



Reforestation tax incentive impacts on financial returns of loblolly pine plantations for family forest landowners in Mississippi

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Abstract

Rates of return from forest plantation investments depend not only on survival and growth rates, but also costs and revenues associated with various practices. Beyond that, tax related issues are another important consideration that are often not addressed, or directly addressed at least, in forest financial assessments. Many financial assessments can be defined as “before-tax.” Forest landowners within Mississippi have the potential to reduce reforestation cost burdens through two important tax-related opportunities. The first being the Federal reforestation deduction and amortization provisions and the second being the state-based reforestation tax credit. An overabundant supply of wood in Mississippi has resulted in fairly poor pine market conditions, particularly for pulpwood stumpage. This has resulted in the likelihood of marginal returns for many landowners without some type of assistance. Beyond that, substantial inflation and increases in fuel costs have resulted in greater reforestation costs plus additional reductions in stumpage values, among other reasons, because of greater costs for loggers during forest harvesting operations.

The impacts of these two income tax reduction opportunities on loblolly pine financial returns were examined for three planting densities of 1,122 and 1,282 and 1,495 seedlings ha⁻¹ for a site index 19.8 m site (base age 25). A combination of chemical and mechanical site preparation was conducted and mass control pollinated (MCP) bareroot seedlings were hand-planted. Varying degrees of rectangularity were assumed, reducing reforestation costs. A first-year herbaceous weed control treatment was implemented but no thinnings and fertilization treatments were conducted. A final harvest clearcut was conducted at age 26. For Federal income tax purposes, a landowner classified as an Investor within the 22% Federal income tax bracket was assumed. Whether before-tax or after-tax, the most viable planting density financially was found to be 1,122 ha⁻¹ seedlings. Reduced reforestation costs and greater yields ha⁻¹ of the more valuable sawlog product class were found to be more influential on landowner financial returns than any reforestation tax provisions.

Keywords

Income tax; *Pinus taeda*; growth and yield; deduction; amortization; tax credit

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1 Introduction

Loblolly pine (*Pinus taeda* L.) plantations are an important source of wood fiber for Mississippi forestry and timber industries. In 2021, pine comprised around 86.9% of the annual timber harvest in the state (Measells and Auel 2022), and loblolly pine plantations occupied around 26.7% (2,076,392 ha) of the total USDA Forest Service Forest Inventory and Analysis (FIA) defined forestland area in the state (USDA Forest Service 2023). Despite its importance to these two industries, pine plantation investment at the current time across much of Mississippi is marginal because of an oversupply of wood (Measells 2020; Lamichhane 2024; Forisk Consulting 2024). Pine pulpwood stumpage price across the state has substantially decreased over the past 20 years (Measells 2020; Lamichhane 2024; TimberMart-South 2024), and this decrease is a nominal price decrease, and hence the impacts of inflation have essentially reduced the value of pulpwood stumpage to an even greater extent. In addition, many landowners cannot conduct a first thinning on their property because of the lack of profitability for loggers, and thus the availability of loggers. Hence, many landowners are struggling to obtain more valuable chip-n-saw and sawlog yields, and thus it is somewhat difficult to justify investment in these plantations given current market conditions.

Therefore, Federal (FSA 2024; NRCS 2024) and State cost-share programs (Mississippi Forestry Commission 2024) and reforestation tax incentives (United States Code 2024, Mississippi Department of Revenue 2024) are extremely important for landowners to obtain reasonable financial returns on investment and in helping to maintain this important supply of wood for the state's economy. The Federal Income Tax Reforestation Deduction and Amortization incentives are available to many landowners across the country. In addition, the State of Mississippi currently has the

very unique Reforestation Tax Credit, which provides a nonrefundable tax credit against state income tax liability up to \$10,000 annually to offset costs of practices leading to the reforestation of a property. This analysis examines how much these two reforestation incentives can help reduce the costs of establishing loblolly pine plantations, thus leading to maximizing financial returns in Mississippi. A more detailed explanation of both incentives is provided below, and is based on Li et al. (2024) and VanderSchaaf (2024). Additionally, for these analyses, it is assumed that a landowner is not seeking any reforestation payments from Federal or State cost-share programs.

Prior to describing these two tax programs, one should understand the difference between a tax deduction, an amortization, and a tax credit. A deduction reduces the amount of income tax that a landowner owes tax on. The actual benefit to the landowner is essentially calculated as a percentage of the deduction amount, where the percentage is the marginal tax rate. The marginal tax rate depends on the landowner's ordinary income tax bracket (e.g. 12%, 22%, 24%), where the tax bracket depends on the taxable income (e.g., line 15 of IRS U.S. Individual Income Tax Return Form 1040) of a landowner. Deductions reduce taxable income for the year in which the practice leading to the deduction occurred. An amortization is similar to a deduction, except that an amortization reduces taxable income across a predetermined tax period. An amortization can essentially be thought of as a deduction taken over several tax years. Thus, given inflation, and the ability to gain interest upon any money generated to the landowner from a deduction, a deduction is superior to an amortized deduction (or amortization). A tax credit is advantageous since it is a reduction in the amount of income tax owed dollar for dollar. Thus, the key difference of a tax credit is that it is a straight reduction in the amount of tax owed (e.g., top of page 2 of the IRS U.S. Individual Income Tax Return Form 1040), not a reduction in the amount of income on which tax is owed. Therefore, a tax credit is a 1 to 1 reduction in income tax, and is basically in units of a dollar, and is therefore superior. Some tax credits can be carried forward or backwards across tax years, and some are refundable, meaning that if the credit exceeds income tax liability the taxpayer essentially generates an income.

1.1 Federal income tax reforestation deduction and amortization incentives

For any justified (qualified) reforestation expenditure in a particular tax year, a landowner can deduct up to \$10,000 for any qualified timber property (QTP). For any amount of justified (qualified) reforestation costs greater than \$10,000 in a particular year, a landowner can amortize that amount over an 84-month period, over 8 tax years due to the half-year convention. In the first tax year and the last, or eighth tax year, 1/14th of the reforestation expenses in excess of \$10,000 can be deducted while in tax years 2 to 7, 1/7th of the expenses can be deducted.

There are some limitations in the applicability of these provisions to a landowner. Since landowners classified as Investment (Investors) or Business (or Trade) have a clear profit motive, they can use these two provisions. Any use of these two incentives, or provisions, reduces the landowner's timber tax basis by the amount deducted or amortized. A timber tax basis is important because it can be used to reduce the amount of taxable income generated, or capital gain, from a timber harvest (Henderson et al. 2019; Li et al. 2024). However, given the time value of money, inflation, and that any amount of capital (money) in a timber tax basis does not earn interest, plus deductions will offset ordinary income which have higher tax rates than

long-term capital gains, this likely makes deductions near the time of planting advantageous to waiting 13 or more years for a timber harvest (e.g., first thinning, subsequent thinnings, and final harvest clearcut) to apply the timber tax basis against timber harvest income. The financial value of a timber tax basis today is what it will be 15, 20, or 30 years into the future, there is no interest earned on a tax basis. Beyond that, inflation reduces the “buying power” or “value” of a timber tax basis.

