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Preamble

Perspectives on site productivity of loblolly pine plantations in the southern United States

Pine plantations in the U.S. South include some of the most intensively managed and productive forests in the world. Studies have been established in recent decades to answer questions about whether the productivity of these plantations is sustainable. While intensive management practices greatly enhance tree growth, their effects on factors controlling growth responses across sites are not well understood. Papers in this set represent six perspectives on the issue of sustainable productivity of intensively managed loblolly pine, the South's most prevalent and commercially valuable pine species. They were among the papers presented during a symposium entitled "Long-term site productivity of loblolly pine plantations in the southern United States," held in New Orleans, LA, USA and co-sponsored by NCASI and the USDA Forest Service.

The first perspective is historical, describing the convergence of incentives and research that have led to the establishment of large areas of productive southern pine plantations in the South (Carter and Foster). The realization of improved productivity of southern pine has led to a substantial and increasing contribution of these forests to the U.S. supply of fiber and forest products. This review highlights major breakthroughs in policy incentives, research, and applications over the last half century that have brought forestry in the South to where it is today.

The second perspective focuses on the effects of site resource manipulations on productivity of loblolly pine stands of North Carolina and Louisiana (Sanchez et al.). These studies represent two of the oldest installations comprising the Long-term soil productivity (LTSP) network established in 1990 by the USDA Forest Service and collaborating institutions across the United States and Canada. The focus of the LTSP network is on the manipulation of site organic matter, soil porosity, and resource availability by varying harvest intensity (bole, whole-tree, whole-tree plus forest floor) and compaction (none, moderate, and severe), with and without the control of competing vegetation. Surprisingly, 10-year results from these installations show that removing all aboveground biomass and forest floor and severely compacting the soil had no significant effect on stand volume relative to bole-only removals with no compaction. The overriding treatment factor was instead competition control, which increased mean stand volume by 40% and 30% for the NC and LA sites, respectively. Organic matter removal did not consistently alter soil N pools but reduced extractable soil P, although this did not translate into reduced foliar P concentrations. The findings reveal a remarkable resilience of these systems to disturbance but suggest a potential for future P deficiencies resulting from organic matter removal.

The third perspective is based on optimizing site resources for loblolly pine through annual fertilization and complete interspecific competition control in the Lower Coastal Plain of Georgia (Will et al.). Over 13 years, these treatments increased stand basal area by over 50% and 20%, respectively, and tree growth rates with both treatments combined were among the highest documented in the southeastern U.S. Over 90% of fertilizer N was retained within the system (35% in aboveground biomass, 33% in O horizon, 22% in 0–10 cm soil layer) while about 100% of fertilizer P was retained. These retention rates are exceptional, given the high amounts of fertilizer applied (ca. 900 kg ha^{-1} N and 200 kg ha^{-1} P) to a site with coarse textured soils and a relatively shallow water table, and were likely enhanced by the frequent application regime. While competition control increased tree growth early in stand development, continued fertilization appears critical for sustaining accelerated growth rates beyond crown closure.

The fourth perspective is based on a mechanistic understanding of soil factors controlling loblolly pine seedling root growth as a key site productivity indicator (Morris et al.). The authors provide evidence that soil mechanical resistance, water potential, and air-filled porosity are the soil factors primarily responsible for reducing root growth below optimal levels. Relationships between soil water content and these factors developed from greenhouse and rhizotron studies were used to structure a model of first-year pine seedling growth. A preliminary test of the model on the Upper Coastal Plain of Georgia showed that it provided reasonable estimates of seedling growth and responses to tillage compared with measured values. The model and derived relationships could have utility for understanding and predicting seedling and ultimately stand growth responses to changes in soil moisture and management regime.

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The fifth perspective addresses the often overlooked interaction between the deployment of improved genetic stock and site environmental and resource factors, sometimes referred to as G × E (McKeand et al.). Biomass allocation patterns and nutrient requirements associated with improved seedlings may alter traditional site productivity paradigms and increasingly uniform seedlings may influence resistance to insects or disease when deployed in new environments. A number of G × E studies using open-pollinated, half-sib, and full-sib loblolly pine families and clones across a range of sites and management intensities are examined. Significant G × E were relatively rare (i.e., better families tend to be better on both high and low quality sites) within limited geographic ranges, but the authors caution that G × E could become more prominent as the use of improved genetics and intensive management regimes become more widespread.

The final site productivity perspective focuses on linkages between research and alternative forest functions, which is particularly relevant to the 70% of southern forest land in non-industrial private ownership. The relevance of site productivity principles to non-timber values such as wildlife habitat and water quality is evaluated. While low-intensity management regimes may have relatively small impacts on site productivity and related environmental values in most cases, they also rely on inherent site resources with fewer mitigation options than more intensive regimes. The authors urge that assessments of alternative functions be incorporated into site productivity research as part of an overall strategy to sustain the economic and environmental contributions of southern forests.

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