Ten-Year Growth of Loblolly Pine Planted in Different Configurations Targeting Varied Product Objectives

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The Bottom Line

By changing the planting density and between- or within-row spacing, it is possible to design loblolly pine plantations to achieve a mix of product objectives. In this study, planting alternate rows at different spacings produced up to 51% more volume within a 10-year time frame compared to a more traditional 10 ft. x 10 ft. spacing (436 trees per acre).

Abstract

A study was installed in spring 2012 to compare the growth and productivity of loblolly pine planted at varying densities in four planting configurations. A planting density of 436 trees per acre (tpa) on a 10 ft. x 10 ft. spacing was compared to three other configurations where alternating rows were planted at within-row densities intended to produce shorter-rotation (biomass or pulpwood) vs. longer-rotation (chip-n-saw or sawtimber) products. One replication of these treatments was installed at each of three state forests: Appomattox-Buckingham, Cumberland and Dragon Run.

After 10 years, there are significant differences in tree diameter, basal area and fiber production among the four planting concepts. Compared to the 436 tpa planting, the three alternatives increased total inside-bark volume per acre by as much as 51%. If this pattern of growth continues, these planting options would enable landowners to consider removing the higher-density rows for biomass or pulpwood products in one or more early (age 10-16) thinning operations while leaving the lower density rows for a subsequent harvest of solid-wood products.

Background

Conditions involving supply and demand for wood fiber between 2005 and 2010 led some analysts to forecast shortages of wood for the biofuel market. There was concern that loblolly pine removals could exceed production in some areas of Virginia. One approach to address this scenario was examined in this study: by designing planting configurations to provide multiple products from the same acre of land, it could be possible to generate more total pine volume per acre and increase the availability of small-diameter trees for chip or pellet markets while still maintaining a portion of the stand for a more traditional pulpwood and/or sawtimber product mix.

Methods

To examine the potential growth responses of several alternative planting designs, a study was planted in spring 2012 on three state forests: Appomattox-Buckingham, Cumberland and Dragon Run. At each location, four plots were installed to compare four planting configurations (Figure 1):

1. 436 trees per acre (tpa) planted on a square 10 ft. x 10 ft. spacing (the "Traditional" configuration – Figure 2a);

2. 720 tpa planted in rows spaced 10 ft. apart and alternating between rows with 10 ft. (sawtimber) and 4 ft. (biomass) within-row spacings (the "Biomass*1" configuration – Figure 2b);

3. 1,300 tpa planted with one sawtimber row alternating with two biomass rows (the "Biomass*2" configuration – Figure 2c); and

4. 1,240 tpa planted with three alternating rows spaced 9 ft. apart – one at a 9 ft. (sawtimber) spacing, one at a 3 ft. (biomass) spacing and one at a 6 ft. within row (pulpwood) spacing (the "3-Product" configuration – Figure 2d).

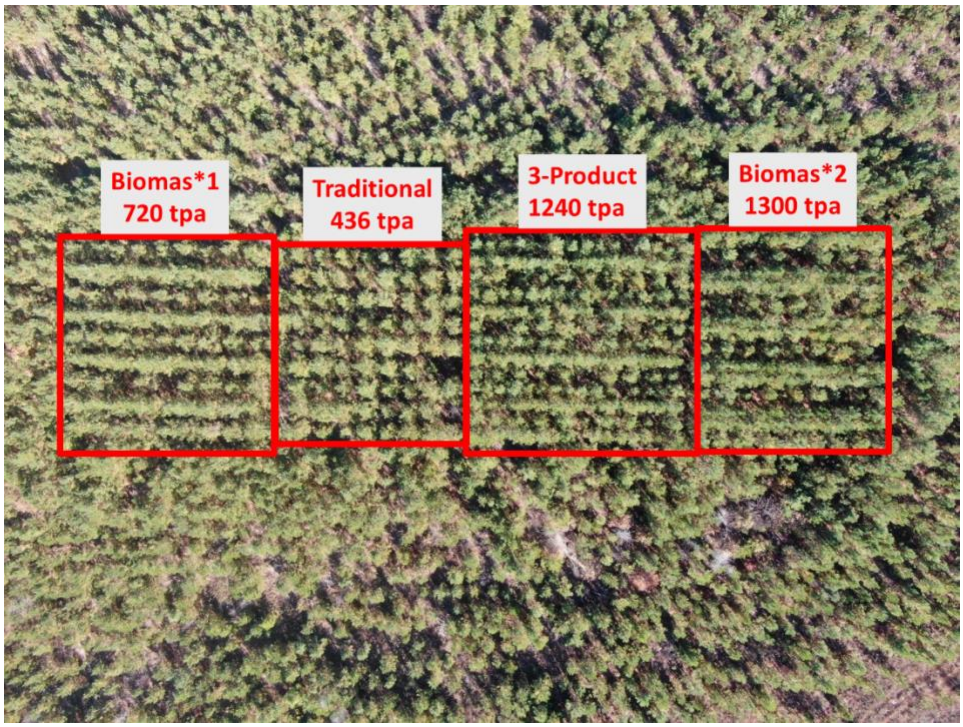

Figure 1. Aerial image of one replication of the alternate planting configurations.

Figure 2. Stand conditions in the four planting configurations at age 10 at the Appomattox-Buckingham State Forest location: a) Traditional - 436 tpa (top left); b) Biomass*1 - 720 tpa (top right); c) Biomass*2 – 1,300 tpa (bottom right); and d) 3-Product – 1,240 tpa (bottom left).