These Federal provisions are highly advantageous as well because they can be used to offset any source of income, whether it be wage, salary, or capital gain. Ironically, these provisions (particularly the amortization) may reduce taxes owed to a greater extent for landowners who spend more on reforestation, or those with higher incomes and hence higher income tax brackets and marginal tax rates.

The definition of a Qualified Timber Property (QTP) is subjective and can lead to confusion. For simplicity, for this analysis, we will just assume it is a particular loblolly pine plantation, whether the area is 4.0 ha, 20.2 ha, or 121.4 ha. These reforestation tax incentives offer some extremely important advantages when compared to cost-share programs; there is no sign-up period and no waiting in line or a ranking system.

1.2 Mississippi State income tax nonrefundable reforestation tax credit

The State of Mississippi offers nonindustrial private forest landowners (NIPF) the opportunity to use up to 50% of the costs incurred during a tax year associated with conducting approved reforestation activities to offset that tax year’s state income tax liability (VanderSchaaf 2024). The maximum credit amount that can be received annually is \$10,000. It should be made clear though, that the nonrefundable credit only offsets income tax liability. Thus, if a landowner’s income tax liability in any year is less than \$10,000 or any other amount of tax credit received, the remainder of the credit carries over to subsequent tax years until it is fully utilized. For example, if a landowner owes \$2,000 in Mississippi state income tax during the year in which the reforestation costs were incurred, and assuming the landowner qualified for \$10,000 of tax credit, the \$10,000 annual tax credit will only offset the \$2,000 income tax liability, and the remaining \$8,000 will carry over for use in subsequent tax years to offset Mississippi state income tax liability, and so forth. Each tax year, beginning with the tax year in which reforestation costs were first incurred, a landowner can earn up to \$10,000 in nonrefundable tax credit, and tax credit amounts incurred in each year can be carried forward to succeeding tax years to offset Mississippi state income tax liability up to a lifetime total of \$75,000 in nonrefundable tax credit.

As with the Federal income tax provisions, there are certain restrictions for landowners to qualify; a partial description follows. Firstly, only Mississippi taxpayers reforesting Mississippi land can claim the nonrefundable credit (e.g., Mississippi Department of Revenue Individual Income Tax Form 80-315). Secondly, a landowner must have an approved reforestation plan produced by a Registered Forester. Thirdly, in most cases, any costs of practices conducted on ha receiving Federal or State cost-share assistance funds for that same practice are not eligible for the tax credit. Fourthly, there are only certain practices approved by the Mississippi Forestry Commission (MFC), and each tax year the MFC establishes reasonable average costs for each practice (to avoid abuse). Practices include the costs of seedlings (different prices for bareroot versus container), costs of labor for the actual planting of seedlings, various site preparation activities, and a first-year herbaceous weed control treatment. Total

reforestation costs eligible for the credit is 50% of the lesser of either 1.) the actual costs for approved reforestation practices or 2.) the average costs as established by the MFC for approved reforestation practices (once again to avoid abuse) up to a \$10,000 annual maximum. Currently, for loblolly pine plantations, the targeted planting density ha^{-1} must be 1,112 seedlings or greater, and there does not appear to be any direct restrictions on planting configuration (e.g., rectangularity).

1.3 Reducing reforestation costs silviculturally

Beyond reforestation tax provisions, landowners should consider other methods to reduce reforestation costs such as reducing their planting density and establishing seedlings in varying degrees of rectangularity (as opposed to a square configuration). Planting fewer seedlings ha^{-1} decreases the costs of purchasing the seedlings, it will also decrease the cost of placing the seedlings into the ground. Beyond that, the costs of any operation that depends on the number of passes on a property, such as bedding, subsoiling/ripping, and banded herbaceous weed control treatments, will likely be decreased when planting density is reduced. Plus, fewer rows resulting from a decrease in planting density, may result in lowering the amount of chemical applied to a property, which is beneficial both economically and environmentally.

For the same planting density ha^{-1} , rectangular plantings can reduce reforestation costs because once again the number of passes on the property should be less, and thus the associated benefits as described in the previous paragraph also apply. Greater degrees of rectangularity should result in a greater reduction in reforestation costs. However, one should consider reductions in yields resulting from extreme degrees of rectangularity. For loblolly pine, it has generally been found that rectangularity ratios of between row to within row spacing that are 3:1 or less result in decreased reforestation costs with minimal impacts on yields (Adams and Clason 2002; Amateis et al. 2004; VanderSchaaf and South 2004a).

Beyond reforestation costs, lower planting densities within a reasonable range can be beneficial financially since yields of more valuable product classes of chip-n-saw and sawlogs can be obtained at an earlier age, and that across time, greater yields per ha^{-1} of these more valuable product classes can be obtained (Land et al. 2004; Amateis and Burkhart 2012). Stumpage values in southwestern Mississippi per green ton for pine pulpwood, chip-n-saw, and sawtimber were \$2.00 (\$2.20 Mg), \$11.63 (\$12.82 Mg), and \$19.50 (\$21.50 Mg) in the 1st quarter of 2024 (Lamichhane 2024). Pulpwood prices continue to decrease. Hence, a landowner would want to use a planting density that not only reduces the amount of pulpwood, but also that reduces the length of time required for the initiation of chip-n-saw and sawlog production relative to greater planting densities such as those that were commonly used in the past (Aspinwall et al. 2012; Hernández et al. 2016). Planting densities ranging from around 741 to 1,544 ha^{-1} , given the quality of seedling being planted today, should produce a quality stand. Planting densities at the lower end of this range will result in obtaining sawlogs at an earlier age and in unthinned stands, may result in more sawlog production ha^{-1} across economic rotation ages. Plus, lower planting densities will likely eliminate the need for a “pulpwood-dominated” first thinning.

1.4 Planning the timing of reforestation activities as a tax strategy

For Federal income tax purposes, as previously mentioned, each tax year landowners can deduct up to \$10,000 annually of costs incurred related to qualifying reforestation expenditures, the remainder is amortized over the next 84 months (or next 8 tax years). Thus, in some cases, landowners could benefit financially by spreading their reforestation practices and associated costs over two tax years. Therefore, a landowner may consider conducting a practice in a different tax year or incurring the expenditures in a different tax year to ensure that enough expenses occurred such that \$10,000 could be deducted in that tax year. Although some reforestation practices such as chemical and mechanical site preparation activities are often limited to occurring only in tax year 1 (say in the Summer or Fall prior to planting in that winter), some activities such as early herbaceous weed control, the actual costs of purchasing seedlings or of having seedlings transported, and the actual placement of seedlings into the ground can be moved to different tax years.

