three to four year old seedlings in place. The merchantable wood mean annual increment was 3.0 tons/acre/year for the 38-year rotation (Table 2).

The natural mixed (primarily maple, oak, and sweetgum) upland hardwood regeneration scenario had a pre-commercial thinning at age 20-years and commercial thinnings at ages 30- and 40-years and a clear-cut with advanced regeneration in place for the next rotation at age 50-years. The merchantable wood mean annual increment was 2.2 tons/acre/year for this 50-year rotation (Table 3).

Costs for the three scenarios:

For all three scenarios the following annual costs were used. Fire protection cost was assumed$2/acre/year, stand management at $2/acre/year, and property taxes at $6/acre/year. Thus, the total annual costs for each year of the rotation were $10/acre. Results are reported in constant dollars, before federal and state income or capital gains taxes. It is assumed that land is already owned. Regardless of what one is growing, there are costs to owning land.

► The artificial loblolly pine regeneration site preparation cost of $110/acre included chemical site preparation @ $75/acre and a site prep burn @ $35/acre (current average costs for these activities in Georgia). This site prep cost was for those acreages where a mechanical treatment was not warranted.

Loblolly seedlings were assumed to cost $75 per 1000 and planted at 726/acre (6x10 ft spacing) for a per acre cost of $55. Planting cost per acre was assumed to be $80.

The total cost per acre for the site preparation, seedlings and planting for the artificial loblolly pine regeneration scenario was $245. Other combinations of site preparation, burning (on no burning) and/or mechanical site preparation, seedlings and planting scenarios may also, cost-wise, be approximately equal to the total cost presented and used here. Site preparation options and associated costs vary extensively by location, prior stand history, harvesting utilization, and contractor competition. Landowner objectives, monies available, and anticipated future stumpage value and demand also affect the site preparation method(s) chosen. The assumption used was that level of site preparation intensity was matched to level of competition control needed so that wood-flows were comparable within site productivity levels, after site preparation and planting.

► The natural regenerated loblolly scenario had a cost of $25/acre for site prep burn in early fall prior to seed fall to prepare the seed bed after the second thinning and four years prior to the seed tree removal and a pre-commercial thinning at age 7-years at a cost of $140/acre to achieve a more consistent trees per acre spacing (loblolly pine natural regeneration stocking is usually very variable with from 300 to 2500 seedlings per acre and, if left as is, can cause very low growth and a long time to merchantable wood size).

► The natural regenerated upland mixed hardwood scenario had a cost of $150/acre for a pre-commercial thin at age 20-years.

Product class specifications:

Pine Product class specifications are:
► pulpwood (PW) at a d.b.h. of 4.6 to 9 inches to a 3 inch top;
► chip-n-saw (CNS) at a d.b.h of 9 through 12 inches to 6 inch top; and,
► sawtimber (ST) with a d.b.h greater than 12 inches to a 10 inch top were assumed.

Hardwood Product class specifications are:
► pulpwood (PW) at a d.b.h of 10 through 14 inches to an 8 inch top and
► sawtimber (ST) with a d.b.h of greater 14 inches to a 10 inch top were assumed.

Three sets of pine stumpage and hardwood prices were used in this economic paper (Table 4).

(1) The Georgia statewide historic average (4th quarter 1976 through 2nd qtr 2013) for pine
(2) The Georgia statewide 1999 four quarter average for pine and hardwoods
(3) The Georgia statewide 1st, 2nd and 3rd quarter 2017 pine and hardwood prices

Merchantable Wood Yields

Table 1. Site prep and planted (artificial regeneration) loblolly pine harvested wood yields by age.

Age	---------- tons/acre ----------		
(years)	pulpwood	chip-n-saw	sawtimber

15	25		
24	21	24	2
33	23	43	55

Mean annual increment = 5.85 tons/acre/year

Table 2. Naturally regenerated loblolly pine harvested wood yields by age.

Age	---------- tons/acre ----------		
(years)	pulpwood	chip-n-saw	sawtimber
28	25		
38	8	49	20
42		2	10

Mean annual increment = 3.00 tons/acre/year

Table 3. Naturally regenerated upland mixed hardwood harvested wood yields by age.

Age	---------- tons/acre ----------		
(years)	pulpwood		sawtimber
30	25		
40	25		10
50	10		40

Mean annual increment = 2.20 tons/acre/year

Stumpage price sets

Table 4. Pine and hardwood stumpage price sets used in economic analysis ($/ton); GA statewide TM-S.

Pine prices	1976-2013(pine) or 2017 (hdwd) average	1999 average	2017 average
Pulpwood	9	10	12
Chip-n-saw	22	36	18
Sawtimber	30	46	24
Hardwood prices			
Pulpwood	5	5	8
Sawtimber	16	15	32

Table 5. Scenario Soil Expectation Values ($/acre) using a 4% discount rate using three stumpage price sets.

Scenario	---------- historic or year average stumpage price sets ----------		
	1976–2013 pine, 2017 hwd	1999 average	2017 average
site prep+plant loblolly	1064	1861	934
natural regen loblolly	248	586	181
upland mixed hardwoods	-103	-112	91

Pine and hardwood stumpage price sets used are from Table 4.

Table 6. Scenario Soil Expectation Values ($/acre) using a 6% discount rate using three stumpage price sets.

Scenario	---------- historic or year average stumpage price sets ----------		
	1976–2013 pine, 2017 hwd	1999 average	2017 average
site prep+plant loblolly	363	745	312
natural regen loblolly	-11	133	-36
upland mixed hardwoods	-124	-128	-48

Pine and hardwood stumpage price sets used are from Table 4.

