Analysis of Biomass Production in Young Loblolly Pine

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The potential advantages of domestic biomass and biofuel production are at the center of much public discussion given the potential impact of these technologies on fuel costs and supplies, foreign relations (especially with regard to oil-producing countries), and the environment. This discussion increasingly includes the production of cellulosic ethanol, and given the prominent place of loblolly pine (*Pinus taeda* L.) in the timber industry in the southeastern U.S., it is sensible to explore the potential for its use for biofuel. There is much literature concerning yields of loblolly and of other species that grow in the Southeast. Cobb et al. (2008) is an excellent recent example of such studies, and indicates the superiority of loblolly yields to those of slash pine, sweetgum, and sycamore over a wide range of conditions. Any biofuel industry will need a large volume of uniform feedstock, and loblolly pine is singular in its ability to provide this in the Southeastern U.S.

As steps are taken toward utilizing loblolly pine for biofuel, it will be essential to have an idea of potential biomass production in young loblolly pine across a range of sites and conditions. We are evaluating growth data from numerous 2nd-generation progeny tests measured by the NC State University Cooperative Tree Improvement Program to characterize biofuel potential of loblolly pine. These tests were measured every year through age eight (and frequently beyond) and can be used to look at potential biomass production in young loblolly pine stands. Yearly measurements of this nature are not the norm, and this data set presents a unique opportunity to obtain real numbers for loblolly pine biofuel yields. In total, there were 25 test series with a total of 101 tests. In this analysis, only a small subset of these tests was examined. Biomass production of seven individual tests from different regions planted at a variety of spacings (from 538 to 908 trees per acre) was examined.

METHODS

The selected tests are located in four regions: SC Coastal, NC Coastal, SC-GA Piedmont, and Virginia. Planting densities for the tests were 538, 545, 726, 778, and 908 trees per acre. Tests were measured yearly from ages one through eight and at year twelve. Characteristics measured include survival, height, diameter (and others not pertinent to this analysis). The selected tests were of good quality, with survival at 94% at age eight and with reasonable coefficients of variation for height at age eight. For the net present value (NPV) analysis, the basic discounted cash flow formula was used:

$$PV = FV/(1+i)^t$$

Where PV = present value, FV = future value, i = interest rate, and t = age (i.e. the number of years FV is being discounted). An interest rate of 8% was used, and FV was calculated by multiplying volume at age *t* by $7 (price per ton of pulpwood). To get NPV, an establishment cost of $300 + $0.05/seedling was subtracted from the PV.

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RESULTS AND DISCUSSION

Across the seven tests, stemwood volume at age eight ranged from 30.5 to 69.5 green tons/acre. At age twelve, volumes ranged from 67.3 to 127.2 green tons/acre. Ages eight and twelve are the main focus of the following analysis as this provides a contrast of two ages that are realistic rotation ages for biomass plantations.

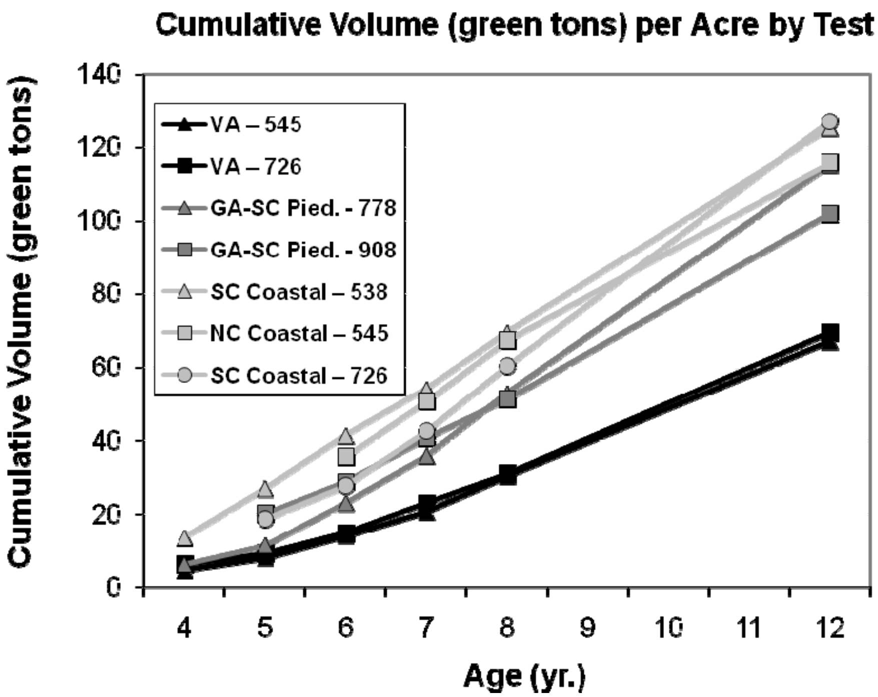

Figure 1. Mean height by test for years one through eight and year twelve. The general location and the trees per acre for each test are given in the legend.

As shown in figure 1, the rankings of the tests are not identical between ages eight and twelve, but relative to all of the tests, no test changes significantly. There are two important results from these data: (1) A very wide range of volumes can be obtained from young loblolly plantations, and (2) site has a clear influence on productivity. As might be expected, tests in the Coastal Plain grew the best, followed by tests in the piedmont, and then by tests in Virginia.

Spacing effects are confounded by site and genetic differences, so drawing conclusions on spacing effects is not possible. Genetic material varies from test to test (only the GA-SC piedmonts tests were planted with the same seedlots), so genetic effects are also confounded. Within tests, however, genetics clearly had an impact on productivity. At age eight, on the most productive site, the best family yielded 23.5 green tons/acre more than the seed orchard mix (SOM), and on the least productive site the best family yielded 5.2 green tons/acre more than the SOM. For the same two tests at age twelve, the difference between the best family and the SOM was 64 green tons/acre on the high productivity site and 15.2 green tons/acre on the low productivity site.

These tests provide a unique opportunity to examine productivity at young ages, especially given that growth and yield simulators are generally geared toward sawtimber production and much longer rotations. To determine what this biomass may be worth, we calculated NPV of trees harvested at ages

8 and 12 years (Table 1).

Table 1. NPVs for top family and SOM in high and low productivity tests and for average top family and average SOM across all seven tests.

	AGE 8	AGE 12
High Productivity Test Top Fam.	-$8	$129
High Productivity Test SOM	-$97	-$49
Low Productivity Test Top Fam.	-$191	-$100
Low Productivity Test SOM	-$211	-$142
Avg. Top Fam.	-$91	$38
Avg. SOM	-$140	-$58

Not surprisingly, under all scenarios at age eight, the net present value is negative. Under current market conditions and reasonable productivity scenarios, harvesting young loblolly pine stands solely for biomass is not profitable. However, at age twelve, using the best genetics on the high productivity site is projected to be profitable. In addition, the average top family (but not the average SOM) makes money at age twelve. While this analysis is highly dependent on assumed variables (interest rate, pulpwood costs, establishment costs, and site productivity), it illustrates the value of good genetic material and good site conditions. Moreover, if establishment costs can be reduced or if pulpwood prices go up (a realistic expectation if loblolly pine biomass becomes a commodity in the biofuels sector), it will be possible to increase revenues for all scenarios.

REFERENCES

Cobb, WR, RE Will, RF Daniels, MA Jacobson. 2008. Aboveground biomass and nitrogen in four short-rotation woody crop species growing with different water and nutrient availabilities. Forest Ecology and Management 255:4032-4039.