For example, one may consider planting in December (tax year 1) rather than January or February (tax year 2). Traditionally, first-year herbaceous weed control was conducted in March to May following the planting of seedlings in that winter, thus these costs would be incurred in tax year 2. However, in the recent past, to reduce reforestation costs and often because of difficulty in finding vendors to conduct the practice, some landowners have combined chemical site preparation and early herbaceous weed control into the same operation through tank mixes, thus the cost of both operations would be incurred in tax year 1. To take full advantage of the \$10,000 deduction each tax year, if biologically feasible and vendors were available, a landowner could conduct the herbaceous weed control at the more traditional time of March to May in tax year 2. A third example would be where a landowner orders seedlings in June of tax year 1, potentially incurring a down payment of 10% of the seedling costs to reserve the seedlings, and then paying the remaining costs in tax year 2 when they plant in January or February. There are many other potential examples.

For some landowners, given the number of ha in their stand, availability of vendors, and costs of activities, this tax strategy may be beneficial. This strategy may also be beneficial in relation to the Mississippi Reforestation Tax Credit. The form 80-315 uses a term of Post Planting Site-Preparation which is essentially an herbaceous weed control operation after planting seedlings. Similar to the Federal tax provisions, one could alter the timing of this vegetation control operation to take full advantage of the potential to receive \$10,000 in nonrefundable tax credit annually.

With all of this said, one should carefully consider the potential tax benefits of altering the timing of operations with their impacts on reforestation success and future yields. Additionally, as previously mentioned, although a landowner may want to alter the timing of operations, vendor availability may limit or even eliminate those opportunities.

The objective of this analysis was to assess the impacts of these two income tax reduction opportunities, along with reducing planting density ha^{-1} , on loblolly pine financial returns. To determine how reduced reforestation costs from lower planting densities may impact financial returns, planting densities of 1,122 and 1,282 and 1,495 seedlings ha^{-1} were examined for a 32.4 ha plantation with a site index of 19.8 m (base age 25). Varying degrees of rectangularity when planting seedlings were assumed,

reducing reforestation costs. For Federal tax purposes, a landowner classified as an Investor within the 22% Federal ordinary income tax bracket was assumed.

2 Methods

2.1 Growth and yield projections

A Microsoft Excel based simulator entitled GulfLOB, produced by the lead author from which a copy can be obtained, was used for this analysis to obtain growth and yield projections using equations presented by Baldwin and Feduccia (1987). The majority of the plantations used in model development were established in the 60's and 70's, with a few established in the 80's. Plantations were established in Louisiana, southern Mississippi, and east Texas on cutover sites. Simulations were for three planting densities (i.e., 454 [16 feet x 6 feet], 519 [12 feet x 7 feet], 605 [12 feet x 6 feet] trees acre⁻¹) (1,122 and 1,282 and 1,495 seedlings ha⁻¹, respectively) and for land with a site index of 19.8 m (base age 25). Based on anecdotal experience of NIPF, or family forest landowners, in Mississippi, no fertilization treatments were considered. Mississippi family forest/NIPF landowners rarely fertilize pine plantations. It has generally been found that rectangularity ratios of between row to within row spacing of 3:1 or less do not meaningfully impact loblolly pine yields (Adams and Clason 2002; Amateis and others 2004; VanderSchaaf and South 2004a); thus no direct adjustments in yield estimates were made for a particular planting density.

To account for the effects of improved genetics, better nursery practices, improved site preparation activities, better vegetation control, among other factors (Fox et al. 2007; Subedi et al. 2019), a 2-year age-shift (South and VanderSchaaf [2006], a Type A response as defined by VanderSchaaf and South [2004b]), was applied to the growth and yield projections from GulfLOB. Thus, yields at age 28 years were assumed to occur at the final harvest age of 26 years. In addition, a Type 2 response in carrying capacity (South et al. 2006; Ramirez et al. 2022) of 15% was used for tons ha⁻¹; thus allowing for the projected tons ha⁻¹ annually from GulfLOB to be increased. Silvicultural gains of 15% relative to the previous generation silvicultural practices (e.g 60s, 70s, and 80s) used to produce equations found in GulfLOB are likely conservative (Fox et al. 2007; Burkhart and Yang 2022).

2.2 Silvicultural activities and associated costs

GulfLOB does not allow for a direct response in growth and yield to various site preparation activities. However, it was assumed an aerial chemical treatment was applied in July and mechanical treatments were applied in November of Reforestation Year 0. Costs were \$241.10 and \$503.85 ha⁻¹, respectively; these costs were based on Maggard and Natzke (2023) for the year of 2022. Additionally, a banded first-year herbaceous weed control treatment was conducted in April (Reforestation Year 1), and due to assumed rectangularity in the planting configurations, a reduction factor in costs was assumed (VanderSchaaf and South 2004a).

The herbaceous weed control cost was \$59.94 acre⁻¹ (Maggard and Natzke 2023) (\$148.11 ha⁻¹). Since the 1,282 and 1,495 ha⁻¹ planting densities both used 12-foot row (3.6576 m) spacings, they were considered the standard and the entire \$59.94 (\$148.11 ha⁻¹) was applied. However, for the 1,122 planting density, since 16-foot row (4.8768 m) spacings will reduce the number of passes on the property (hence reduce

fuel, labor, and chemical), the first-year herbaceous weed control costs were reduced to \$44.96 acre⁻¹ (\$111.09 ha⁻¹) for the 1,122 spacing. This reduction in cost was obtained based on the relative values of the number of passes on the property. The square root of 43,560 square feet acre⁻¹ is 208.71, and this value was then divided by 12 feet (3.6576 m) and 16 feet (4.8768 m). Thus, for the 519 (1,282 ha⁻¹) and 605 (1,495 ha⁻¹) planting densities there were 17.39 passes and for the 454 (1,122 ha⁻¹) planting density there were 13.04 passes. The relative value of 13.04/17.39 was multiplied by \$59.94 to produce \$44.96 acre⁻¹ (\$111.09 ha⁻¹). Since the cost adjustments related to the use of greater rectangular configurations are based on English units, the description is in English units to help the reader better understand the logic behind particular metric measurements.

Table 1. The timing and costs ha⁻¹ by planting density of reforestation activities, operating expenses, carrying charges, timber sale administration of the final clearcut at age 26, and associated state & local timber severance and Federal & state income taxes. For the operating expenses and carrying charges, the first value is the annual cost and the second value after the comma is the sum of all annual costs to age 26 when the clearcut operation is conducted. *For Total Discounted Reforestation Costs, costs of reforestation operations incurred during Reforestation (Reforest) Year 1 were discounted one year at a 5% real interest rate. For simplicity we assume income taxes are filed in April of the succeeding year, and thus Tax Year is always one year greater than Reforestation (Reforest) Year.

