An Analysis of the Feasibility of Forest Biomass Production from Pine Plantations in Georgia

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INTRODUCTION

Future expansion of the biofuels, bioenergy, and wood pellet industries in Georgia will result in increased use of forest biomass. Many forest landowners and managers speculate how these new markets for wood materials will impact forest management decisions such as planting density and the timing of thinning and harvest activities. At what forest biomass stumpage prices will landowners make changes in forest management in order to increase biomass supply to the market? To answer this question, we examined how rising forest biomass stumpage prices impact the economic viability of three loblolly pine plantation management scenarios that were designed to produce low, moderate, or high levels of forest biomass to the market.

METHODOLOGY

Management Regime Assumptions

Three forest management regimes were modeled using SiMS 2009 growth and yield software. Each regime consisted of a loblolly pine plantation established on an open cutover site in the upper coastal plain of Georgia. The site in question was of average productivity, with a site index of 65 (base age 25 years). Site preparation was identical for each regime, consisting of a medium-level chemical site preparation treatment, burn, and post-plant herbaceous weed control. Site preparation costs for all regimes equaled \$150 acre^{-1}. Planting costs varied across the regimes due to differences in planting densities; per seedling cost was assumed at \$0.055 seedling^{-1}. Machine planting was assumed at \$0.08 seedling^{-1}. Annual costs consisted of fire protection (\$2 acre^{-1} year^{-1}), stand management costs (\$2 acre^{-1} year^{-1}), and property taxes (\$6 acre^{-1} year^{-1}).

The three management regimes varied in planting density, rotation length, number of thinnings, and quantity of biomass produced:

1. **Conventional Management**. The stand was managed exclusively for traditional forest products. The only source of forest biomass was from harvest residuals[1] collected after each thinning and harvest activity. Planting density was assumed at 622 trees acre^{-1} (7 x 10 feet spacing). The stand was thinned at ages 14 and 23 years down to a residual basal area of 70 square feet acre^{-1}. The stand was clearcut at age 34 years. Mean annual biomass production equaled 0.44 tons acre^{-1} year^{-1} (green weight basis).

[1]Harvest residuals include tops, limbs, and branches that are typically left on-site after a harvest or thinning operation. Any ingrowth in the understory is not included.

2. **Integrated Management**. The stand was managed in consideration of both forest biomass and traditional forest products. Initial planting density was increased to 968 trees acre^{-1} (5 x 9 feet spacing). At age = 10 years, 50% of the trees (1-in-2 row thin) were harvested for forest biomass. Residual trees were subsequently managed to produce traditional forest products. The stand was thinned again at ages 18 and 27 years down to a residual basal area of 70 square feet acre^{-1}. The stand was clearcut at age 38 years. Harvest residuals were collected and sold after each thinning and harvest activity. Mean annual biomass production equaled 1.3 tons acre^{-1} year^{-1} (green weight basis).

3. **Dedicated Management**. The stand was managed as a dedicated short-rotation forest biomass plantation. Initial planting density was set at 968 trees acre^{-1}. Rotation length was set at 15 years and the stand was not thinned prior to harvest. Harvest residuals were included as forest biomass. Mean annual biomass production equaled 7.36 tons acre^{-1} year^{-1} (green weight basis).

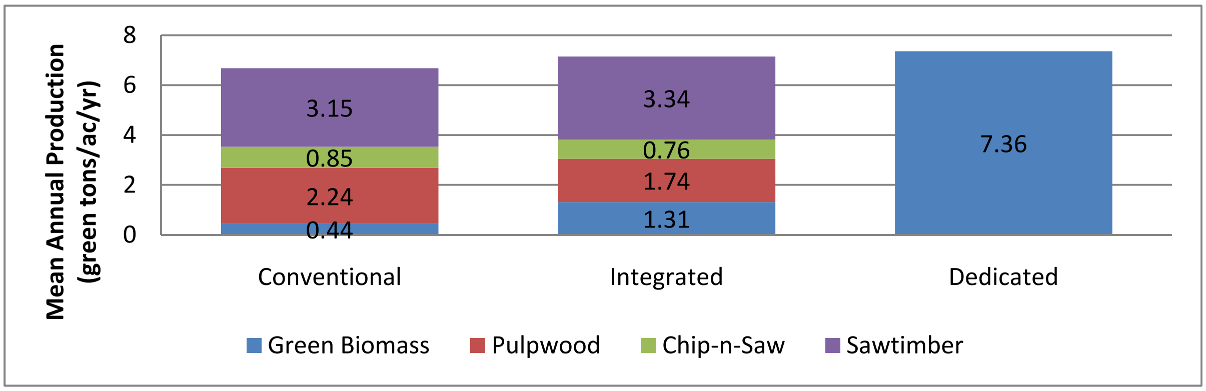

Figure 1. Mean annual production rates of the pulpwood, chip-n-saw, sawtimber, and biomass products for the three management regimes considered in this analysis.