Table 7. Merchantable wood mean annual increment of growth (tons/acre/year) and internal rate of return by scenario.

Scenario	---------- historic or year average stumpage price sets ----------		
	1976–2013 pine, 2017 hwd	1999 average	2017 average
site prep+plant loblolly MAI = 5.85	8.6	10.3	8.5
natural regen loblolly MAI = 3.00	5.8	7.4	5.5
upland mixed hardwoods MAI = 2.20	2.4	2.2	5.0

Pine and hardwood stumpage price sets used are from Table 4.

Table 8. Rotation gross merchantable wood revenues by scenario using 2017 average prices.

Scenario			
	1st thin income	2nd thin income	Final harvest & (total) $/acre income
site prep+plant loblolly MAI = 5.85	300	732	2370 (3402)

natural regen loblolly MAI = 3.00	300	1164	276[ł] (1740)
upland mixed hardwoods MAI = 2.20	200	520	1360 (2080)

[ł] seed tree cut

Results

Soil Expectation Values by Scenario and Stumpage Price Set

The site prepped and planted, two thin, 33-year loblolly rotation produced the highest SEVs by a large margin compared to the natural regenerated 38-year loblolly scenario and the 50-year upland mixed hardwood scenario using the 4 and 6 percent discount rates (Tables 5 and 6). The 38-year naturally regenerated loblolly scenario produced SEVs much greater than the 50-year, two thin naturally regenerated upland mixed hardwood scenario using the Georgia statewide historic average and the Georgia statewide 1999 average stumpage prices sets using the 4 and 6 percent discount rates (Table 5 and 6), but the difference was much less using the respective pine and hardwood Georgia statewide 2017 average prices at the 6 percent discount rate (Table 6).

The Georgia statewide 2017 hardwood average prices were 1.6 fold greater for pulpwood ($5 versus $8/ton) and 2 to 2.13 fold greater for sawtimber ($32 versus $15 or $16/ton) than the historic average of the 1999 hardwood prices. The Georgia statewide 2017 average prices for pine pulpwood were 1.2 to 1.33 fold greater than the historic average or the 1999 average. The Georgia statewide 2017 average pine chip-n-saw prices were 1.22 to 2 fold lower than the historic average and the 1999 prices, respectively and the sawtimber prices were 1.25 and 1.9 fold lower than the historic statewide average and the 1999 price set, respectively (Table 4).

Internal Rate of Return values and gross wood revenues

The site prepped and planted 33-year loblolly rotation produced IRRs of 8.6, 10.3 and 8.5 percent using the Georgia Historic historic average, 1999 average and the 2017 average pine stumpage prices, respectively (Table 7). The naturally regenerated 38-year rotation loblolly scenario produced IRRs of 5.8, 7.4 and 5.5 percent for the historic average, 1999 average and the 2017 average, respectively. The 50-year upland mixed hardwood scenario produced IRRs of 2.2, 2.4 and 5.0 percent using the historic average, the 1999 average and the 2017 average hardwood prices, respectively (TM-S, Table 7).

Using the most recent Georgia statewide pine and hardwood stumpage prices (TM-S 2017, Table 4), gross wood revenue was greatest for the site prepped and planted 33-year, two thin loblolly pine scenario at $3402/acre. The 50-year, two thin naturally regenerated upland mixed produced the second most income from wood sales at $2080/acre (Table 8). The 38-year, naturally regenerated loblolly scenario produced the least wood sales income at $1740/acre (Table 8). The site prepped and planted 33-year rotation loblolly scenario gross wood revenue total was 1.64 fold greater than the upland mixed hardwood scenario and approximately 2 fold greater than the naturally regenerated loblolly scenario realized in a shorter time frame (33- versus 38- and 50-years).

Impact of artificial or natural loblolly pine and upland mixed hardwood growth rates on gross wood revenue and Rate of Return

The site prepped and planted loblolly pine, two thin, 33-year rotation, due to its higher growth rate (5.85 tons/acre/year versus 3.0 and 2.2 tons/acre/year) and more wood produced across all three product classes produced higher SEVs, IRRs and gross wood revenues then the naturally regenerated loblolly pine and upland mixed hardwood scenarios and rates of return. These results occurred even with an upfront cost of $235/acre for site prep, seedlings and planting versus the lower costs of $25 site prep burn to prepare the seed bed and the $140/acre to pre-commercial thin the stand at age 7-years for the naturally regenerated loblolly and the $150/acre pre-commercial thin at age 20-years for the upland mixed hardwood scenario.

Summary and Discussion

Non-industrial private forest landowners do have some attractive forest management options for natural and artificial regeneration of loblolly pine and natural regeneration of upland mixed hardwood sites. On large landscapes, we tend to find areas that lend themselves to upland mixed hardwood management with an emphasis on wildlife, the soils may be more conducive to hardwoods, or there is quality advanced regeneration in the understory after the hardwood clear-cut. Other areas of thinned loblolly pine may have a well stocked understory of pine seedlings and saplings and the landowner may want to use those young trees as the next rotation. To maximize SEVs, gross wood revenues, and IRRs, landowners need to be flexible when thinning or clearcutting their stands, possibly looking into a 3 to 5 year horizon and closely following local pine stumpage prices. Selling wood when stumpage prices are relatively high in these planning horizons can improve SEVs, IRRs and gross wood revenues. The findings in this paper are specific to the assumptions made. Changes in assumptions will alter the results which can alter scenario attractiveness when compared than others. In this paper growth rates, establishment costs, and stumpage price sets may be different than what some forest landowners would use. Familiarize yourself with financial tools like the Biomass Green Weight Estimation and Financial Analysis Tool (Love, 2011) that was used here or FORVAL online (Bullard and others. 2001).

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