Operation	Reforest Year	Tax Year	Cost ha ⁻¹ by planting density		
			1,122	1,282	1,495
Chemical Site Preparation	0	1	\$241.10	\$241.10	\$241.10
Mechanical Site Preparation	0	1	\$503.85	\$503.85	\$503.85
Seedlings (Elite MCP)	0	1	\$282.71	\$323.18	\$376.74
Hand Planting	1	2	\$123.40	\$141.07	\$164.45
First-Year HWC (Banded)	1	2	\$111.09	\$148.11	\$148.11
Total Discounted Reforestation Costs*			\$1,250.98	\$1,343.55	\$1,419.36
Operating Expenses					
Maintenance & Firelanes	0 - 26	1 - 27	\$9.88, \$266.87	\$9.88, \$266.87	\$9.88, \$266.87
Carrying Charges					
Ad Valorem Property Taxes	0 - 26	1 - 27	\$12.36, \$333.59	\$12.36, \$333.59	\$12.36, \$333.59
Timber Sale Administration					
Clearcut (10% of revenue)	26	27	\$660.48	\$673.82	\$688.50
Severance Taxes					
Pulpwood (whole-tree & topwood, \$0.30/cord)	26	27	\$6.69	\$7.26	\$8.02
Chip-n-saw (\$0.12/ton)	26	27	\$30.70	\$34.15	\$38.10
Sawtimber (\$0.12/ton)	26	27	\$21.62	\$20.32	\$18.79
Total			\$59.01	\$61.73	\$64.91
Income Taxes					
Federal (15% capital gains)	26	27	\$792.73	\$810.33	\$829.66
State (5% ordinary)	26	27	\$264.24	\$270.11	\$276.55

Costs by reforestation year, tax year, and planting density are shown in Table 1. Outright deduction and amortization values by tax year and planting density are shown in Table 2. Tables 3 and 4 contain calculations related to the Mississippi Reforestation Tax Credit. For the reforestation costs incurred in Reforestation Year 0, regardless of planting density, the MFC costs of approved reforestation activities (2023 tax year) were

lower relative to the actual reforestation costs. Hence, the landowner is entitled to a nonrefundable tax credit to offset state income tax liability of 50% of the MFC average costs for approved reforestation activities (MFC Approved Costs in Table 3), but only up to the \$10,000 annual maximum. For the reforestation costs incurred in Reforestation Year 1, regardless of planting density, the actual costs of approved reforestation activities (2023 tax year) were lower relative to the MFC Approved Costs. Since both the approved and actual costs were less than the \$10,000 annual maximum, the landowner is entitled to a nonrefundable tax credit to offset state income tax liability of 50% of their actual costs for approved reforestation activities (Actual Costs in Table 4).

Table 2. Per ha recovery from the outright deduction of reforestation costs and amortization schedule by planting density. Recovery values were calculated using 0.22 (landowner Federal income marginal tax rate) and then divided by 32.4 ha. TD is the total discounted financial recovery by reforestation year of when reforestation costs were incurred, for both the outright deduction and the amortized deductions by planting density. Both is the discounted total recovery of the reforestation costs incurred in both reforestation years 0 (tax year 1) and 1 (tax year 2), and both the outright deduction and amortized deduction by planting density. A 5% interest rate was used. *For TD and Both, the outright deduction for Reforestation Costs Year 0 and Reforestation Costs Year 1 are discounted one year and two years, respectively. For simplicity we assume income taxes are filed in April, and thus Tax Year corresponds to the number of discounting periods.

Tax Year	Reforestation Costs Year 0			Reforestation Costs Year 1		
	1,122	1,282	1,495	1,122	1,282	1,495
	Outright Deduction of Up to \$10,000					
1	\$67.95	\$67.95	\$67.95	-	-	-
2	-	-	-	\$51.59	\$63.62	\$67.95
	Amortization Schedule of Costs in Excess of \$10,000					
1	\$11.30	\$11.93	\$12.77	-	-	-
2	\$22.59	\$23.86	\$25.55	\$0.00	\$0.00	\$0.06
3	\$22.59	\$23.86	\$25.55	\$0.00	\$0.00	\$0.12
4	\$22.59	\$23.86	\$25.55	\$0.00	\$0.00	\$0.12
5	\$22.59	\$23.86	\$25.55	\$0.00	\$0.00	\$0.12
6	\$22.59	\$23.86	\$25.55	\$0.00	\$0.00	\$0.12
7	\$22.59	\$23.86	\$25.55	\$0.00	\$0.00	\$0.12
8	\$11.30	\$11.93	\$12.77	\$0.00	\$0.00	\$0.12
9	-	-	-	\$0.00	\$0.00	\$0.06
Non-Discounted Total	\$158.13	\$167.04	\$178.82	\$0.00	\$0.00	\$0.81
Discounted Total	\$127.60	\$134.79	\$144.29	\$0.00	\$0.00	\$0.62
TD	\$195.56	\$202.74	\$212.25	\$51.59	\$63.62	\$68.58
Both	\$247.14	\$266.36	\$280.83			

Table 3. Mississippi Reforestation Tax Credit calculations incurred during reforestation year 0 and correspondingly in tax year 1. MFC Approved Costs are eligible costs for the tax credit based on average rates set by the Mississippi Forestry Commission (MFC) per approved reforestation activity (2023 tax year). Actual costs are the actual costs incurred by the landowner, based on the assumed costs for this analysis, of reforestation activities. 50% refers to fact that the landowner receives in tax credit half of the lesser of the MFC Approved Costs or Actual Costs, up to \$10,000 annually. The Mississippi Reforestation Tax Credit only offsets income tax liability, thus the lower table shows the recovery of the tax credit per tax year assuming the landowner incurs \$2,176.00 annually in Mississippi income tax (ordinary tax rate of 5%). An interest rate of 5% was used for discounting. For simplicity we assume income taxes are filed in April, and thus Tax Year corresponds to the number of discounting periods.

	MFC Approved Costs		Actual Costs		
	ha ⁻¹	All 32.4 Ha	1,122	1,282	1,495
Bareroot Seedlings	\$140.85	\$4,560.00	\$9,152.64	\$10,463.04	\$12,196.80
Labor	\$160.62	\$5,200.00	\$3,995.20	\$4,567.20	\$5,324.00
Chemical Site Preparation	\$247.11	\$8,000.00	\$7,805.60	\$7,805.60	\$7,805.60
Mechanical Site Preparation	\$469.50	\$15,200.00	\$16,312.00	\$16,312.00	\$16,312.00
Total		\$32,960.00	\$37,265.44	\$39,147.84	\$41,638.40
50%			\$10,000.00	\$10,000.00	\$10,000.00
Tax year	Income tax liability offset	Credit Remaining	ha ⁻¹	Discounted to Year 0	
1	\$2,176.00	\$7,824.00	\$67.21	\$64.01	
2	\$2,176.00	\$5,648.00	\$67.21	\$60.96	
3	\$2,176.00	\$3,472.00	\$67.21	\$58.06	
4	\$2,176.00	\$1,296.00	\$67.21	\$55.30	
5	\$1,296.00	\$0.00	\$40.03	\$31.37	
Total	\$10,000.00		\$308.88	\$269.70	

Table 4. Mississippi Reforestation Tax Credit calculations incurred during reforestation year 1 and correspondingly in tax year 2. MFC Approved Costs are eligible costs for the tax credit based on average rates set by the Mississippi Forestry Commission (MFC) per approved reforestation activity (2023 tax year). Actual costs are the actual costs incurred by the landowner, based on the assumed costs for this analysis, of reforestation activities. 50% refers to fact that the landowner receives in tax credit half of the lesser of the MFC Approved Costs or Actual Costs, up to \$10,000 annually. The Mississippi Reforestation Tax Credit only offsets income tax liability, thus the lower table shows the recovery of the tax credit per tax year assuming the landowner incurs \$2,176.00 annually in Mississippi income tax (ordinary tax rate of 5%). An interest rate of 5% was used for discounting. For simplicity we assume income taxes are filed in April, and thus Tax Year corresponds to the number of discounting periods.

