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Silvicultural Research In the News

North Carolina Forest Service
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How Many Trees To Plant? One Density Does NOT Fit All.

Choosing how many trees to plant is an important reforestation decision facing land managers. Planting density and spacing affect growth and development of pine plantations and thus the amount and size of the wood harvested. A choice today determines the timing (and need) of future harvests, including thinning, and resulting harvest products, i.e., pulpwood or sawtimber.

To evaluate spacing and density effects on loblolly pine plantation development and product yield, four study sites were established in 1983 in the Piedmont and Coastal Plain regions of Virginia and North Carolina. The study looked at 16 spacings, 4 square and 12 rectangular plots, ranging from 303 to 2272 trees per acre. In a 2012 paper in the Southern Journal of Applied Forestry[1], Ralph Amateis and Harold Burkhart use 25 years of study data to make recommendations on the best planting density for specific timber products produced without thinning.

- The amount of space per loblolly tree is more important to growth than the shape of the initial spacing (rectangular versus square).
- Similarly, planting density has a greater influence on harvest yield and products then degree of rectangularity.
- In the absence of thinning, the more trees planted resulted in smaller timber size.
- For growing sawtimber (with no thinning), plant fewer trees. For 25-year-rotations, the authors recommend planting as few as 300 trees per acre.
- Conversely, plant more trees for increased biomass. For pulpwood on a short rotation, planting 680 trees per acre may be suitable.
- The authors further conclude, "Considered together, the results of this study suggest that no single planting density will be optimal for all management objectives. Rather, managers will need to consider product objectives desired at final harvest and whether opportunities exist for thinning and other silvicultural interventions will be present during mid-rotation when selecting an initial planting density."

The abstract for the Amateis & Burkhart (2012) paper[1] follows:

This study reports cubic-foot volume yields for particular product definitions from a 25-year-old loblolly pine spacing trial and shows how closely, in the absence of thinning, total and merchantable wood production are linked to initial spacing. Results at the close of the study indicate that (1) high-density plantations can be managed on short rotations for woody biomass production; (2) pulpwood yields can be maximized at a planting density in the neighborhood of 680 trees/ac; (3) the production of solidwood products, without imposing thinning, requires lower establishment densities, with as few as 300 trees/ac planted resulting in a substantial proportion of the total yield recovered as large sawtimber; and (4) a ratio of between-row to within-row planting distances of at least 3:1 does not substantially affect yield production. Considered together, the results of this study suggest that no single planting density is optimal for the wide array of product objectives for which loblolly pine is managed in the South. Rather, managers must select an appropriate planting density in view of the products anticipated at harvest.

Numerous other papers have also been published from the same study. Related research highlights include:

- Wider spaced trees grow taller than closer spaced trees; however, this increase in height diminishes at less than 450 trees per acre[4].
- Planting density effects on height begin as early as age 6 and continue through at least 25 years (the length of this study) [4,5].
- Negative effects on height suggest that site index is also affected by planting density (either reduced or increased).[4]
- Rectangularity of planting did not affect survival, height, diameter, volume yield, and basal area[6].
- Wider row spacings produced larger crowns. Crown shape becomes elliptical in the more rectangular spacings[6].
- Total lumber production is higher from the larger trees grown at lower planting densities (302 tpa planting density produced 16% more lumber than 681 tpa density and 40% more lumber than the 1210 tpa density)[2].
- Lower planting densities produced more board feet and a greater proportion of Grade #3 or better lumber. Thus, lumber sawn from the lower planting densities have higher value [2].

Citations:

[1]**Amateis, Ralph & Burkhart, Harold. 2012. Rotation-Age Results from a Loblolly Pine Spacing Trial. Southern Journal of Applied Forestry. 36. 11-18. 10.5849/sjaf.10-038. www.researchgate.net/publication/272127449**.

[2]Amateis, Ralph & Burkhart, Harold. 2013. Relating Quantity, Quality, and Value of Lumber to Planting Density for Loblolly Pine Plantations. Southern Journal of Applied Forestry. 37. 97-101. 10.5849/sjaf.12-012.

[3]Antón Fernández, Clara, H. Burkhart, & R. Amateis. 2012. Modeling the Effects of Initial Spacing on Stand Basal Area Development of Loblolly Pine. Forest Science. 58. 95-105. 10.5849/forsci.10-074.

[4]Antón Fernández, Clara, H. Burkhart, M. Strub, & R. Amateis. 2011. Effects of Initial Spacing on Height Development of Loblolly Pine. Forest Science. 57. 201-211.

[5]Macfarlene, D. W., E.J. Greene, H. Burkhart. 2000. Population density influences assessment and application of site index/ Can. J. For. Res. 30:1472-1775.

[6]Sharma, Mahadev, H. Burkhart, & R. Amateis. 2002. Spacing rectangularity effect on the growth of loblolly pine plantations. Can. J. For. Res. 32.1451-1459.