To address concerns about increasing seedling costs when planting densities nearly triple (as under some of these designs), the "sawtimber," "pulpwood" and "biomass" seedlings were planted with the VDOF Nursery's Virginia's Best, Premium and Orchard Mix genetic offerings from the 2012 catalog, respectively. By planting so that seedling density is inversely related to price (i.e., using the cheapest seedlings for the highest density rows), seedling cost can be minimized.

Hardwood competition was controlled on all plots at all locations with both operational aerial herbicide applications and follow-up backpack applications. Volunteer pines were removed manually. Pine survival, height, and diameter breast height (dbh) have been measured annually since planting. From those data, basal area and total tree volume (inside bark from stump to tip, using equations developed by the Forest Modeling Cooperative for unthinned stands) were calculated – also annually. Means were compared using two-way analysis of variance for a randomized complete block experimental design with three replications (locations) and four treatments (planting configurations).

Results

After 10 growing seasons, effects of planting design on average survival or tree height are not statistically significant but average tree dbh and plot basal area and volume vary significantly among planting configurations. The trends in the data continue to follow logical patterns (Table 1). Trees of the better genetics and at the wider row spacing (sawtimber) are larger individually than the lower rated and more densely planted trees (biomass or pulpwood). Sawtimber trees average from 6.3 (on the 3-Product plots) to 7.3 (on the Traditional plots) inches in dbh while the biomass trees range from 4.6 (on the 3-Product plots) to 5.5 (on the Biomass*1 plots) inches in dbh.

Integrating the effects of planting density and growth differences, the volume per acre productivity (Figure 3) tells the story. Including just one alternating row of tightly-spaced trees has increased fiber production by 15% compared to the 436 tpa spacing, and adding a second row has increased it by more than 50%.

Table 1. Individual tree and stand level metrics for loblolly pine ten growing seasons after establishment under four alternative planting configurations.

Planting Configuration	Product Objective	Survival (%)	Height (ft.)	DBH (in.)	Basal Area ($ft.^2$/acre)	Percent BA Gain	Volume ($ft.^3$/acre)	Volume Gain (%)
Traditional 436 tpa	Sawtimber	89%	37.2	7.3	117.0	n/a	1581	n/a
Biomass*1 762 tpa	Combined	87%	36.5	6.2	130.1	11%	1817	15%
	Sawtimber	91%	38.0	7.3	61.6		914	
	Biomass	84%	35,7	5.5	68.5		903	
Biomass *2 1,136 tpa	Combined	86%	35.5	5.3	175.7	50%	2386	51%
	Sawtimber	92%	37.5	7.0	50.0		781	
	Biomass	85%	35.0	4.9	125.7		1605	
3-Product 1,268 tpa	Combined	89%	34.8	5.2	168.4	44%	2198	39%
	Sawtimber	97%	36.8	6.3	44.2		629	
	Pulpwood	86%	34.8	5.5	63.8		745	
	Biomass	88%	34.0	4.6	60.4		824	

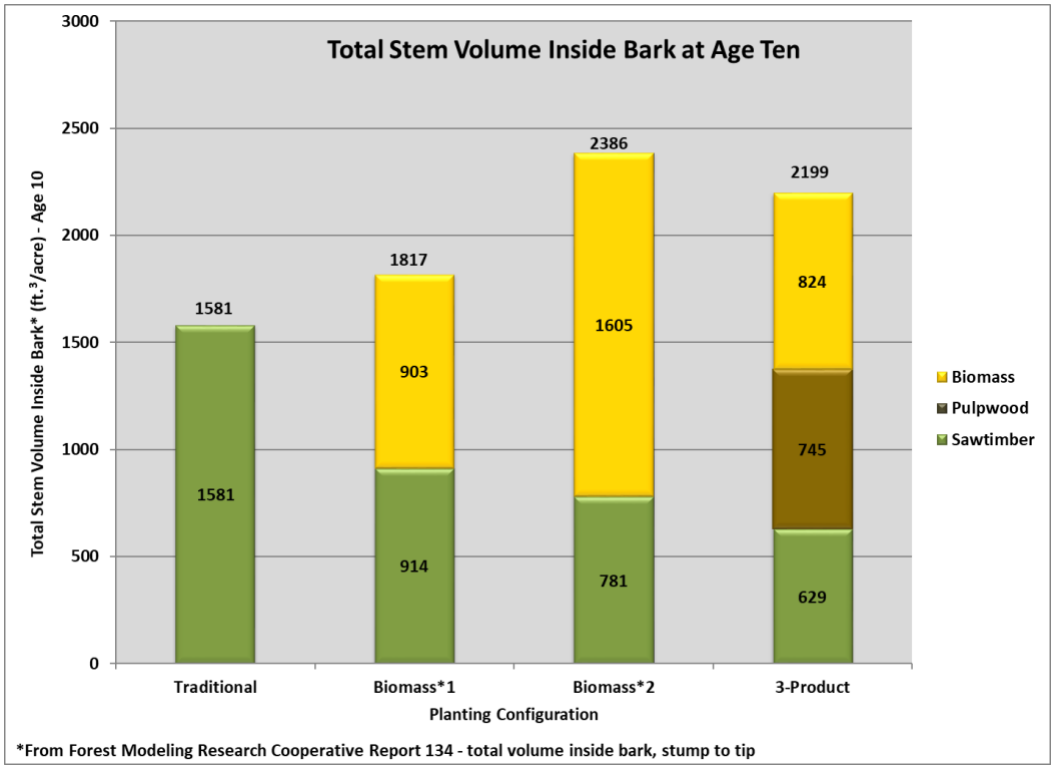

Figure 3. Volume per acre (total inside bark, ft.³/acre) produced after 10 years on plots of the alternate planting configurations study.