	MFC Approved Costs		Actual Costs		
	ha ⁻¹	All 32.4 Ha	1,122	1,282	1,495
Post-planting Site-Preparation	\$197.68	\$6,400.00	\$3,596.40	\$4,795.20	\$4,795.20
Total		\$6,400.00	\$3,596.40	\$4,795.20	\$4,795.20
50%			\$1,798.20	\$2,397.60	\$2,397.60
Tax year	Income tax liability offset	Credit Remaining	ha ⁻¹	Discounted to Year 0	
		1,122 Seedlings ha ⁻¹			
2	\$1,798.20	\$0.00	\$55.54	\$50.38	
Total	\$1,798.20		\$55.54	\$50.38	
		1,282 Seedlings ha ⁻¹ and 1,495 Seedlings ha ⁻¹			
2	\$2,176.00	\$221.60	\$67.21	\$60.96	
3	\$221.60	\$0.00	\$6.84	\$5.91	
Total	\$2,397.60		\$74.06	\$66.88	

2.3 Number of annual discounting periods and interest rate

Determining the number of appropriate annual discounting periods can be difficult, particularly when conducting an after-tax assessment. Due to the common timing of reforestation activities in the southeastern United States, we separated reforestation into years 0 and 1. Thus, for the Before-Tax assessment, costs associated with reforestation activities occurring in year 0 were not discounted and those occurring in year 1 were discounted one year. Stumpage revenues from the clearcut at age 26 were assumed to be received at the end of the year and thus those revenues were discounted 27 periods. For this analysis it was assumed that both Federal and Mississippi state income taxes were filed in April of the tax year succeeding either a cost or revenue. Thus, the income tax benefit or loss was discounted one additional year relative to the forestry related revenue or cost, respectively. A commonly used interest rate of 5 percent was selected (Klemperer 2003; Huang et al. 2005; Cushing and Newman 2018; IRS 2023). An interest rate of 5% is reflective of current loan rates by the regional (Texas, FCB) Farm Credit System Bank (IRS 2023) and thus of potential alternative rates of return.

2.4 Seedling and planting costs

Mass-control pollinated (MCP) Elite bareroot seedlings at a cost of \$252 per thousand were planted by hand. It is assumed that seedlings were purchased in June of tax year 1, since it is important to order seedlings as soon as possible and as allowed by the nursery. Seedling costs were based on observation of common prices for the 2022-2023 planting season. Hand planting per seedling was assumed to cost \$0.11 (Maggard and Natzke 2023). Seedling planting costs occurred in tax year 2 (for example, planting in January and/or February).

2.5 Merchandizing specifications and stumpage revenues

Upper stem diameter outside bark (DOB)s of 8 inches (20.32 cm), 4 inches (10.16 cm), and 2 inches (5.08 cm) were assumed to represent sawtimber, chip-n-saw, and pulpwood merchantable classes, respectively. Minimum diameters at breast height (dbh) were 12 inches (30.48 cm), 8 inches (20.32 cm), and 4 inches (10.16 cm) for sawtimber, chip-n-saw, and pulpwood merchantable classes, respectively. A market for upper-stem pulpwood, or topwood, on chip-n-saw and sawtimber classified trees was assumed to a 2-inch DOB (5.08 cm). Stumpage values per green ton for pine topwood, pulpwood, chip-n-saw, and sawtimber were \$2.00 (\$2.20 Mg), \$2.00 (\$2.20 Mg), \$11.63 (\$12.82 Mg), and \$19.50 (\$21.50 Mg), respectively, and were obtained from the 1st quarter, 2024 Mississippi Timber Price Report (Lamichhane 2024) for southwestern Mississippi. No sources of revenue beyond topwood, pulpwood, chip-n-saw, and sawlog markets were assumed (e.g. plylogs, poles, carbon markets, pine straw markets, hunting or recreational leases, etc.). Figure 1 contains estimated yields ha⁻¹ by product class (based on assumed merchandizing specifications) and planting density, and revenues ha⁻¹ based on predicted yields and stumpage values.

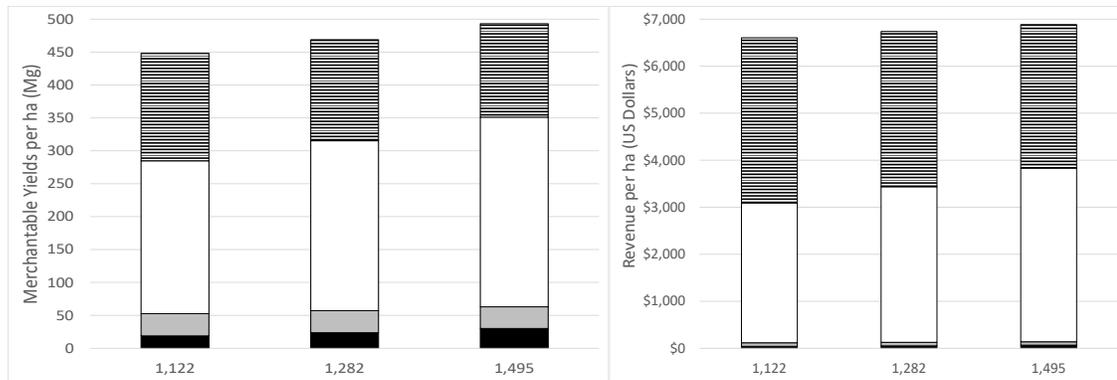


Figure 1. Yields ha^{-1} (Mg) by product class and planting density (left), and revenues ha^{-1} (right) by planting density at age 26. Black bars is whole tree pulpwood, gray bars is topwood pulpwood, white bars is chip-n-saw, and black bars is sawlog.

2.6 Income tax classification of landowners' forest holding

As stated earlier, for simplicity, it is assumed that each planting density generates a single, but distinct, Qualified Timber Property (QTP). It is assumed the landowner owns the property (hence no mortgage interest). Beyond that, it is assumed the landowner is classified as an Investor for their forest ownership since the landowner has a profit motive for their property (hence they are not Personal Use or Hobby), and they have a management plan demonstrating their profit motive, but they do not have the activities required to classify their forest ownership as a Trade or Business. Landowners classified as Business (both material participant and passive), generally have superior tax benefits since they have less restrictions to deduct the costs of ordinary and necessary practices associated with carrying on their business during the year in which they were incurred. However, in order to be classified as a Business, a landowner must spend a meaningful amount of time (and thus cost) visiting and managing their property and/or attending educational activities. The landowner must demonstrate through documentation to the IRS that indeed they conduct practices justifying the Business classification.