Sensitivity Analysis Assumptions

Land Expectation Value (LEV) was used to evaluate the financial performance of each management regime as the biomass stumpage price ranged from \$4 - \$23 green ton^{-1}. Annual equivalent values (AEVs) for each scenario are provided in Appendix Tables 1 - 3. In order to account for possible increases in pulpwood prices that may result from expanded demand for biomass, three pulpwood/biomass stumpage prices relationships were considered. Stumpage prices for pine chip-n-saw and sawtimber remained constant under all sets of assumptions[2].

1. **Constant pulpwood stumpage**. As biomass increases from \$4 - \$23 per ton, pulpwood remains constant at \$10.72 per ton.

2. **Higher value pulpwood stumpage.** As biomass increases from \$4 - \$23 per ton, pulpwood is assigned a price that is \$2 per ton higher than biomass. This scenario assumes higher costs of harvesting biomass.

3. **Biomass/pulpwood stumpage parity.** Biomass and pulpwood stumpage prices are assumed to be equal at stumpage prices greater than or equal to \$10.72 green ton^{-1}. At prices less than \$10.72 green ton^{-1} for biomass, pulpwood prices remained unchanged. This scenario assumed the highest level of competition for forest biomass between traditional and bioenergy industries.

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[2] Timber Mart-South (TM-S) 4th quarter 2010 average stumpage prices in South Georgia were used in this analysis: Pine Pulpwood = \$10.72 per ton; Pine Chip-n-Saw = \$16.31 per ton; Pine Sawtimber = \$27.81 per ton.

RESULTS

Land expectation value (LEV) was used to determine break-even prices for each biomass/pulpwood stumpage scenario. LEVs are shown in Figures 2 - 4 in this section. Annual equivalent value (AEV) was also calculated for each scenario in order to provide the reader with a better sense of the scale of the financial returns throughout the biomass/pulpwood price ranges. Refer to Tables 1 - 3 at the end of this document.

The conventional and integrated scenarios both generated positive economic returns for all biomass stumpage prices considered (\$4 to \$23 green ton^{-1}). The dedicated biomass scenario did not generate positive returns until the price for biomass reached \$7.15 green ton^{-1}.

Price Sensitivity: Constant Pulpwood Stumpage (Figure 2)

- At biomass stumpage prices of \$4 to \$8.38 green ton^{-1}, the conventional management regime generated the highest LEVs.
- At biomass stumpage prices of \$8.39 to \$17.93 green ton^{-1}, the integrated management regime generated the highest LEVs.
- At biomass stumpage prices of \$17.94 green ton^{-1} or higher, the dedicated management regime generated the highest LEVs.