2.7 Capitalized Ad valorem property taxes and maintenance/firelane costs

In addition, an annual property tax (Ad valorem) of $\$12.36 \text{ ha}^{-1} \text{ year}^{-1}$ was assumed, and annual property maintenance/firelane costs of $\$9.88 \text{ ha}^{-1} \text{ year}^{-1}$ was assumed (Table 1). An Ad valorem tax rate of $\$12.36 \text{ ha}^{-1} \text{ year}^{-1}$ is based on revenues and acreages from 2018 across the state of Mississippi ($\$9.88 \text{ ha}^{-1} \text{ year}^{-1}$), but increased slightly to bring forward to 2023. Since the landowner is considered an Investor, and that essentially operating expenses have been excluded from being deducted for tax years 2018 to 2025 when classified as an Investor due to the Tax Cuts and Jobs Act of 2017 [TCJA], property maintenance/firelane costs ($\$9.88 \text{ ha}^{-1} \text{ year}^{-1}$) will be capitalized. Stated differently, they will be added to an Investor's timber tax basis. Beyond that, since the standard deduction will be taken each tax year as opposed to itemizing deductions, all annual Ad valorem property taxes ($\$12.36 \text{ ha}^{-1} \text{ year}^{-1}$) will also be capitalized. Thus, these annual costs will be placed into the timber tax basis, and will be used to reduce the capital gains (timber harvest revenues minus timber tax basis minus timber severance taxes minus timber sale administrative costs) from the clearcut at age 26.

2.8 Timber severance tax reducing the amount of capital gain

Beyond this, Mississippi levies a timber severance tax on timber harvested. This money is partially used to fund the Forest Resource Development Program (FRDP) cost-share (80% of tax) and parts of it are returned directly to the county government (20%) in which the timber sale occurred. The Mississippi tax code intends for the landowner (grower) to pay the severance tax, however, it is stated in the code that if the landowner does not pay these taxes, then the “liability” is passed to the purchasers and they need to pay them. Often, in practice, the mill will pay severance taxes in Mississippi, and if not, then the logger will pay them. Currently, within Mississippi, the severance tax rates per ton (or cord for pulpwood) are fairly low and thus severance taxes are not significant on a ha⁻¹ basis. Although purchasers of stumpage may operationally pay the severance tax, for illustrative purposes and this analysis, we will assume the landowner (grower) is incurring the cost.

For each sawlog ton (and assumed chip-n-saw ton), a severance tax of \$0.12 is charged and each 128-cubic foot cord of topwood and pulpwood is taxed \$0.30 (Mississippi Code 27-25-1). Thus, since tons is utilized in this assessment and then ultimately converted to megagrams, the reported pulpwood tonnage from the simulator was converted to a 128-cubic foot cord by dividing tons by 2.6. The value of 2.6 is obtained by dividing 5,200 pounds per cord (Mississippi Code 75-27-39) by 2,000 pounds per ton. This is equivalent to a severance tax of \$0.1154 per ton for pulpwood (\$0.30/2.6). Others have used a value for Mississippi of \$0.12 per ton of pulpwood (Cushing and Newman 2018). Some Mississippi foresters interpret the code (Mississippi Code 27-25-1) to mean that topwood and pulpwood should also be taxed at \$0.12 per ton. However, there is nothing in the Mississippi code that clearly states that a landowner cannot convert from tons to cords when determining how much severance tax is to be paid for pulpwood. Thus, we used a value of \$0.1154 per ton, which, once again, is equivalent to paying \$0.30 cents per cord.

Nonetheless, for Federal and Mississippi state income tax purposes, if paid by the landowner (grower), severance taxes can be subtracted from timber revenues, thus reducing the amount of capital gain that is taxed. Figure 2 contains total severance tax amounts ha⁻¹ and by product class for each planting density.

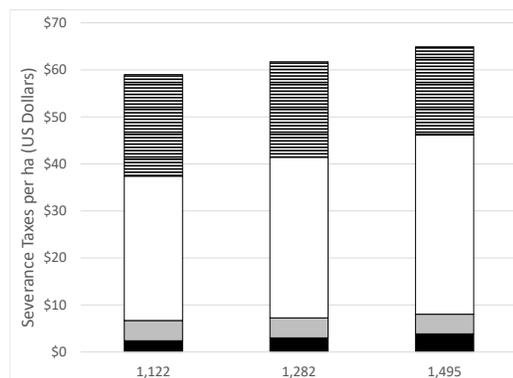


Figure 2. Severance taxes ha⁻¹ associated with the clearcut at age 26 by planting density. Sawtimber (Saw) and chip-n-saw (Chip) product classes are taxed at \$0.12 per ton while pulpwood is taxed at \$0.30 per cord (Mississippi Code 27-25-1). To convert from cords to tons, \$0.30 was divided by 2.6 producing a value of \$0.1154 per ton. Black bars is whole tree pulpwood, gray bars is topwood pulpwood, white bars is chip-n-saw, and black bars is sawlog.

2.9 Assumed investor annual taxable income and federal and state capital gain tax rates

For this analysis, the single landowner annual taxable income, prior to any timber related deductions or amortizations, is assumed to be \$70,000. Thus, this landowner is within the Federal 22% income tax bracket for the 2023 tax year. As an Investor, since the standing timber will have been owned for more than one year before any harvesting operation, and the timber sale will be conducted under a lump-sum contract, the Federal long-term capital gains tax rate applies. It is assumed the landowner is within the 15% capital gains tax rate bracket. Currently, within Mississippi, there is no special capital gain tax rate, and thus all income is taxed at the ordinary income tax rate of 5%.

It is assumed the landowner’s plantation is 32.4 ha. The number of hectares impacts the benefits on a ha⁻¹ basis obtained from the Federal and state income tax provisions. For example, if a landowner owns 40.5 ha or 404.7 ha, the \$10,000 annual Federal Deduction maximum and the Mississippi Reforestation Tax Credit annual maximum amount of \$10,000 still both apply. Table 5 contains capital gain amounts by planting density after subtracting from the ha⁻¹ revenues the timber tax basis (annual carrying charges of ad valorem property taxes and operating costs of site and firelane maintenance), severance taxes, and timber sale administration costs. The table also contains income tax amounts based on the Federal capital gains tax rate of 15% (as opposed to the ordinary income tax rate of 22%) and the Mississippi state ordinary income tax rate of 5%. Remember the state of Mississippi does not have special capital gains tax rates. A parcel of 32.4 ha was also selected to reduce the complexity of the analysis due to factors such as the net investment income tax (3.8%) on timber income of high earners (\$250,000 adjusted gross income married filing jointly or \$200,000 adjusted gross income single taxpayer) classified as an Investor.