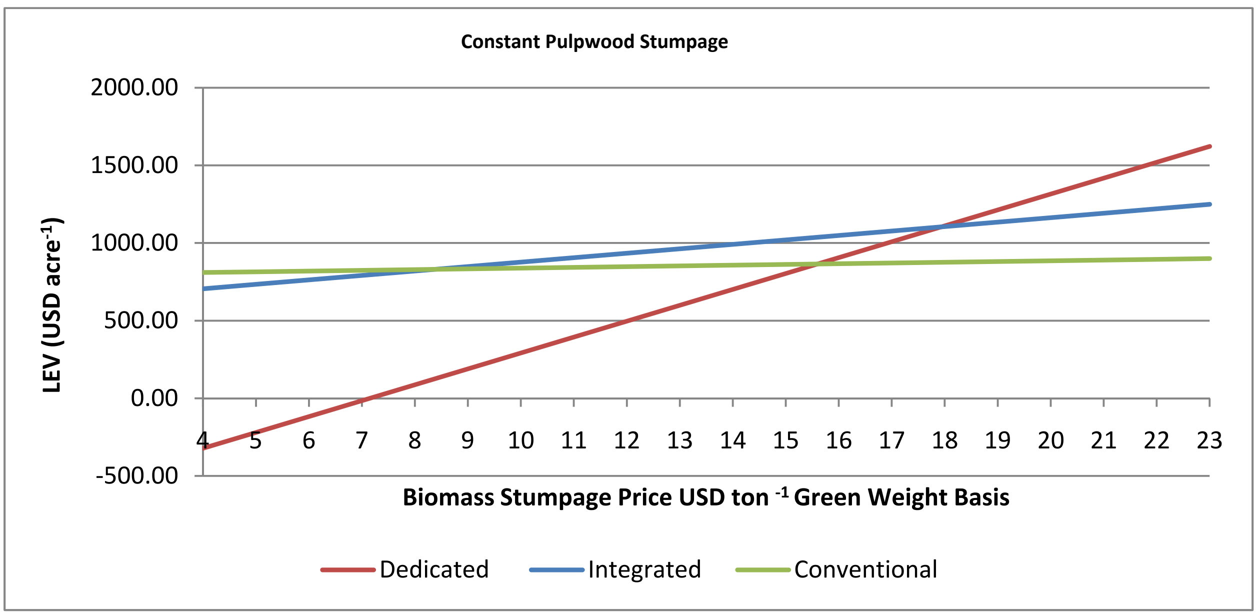

Figure 2. Sensitivity analysis of biomass stumpage prices ranging from \$4 to \$23 ton^{-1} green weight basis for the dedicated, integrated, and conventional management regimes. Pulpwood stumpage prices were held constant.

Price Sensitivity: Higher Value Pulpwood Stumpage (Figure 3)

- At biomass stumpage prices of \$4 to \$8.06 per ton, the conventional management regime generated the highest LEVs.
- At biomass stumpage prices of \$8.07 to \$22.04 per ton, the integrated management regime generated the highest LEVs.

- At biomass stumpage prices of $22.05 per ton or higher, the dedicated management regime generated the highest LEVs.

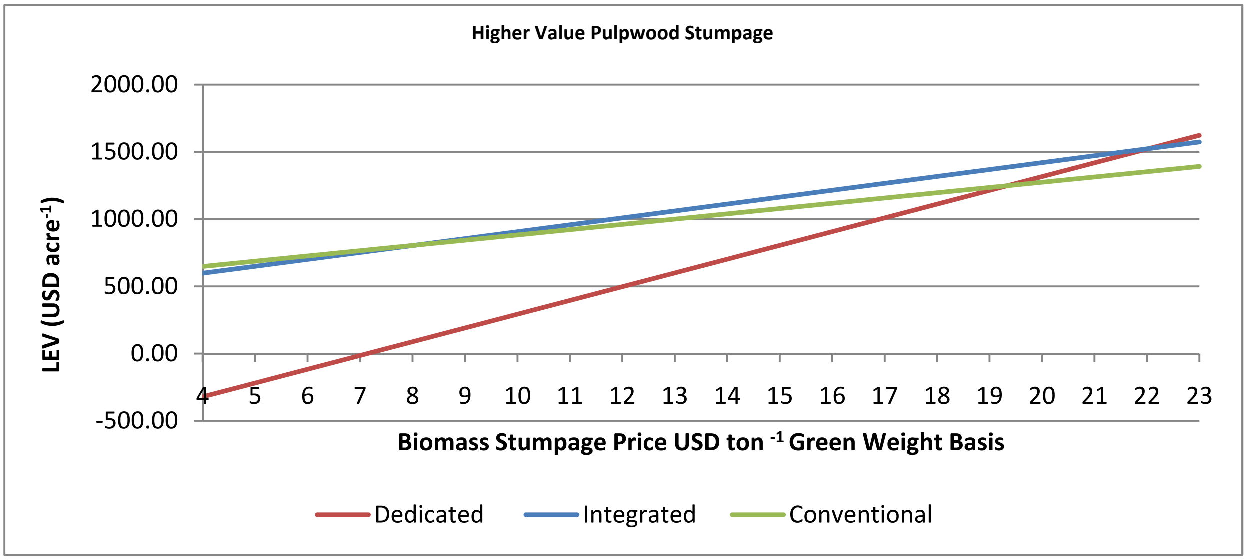

Figure 3. Sensitivity analysis of biomass stumpage prices ranging from $4 to $23 ton^{-1} green weight basis for the dedicated, integrated, and conventional management regimes. Pulpwood was assumed to be $2 per green weight ton higher than biomass.

Price Sensitivity: Biomass/pulpwood stumpage parity (Figure 4)

- At biomass stumpage prices of $4 to $6.11 green ton^{-1}, the conventional management regime generated the highest LEVs.
- At biomass stumpage prices of $6.12 to $21.15 green ton^{-1}, the integrated management regime generated the highest LEVs.
- At biomass stumpage prices of $21.16 green ton^{-1} or higher, the dedicated management regime generated the highest LEVs.