Table 5. Capital gains ha⁻¹ by planting density. Revenue is total revenue across all product classes at the clearcut age of 26 years (see Figure 1). Maint refers to operating costs for site maintenance and firelane construction and/or maintenance (\$9.88 annually from tax year 1 to 27). Property refers to carrying charges of ad valorem property taxes (\$12.36 annually from tax year 1 to 27). Admin is 10% of the Revenue ha⁻¹. Severance is severance taxes at age 26 (see Figure 2). Capital Gain is Revenue minus Maint, Property, Admin, and Severance (equation 1). Federal is the amount of tax owed to the IRS (Federal government) resulting from the capital gain, using the capital gains tax rate of 15%. State is the amount of tax owed to Mississippi based on the ordinary income tax rate of 5%.

Planting Density	Revenue	Maint	Property	Admin	Severance	Capital Gain	Income tax	
							Federal (15%)	State (5%)
1,122	\$6,604.81	\$266.87	\$333.59	\$660.48	\$59.01	\$5,284.86	\$792.73	\$264.24
1,282	\$6,738.21	\$266.87	\$333.59	\$673.82	\$61.73	\$5,402.19	\$810.33	\$270.11
1,495	\$6,884.97	\$266.87	\$333.59	\$688.50	\$64.91	\$5,531.09	\$829.66	\$276.55

2.10 Final taxable amounts

For the final clearcut operation, a 10% timber sale administration and consulting fee will be charged by a consulting forester. This is a common percentage used by consulting foresters (Self 2019; Chhetri et al. 2022) and it has been used in recent timber harvest tax assessments (Baral et al. 2020; Li et al. 2020). Thus, the Federal capital gain (CG) at age 26, see Table 5 for financial values, can be expressed as:

equation [1] $CG = \text{Revenue} - \text{Timber Tax Basis [Ad Valorem Taxes of } \$333.59 + \text{Maintenance/firelane costs of } \$266.87] - \text{Severance Tax} - 10\% \text{ Timber Sale Administration Costs}$

Where:

Revenue – amount of revenue received ha^{-1} from topwood, pulpwood, chip-n-saw, and sawlog yields ha^{-1} and their associated stumpage values at age 26.

At age 26, the timber tax basis only contains the accrued annual ad valorem property taxes ($\$333.59 \text{ ha}^{-1}$) and the operating expenses ($\$266.87 \text{ ha}^{-1}$) associated with maintaining the property and firelanes (Table 1). All reforestation costs were recovered near the time of planting through the Reforestation Tax Deduction and Amortization provisions.

One final note, the regulations related to the Mississippi Reforestation Tax Credit have not been updated since the American Jobs Creation Act of 2004 changed the way in which landowners received reforestation tax benefits from the Federal government. For example, prior to the passing of this act, landowners could receive a tax credit from the Federal government to partially recover reforestation costs. Nonetheless, it currently is not entirely clear for Mississippi state income tax purposes if a landowner can deduct and amortize reforestation costs in excess of the amount of tax credit received by the landowner from the Mississippi Reforestation Tax Credit (VanderSchaaf 2024). Thus, to some degree, recovery of reforestation costs could be increased further beyond what has been reported in this analysis.

3 Results and discussion

3.1 Impacts of taxation on financial returns

Most forest financial assessments of southern forests in the United States are before-tax. This is most likely because of the difficulty in understanding all aspects of taxation and their associated calculations, but also because of the variability among state and local taxation. Since this analysis is specifically for Mississippi, and state income policies such as income tax and severance tax rates differ by state (Cushing and Newman 2018; Baral et al. 2020), and that Mississippi has the very unique reforestation tax credit to offset state income tax liability, the state income tax component won't apply to forest landholdings in other states. However, the Federal taxation component of this paper should be applicable to landowners regardless of the state in which they live. Beyond that, results will differ based on IRS landowner classification, complicating analyses. Being classified as a Business, particularly a material participant, would be advantageous in terms of tax deductions relative to an Investor (Baral et al. 2020; Li et al. 2020). For instance, the operating expenses of site maintenance and the maintaining of firelanes and ad valorem property tax carrying charges could be deducted in the year in which the costs were incurred. This is advantageous for at least 5 reasons. First, the deductions would offset income at the ordinary income tax rate of 22% rather than the capital gains tax rate of 15% such as at the time of harvest. Second, the negative impacts of discounting would be less. Third, inflation would not reduce the "buying power", or the effectiveness or benefit derived from the deduction. Fourth, the recovery revenues could be put into another investment to gain interest (e.g., the bank), or reinvested in the property. Fifth, timber income of high earning ($\$250,000$ married filing jointly or

\$200,000 single taxpayer) Business landowners is not subject to the net investment income tax (3.8%). However, a high earning landowner classified as an Investor is subject to the net investment income tax (3.8%).

Given the assumptions of this analysis, for a particular planting density, when compared to a before-tax financial assessment, landowner net revenues were reduced when conducting an after-tax financial assessment (Table 6). Income taxes reduced income despite reforestation tax provisions and the ability to use expenses to reduce the amount of capital gain (e.g., equation [1]). For the most financially viable planting density of 1,122 seedlings ha⁻¹, when conducting an after-tax financial assessment, net present value (NPV) was reduced by \$245.09 dollars ha⁻¹. The selection of the most financially viable planting density did not change when an after-tax assessment was conducted. Hence, the increased revenues associated with using a lower planting density, resulting from reduced reforestation costs (VanderSchaaf and South 2004a; VanderSchaaf 2023) and a greater amount of sawlog production at the time of harvest (Land et al. 2004; Huang et al. 2005; Amateis and Burkhart 2012), was stronger than the ability of tax provisions allowing landowners to recover greater amounts of reforestation costs for higher planting densities. Although important to Business landowners, given current Federal tax structure and deduction restrictions for Investors (e.g. due to the Tax Cuts and Jobs Act of 2017), this finding is likely more important to landowners classified as Investors (Baral et al. 2020; Li et al. 2020).

Perhaps if the Federal deduction and amortization provisions were changed to a tax credit (such as in the past before the American Jobs Creation Act of 2004), or if the current outright deduction component was changed to \$20,000 rather than \$10,000, the negative impact of additional reforestation costs associated with the 1,282 and 1,495 seedlings ha⁻¹ planting densities could be nullified. Beyond that, the ordinary income and capital gains tax rates could also impact the differences between before-tax and after-tax financial assessments.

The percentage difference between NPVs of the 1,122 and 1,495 planting densities before-tax was 18.0%, while after-tax it was 24.3%. The percentage difference between NPVs of the 1,122 and 1,282 planting densities before-tax was 11.0%, while after-tax it was 11.9%. Hence, although the beneficial tax provisions (after-tax) reduced the absolute difference in NPV among the planting densities, the percentage difference in NPV between the planting densities actually increased. This could be interpreted to mean, given the current tax provision structure, income taxes have a stronger impact on landowner returns than any beneficial expense recovery tax provision. Plus, when only analyzing revenues from traditional timber markets, results suggest that before-tax financial assessments will produce the same ranking of alternative reforestation scenarios as after-tax financial assessments. Thus, very often, more complicated after-tax financial assessments may not be needed to find the most financially viable reforestation scenario among alternatives for loblolly pine plantations in the southeastern US.

Not all southern states levy a severance tax to be paid by the landowner (grower) on stumpage (Cushing and Newman 2018; Baral et al. 2020), and for those states who impose a severance tax on the landowner the methodology of calculating the tax differs (Cushing and Newman 2018). For Mississippi, given current tax rates of \$0.12 per ton of sawtimber and chip-n-saw, and \$0.1154 per ton (\$0.30 per cord/2.6) of pulpwood, and current reforestation practices and associated costs and associated

yields and stumpage values, severance taxes ha⁻¹ will likely average around \$62 (Figure 2).

Table 6. After-Tax and Before-Tax assessment discounted revenues and costs, and Net Present Value (NPV) ha⁻¹ by planting density. An interest rate of 5% was used. Revenue is stumpage values received (Figure 1), Deduct (Table 2) is recovered costs from the Federal Reforestation Tax Deduction and Amortization (Amort) tax provisions (assuming an ordinary income tax rate of 22%). MS Tax Credit are recovered reforestation costs from the Mississippi Reforestation Tax Credit, assuming an annual state income tax liability of \$2,176.00 (Tables 3 and 4). Reforestation Costs are of the chemical and mechanical site preparation operations, seedling purchase and planting costs, and a first-year herbaceous weed control treatment (Table 1). Severance tax (Figure 2), and Maint, Property, Admin, Federal & State Income Tax (Table 5) are as defined elsewhere.

<u>After-Tax Assessment</u>								
Discounted Revenues (5%)								
Planting Density	Revenue	Deduct	Amort	MS Tax Credit	Total			
1,122	\$1,769.09	\$111.51	\$127.60	\$320.08	\$2,328.28			
1,282	\$1,804.82	\$122.42	\$134.79	\$336.57	\$2,398.61			
1,495	\$1,844.13	\$126.35	\$144.92	\$336.57	\$2,451.97			
Discounted Costs (5%)								
Planting Density	Reforestation Costs	Severance Tax	Maint	Property	Admin	Income Tax		Total
					Federal	State		
1,122	\$1,250.98	\$15.81	\$151.97	\$189.96	\$176.91	\$202.22	\$67.41	\$2,055.26
1,282	\$1,343.55	\$16.54	\$151.97	\$189.96	\$180.48	\$206.71	\$68.90	\$2,158.11
1,495	\$1,419.36	\$17.39	\$151.97	\$189.96	\$184.41	\$211.64	\$70.55	\$2,245.29
Net Present Value (NPV)								
Discounted (5%)								
Planting Density	Revenue	Costs	NPV					
1,122	\$2,328.28	\$2,055.26	\$273.02					
1,282	\$2,398.61	\$2,158.11	\$240.49					
1,495	\$2,451.97	\$2,245.29	\$206.69					
<u>Before-Tax Assessment</u>								
Net Present Value (NPV)								
Discounted (5%)								
Planting Density	Revenue	Reforestation Costs	NPV					
1,122	\$1,769.09	\$1,250.98	\$518.11					
1,282	\$1,804.82	\$1,343.55	\$461.27					
1,495	\$1,844.13	\$1,419.36	\$424.76					

Landowners often mention that they have failed to use Federal capital gains tax rates when determining income taxes from timber harvesting operations (Table 5), generally because they were not aware of the benefit. For a planting density of 1,122 seedlings ha⁻¹, if the ordinary income tax rate was used (22%) rather than the applicable capital gains tax rate (15%), a loss in recovery revenue would be \$369.94 ha⁻¹. When discounted back to year 0 using a 5% interest rate this amounts to a loss of \$99.09 in discounted revenues ha⁻¹. If a landowner failed to reduce the amount of capital gain by failing to subtract severance taxes and timber sale administration costs from timber revenues, and when already failing to use the capital gains tax rate of 15%, the landowner would lose an additional \$158.29 ha⁻¹, and when discounted back to year 0

using a 5% interest rate this would result in a further loss of \$42.40 ha⁻¹ in discounted revenue.

Beyond that, if a landowner failed to establish a timber tax basis, when classified as an Investor, and reducing capital gains by subtracting the annual ad valorem property taxes and site maintenance/firelane costs, a landowner would lose an additional \$132.10 ha⁻¹, and when discounted back to year 0 using a 5% interest rate a loss of \$35.38 in NPV ha⁻¹ would be observed. Thus, by failing to fully utilize capital gains tax provisions and their associated tax advantages, when planting 1,122 seedlings ha⁻¹, a landowner would lose \$660.33 ha⁻¹ in revenue, and \$176.87 in discounted revenues ha⁻¹ when using a 5% interest rate. By failing to reduce capital gains by subtracting any timber tax basis, severance taxes, and timber sale administration costs (equation [1]), or any other associated costs with the timber harvest not included here (e.g., lawyer or attorney fees, surveying fees, etc.), Mississippi state income taxes would also be negatively impacted and thus further reduce landowner income.

3.2 Planting density for Mississippi landowners based on financial considerations

Regardless of whether a financial assessment was before-tax or after-tax, for the assumptions used here and given current reforestation costs and stumpage values, and assuming a landowner took advantage of the Federal reforestation tax provisions and the Mississippi Reforestation Tax Credit, an economically viable planting density ha⁻¹ for an unthinned loblolly pine plantation of site index 19.8 m (base age 25) was 1,122 seedlings. Many other studies have showed, given more recent market conditions, that planting loblolly pine at lower densities such as 988 to 1,236 seedlings ha⁻¹ is often better financially (Huang et al. 2005; Aspinwall et al. 2012; Hernández et al. 2016; VanderSchaaf 2023). Currently, pulpwood markets in Mississippi as a whole are poor (Lamichhane 2024). Pulpwood stumpage values are not just poor in southwestern Mississippi, but the entire state. Beyond that, chip-n-saw markets, and even sawtimber markets, are relatively poor. Thus, given the poor pulpwood market, landowners want to reduce reforestation costs associated with seedlings and the planting of those seedlings as much as possible while still obtaining a viable plantation (Cartner 2018; VanderSchaaf 2023). Perhaps including the ability to conduct thinning operations into the analysis would alter which one of the three planting densities examined is the most financially viable. However, when considering thinnings, currently in Mississippi, one should realize that many landowners cannot find a logger to thin their forest, particularly a pulpwood-dominated forest. Thus, although a financial assessment may suggest planting at densities greater than 1,122 seedlings ha⁻¹ and conducting a thinning or even two thinnings is best (e.g. Huang et al. 2005), the inability to actually conduct those thinnings operationally given current market conditions may result in the financial analysis being invalid.

4 Conclusions

When a landowner is classified as an Investor, reducing reforestation costs by planting fewer seedlings and the use of rectangularity when planting, and associated increases in stumpage values resulting from earlier and greater production of the more valuable sawlog product class, seems to have a greater impact on loblolly pine plantation financial returns than reforestation tax provisions. When only analyzing revenues from traditional timber markets, this analysis suggests that often before-tax

financial assessments will result in the same ranking of alternative planting densities as after-tax financial assessments for loblolly pine plantations. Of the planting densities examined, a density of 1,122 seedlings ha⁻¹ appears to maximize landowner financial returns given their capital investment.

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