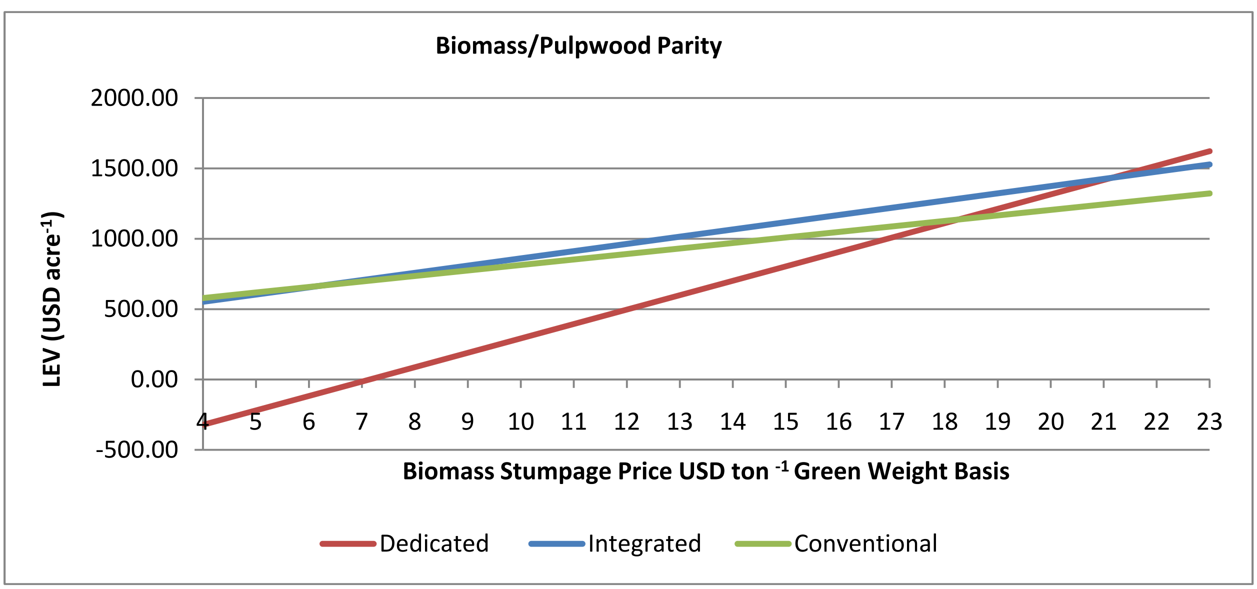

Figure 4. Sensitivity analysis of biomass stumpage prices ranging from $4 to $23 ton^{-1} green weight basis for the dedicated, integrated, and conventional management regimes. Pulpwood and biomass were assumed to have equal stumpage prices.

CONCLUSION

Results of the three sensitivity analyses indicate that until the price paid for biomass reaches \$17.94, \$21.16, or \$22.05 green ton^{-1}, integrated or conventional management systems that produce forest products such as sawtimber will result in superior financial returns to the landowner. The price point at which short rotation pine plantations for biomass produced the highest returns depended upon assumptions of how the value of pulpwood changed in response to rising biomass stumpage prices. When traditional product prices remained unchanged (which is unlikely), the dedicated regime yielded superior returns at \$17.94 green ton^{-1}. When pulpwood product prices increased in concert with rising biomass prices, the break-even point was significantly higher (\$21.16 green ton^{-1}). When pulpwood stumpage was priced \$2 per green ton higher than biomass, the break-even point was even higher, at \$22.06 per green ton.

Compared to the conventional regime only, the integrated regime generated superior financial returns at a significantly lower biomass prices. When the price paid for biomass reached \$8.06, \$8.39, or \$6.11, the integrated regime out-performed the conventional regime. Again, the break-even price depended upon assumptions of how the value of pulpwood changed in response to rising biomass stumpage prices. When traditional product prices remained unchanged, the dedicated regime yielded superior returns at \$8.38 green ton^{-1}. When pulpwood stumpage was priced \$2 per green ton higher than biomass, the break-even point was \$8.07 per green ton. When pulpwood product prices equaled biomass prices, the break-even point was significantly less than the other stumpage scenarios considered (\$6.11 green ton^{-1}).

This analysis demonstrates that biomass stumpage prices will need to rise dramatically before non-industrial private forest (NIPF) landowners will consider the management of pine plantations solely for biomass production. Biomass will need to be produced in conjunction with traditional forest products in order to maximize financial returns, which significantly reduces the amount of potential biomass available to the market.

Questions and comments regarding this fact sheet should be directed to:

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CITATIONS

Shiver, B; Borders, B. 2010. SiMS 2009 Simulator for Managed Stands version 9.3.3. ForestTech International, LLC, Watkinsville, GA 30677.

TM-S 2010. Timber Mart South stumpage prices October - December 2010. UGA-WSFR, Athens, GA 30602

Table 1. Annual Equivalent Values (AEVs) for the integrated, dedicated, and conventional management scenarios using a constant pulpwood stumpage price as biomass stumpage prices increase from $4 to $23 green ton^{-1}.

Biomass Stumpage ($ green ton^{-1})	Pulpwood Stumpage ($ green ton^{-1})	Integrated AEV ($ ac^{-1} yr^{-1})	Dedicated AEV ($ ac^{-1} yr^{-1})	Conventional AEV ($ ac^{-1} yr^{-1})
4	10.72	35.17	-16.57	40.38
5	10.72	36.60	-11.45	40.62
6	10.72	38.03	-6.34	40.85
7	10.72	39.46	-1.22	41.09
8	10.72	40.89	3.90	41.33
9	10.72	42.32	9.02	41.56
10	10.72	43.75	14.13	41.80
11	10.72	45.18	19.25	42.04
12	10.72	46.61	24.37	42.27
13	10.72	48.05	29.49	42.51
14	10.72	49.48	34.60	42.75
15	10.72	50.91	39.72	42.98
16	10.72	52.34	44.84	43.22
17	10.72	53.77	49.96	43.46
18	10.72	55.20	55.07	43.69
19	10.72	56.63	60.19	43.93
20	10.72	58.06	65.31	44.16
21	10.72	59.49	70.42	44.40
22	10.72	60.92	75.54	44.64
23	10.72	62.36	80.66	44.87

Table 2. Annual Equivalent Values (AEVs) for the integrated, dedicated, and conventional management scenarios using a $2 higher pulpwood stumpage price as biomass stumpage prices increase from $4 to $23 green ton^{-1}.

Biomass Stumpage ($ green ton^{-1})	Pulpwood Stumpage ($ green ton^{-1})	Integrated AEV ($ ac^{-1} yr$^{-1)}$	Dedicated AEV ($ ac^{-1} yr$^{-1)}$	Conventional AEV ($ ac^{-1} yr$^{-1)}$
4	6	29.80	-16.57	32.26
5	7	32.37	-11.45	34.21
6	8	34.93	-6.34	36.17
7	9	37.50	-1.22	38.13
8	10	40.07	3.90	40.09
9	11	42.64	9.02	42.04
10	12	45.21	14.13	44
11	13	47.78	19.25	45.96
12	14	50.34	24.37	47.92
13	15	52.91	29.49	49.87
14	16	55.48	34.60	51.83
15	17	58.05	39.72	53.79
16	18	60.62	44.84	55.75
17	19	63.19	49.96	57.70
18	20	65.75	55.07	59.66
19	21	68.32	60.19	61.62
20	22	70.89	65.31	63.58
21	23	73.46	70.42	65.53
22	24	76.03	75.51	67.49
23	25	78.60	80.66	69.45

Table 3. Annual Equivalent Values (AEVs) for the integrated, dedicated, and conventional management scenarios using pulpwood stumpage prices that are equal to biomass stumpage prices.

Biomass Stumpage ($ green ton^{-1})	Pulpwood Stumpage ($ green ton^{-1})	Integrated AEV ($ ac^{-1} yr^{-1})	Dedicated AEV ($ ac^{-1} yr^{-1})	Conventional AEV ($ ac^{-1} yr^{-1})
4	4	27.52	-16.57	28.82
5	5	30.09	-11.45	30.77
6	6	32.66	-6.34	32.73
7	7	35.23	-1.22	34.69
8	8	37.80	3.90	36.65
9	9	40.37	9.02	38.60
10	10	42.93	14.13	40.56
11	11	45.50	19.25	42.52
12	12	48.07	24.37	44.48
13	13	50.64	29.49	46.43
14	14	53.21	34.60	48.39
15	15	55.78	39.72	50.35
16	16	58.34	44.84	52.31
17	17	60.91	49.96	54.26
18	18	63.48	55.07	56.22
19	19	66.05	60.19	58.18
20	20	68.62	65.31	60.14
21	21	71.19	70.42	62.09
22	22	73.75	75.51	64.05
23	23	76.32	80.66	66.01