Investing in Genetically-Improved Loblolly Pine

Landowner Benefits Today and for Generations to Come

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Tree breeders are responsible for the genetic resource that is available today and for generations to come. From the previous discussion and the article by Dougherty and others also in this issue (page 19), the economic incentive for breeding, testing, and selecting the best trees possible should be apparent. Through the application of traditional breeding methods used in agronomic and horticulture crops for decades, tree breeders have developed families or varieties of loblolly pine that produce 30 to 50 percent more wood per acre than was available 40 years ago. These families are more resistant to fusiform rust disease (see article on page 37), have better wood quality due to enhancement of straightness and disease resistance, and are widely adapted to a range of site types and forest management regimes.

Genetics and Plantation Management

For every plantation that is established, forest landowners have one opportunity to choose the appropriate genetics for the long-term investment that they are making. The genetic potential for this investment comes packaged as seedlings that have been propagated from seed or tissue culture, grown in a nursery for 6 to 10 months, and sold for 5 to 40 cents each depending on the genetic quality and the seller of the trees. The seedling costs on a per acre basis can range from $25 to $200, but are typically well under $100 for elite loblolly pine genetics.

The decision landowners make when the seedlings are chosen and planted sets the bar for what is possible to obtain from that plantation. For example, if a landowner plants a family that has been well-tested and has superior attributes for volume production, disease resistance, stem quality, and wood properties, then he or she will have numerous options for managing the stand. If pulpwood or biomass markets are strong, thinnings at appropriate ages can generate much needed income early in the rotation. With high-quality sawtimber trees available to harvest at 25 to 35 years, prices per ton that are usually 5 to 7 times higher than pulpwood prices are typically realized.

Good genetics is critical for having flexible management decisions. If little attention is paid to the genetic quality of the seedlings that are planted, then management options are not as numerous. For example, if sawtimber production is the primary objective, but emphasis is not put on stem quality or disease resistance when the seedlings are planted, then fewer sawlog trees per acre may actually be harvested, and more trees will be relegated to the pulpwood or biomass market.

Genetic Performance

Since the beginning of tree improvement with loblolly pine, more than 10,000 parent trees have been selected and their progeny tested in field trials. The hundreds of families and clonal varieties currently for sale across different regions represent the very best genetics that is available from breeding programs throughout the South. For more than 20 years, southern landowners have planted over 1,000,000 acres with loblolly pine seedlings each year, and every seedling has come from the breeding programs of the members of the different cooperative tree improvement programs[1]. However, these programs have not come close to reaching the potential genetic gains in productivity, disease resistance, and quality traits for loblolly pine in the South. Significant gains will continue through the selection and breeding of superior genotypes, which in turn will increase the growth and economic value of seedlings sold to forest landowners.

When the best genetic material is planted and given the necessary resources, growth rates of 300 cubic feet per acre per year (about 8 tons per acre per year) can be achieved on many sites. There are few other regions in the world where the use of integrated silvicultural systems that may include intensive site preparation, fertilization, weed control, management of stand density via thinning, management of pests, and use of genetically improved planting stock is having such a large, positive impact on plantation productivity and value. Today's plantations are growing more than twice as fast as plantations of the previous rotation, and continuing improvement in loblolly pine genetics will produce even greater increases in the potential productivity and quality of forest plantations.

One absolute is that not all loblolly pine families are created equal. There is tremendous genetic variation among families of loblolly pine for almost all traits. If there are 30 families available to plant, there will be a best family, second-best, third-best, and so on for each trait (e.g. growth, rust resistance, and stem form). The choices of genetic families are wide ranging for each region of the southeastern US, and the number of well-tested families available from various seedling vendors for any given region is well into the hundreds.

Genetic Development Threats and Opportunities

Compared to breeding in agronomic crops such as corn, soybeans, cotton, and wheat, genetic improvement in loblolly pine has just begun (see illustration). The Cooperative Tree Improvement Program at North Carolina State University (NCSU Cooperative) started the breeding effort for loblolly pine in 1956. As we begin the fourth generation of breeding, there is still much more gain to be made to increase the value of loblolly pine to landowners. Although we have many excellent families and varieties available to landowners, breeders have yet to combine all the desirable attributes into the majority of the trees that are commercially available.

The primary threat to the continuation of gain and increased profit to landowners is the potential reduction in effort by tree improvement programs in the region. This might sound strange given the long history of breeding and the high rates of return on the investments in tree improvement. As the forest industry has transformed with mergers and consolidations, and forestland ownership has changed from the large vertically integrated forest products companies that owned both land and mills to more institutional investors that often own land for only short periods of time, the number of tree improvement, seed orchard, and nursery programs has decreased dramatically. Compared to only 20 years ago, the number of companies and state agencies actively involved in the NCSU Cooperative's breeding program has gone from 29 to 12. We have lost significant capacity to breed trees, and the threat to continuing the rate of genetic gain is real.

With the past and current aggressive breeding programs in the Cooperative, the value of plantations established is estimated to increase about one percent each year (i.e. the trees planted this year are one percent more valuable than the trees planted last year). This is due to better genetic material being generated from the breeding programs and delivered to the seed orchard and propagation programs every year. For instance, seedlings available in the 2008 to 2009 planting season came from the cone crop harvested in 2007 when second-generation seed orchards contributed about 77 percent of the total seed, and the higher-valued third-generation orchards produced about 12 percent of the seed crop. For the current planting season (2009 to 2010), third-generation seeds made up 25 percent of the seed harvested, and were grown in nurseries last summer. These seedlings will result in faster-growing, higher-quality, more valuable plantations being planted this year compared to last year. This trend can continue for decades as long as the resources to continue tree improvement efforts are available.

Maintaining efforts in tree improvement has enormous economic development implications for the South. Unlike other silvicultural inputs into plantations, the benefits from planting genetically improved seedlings are permanent and are spread over millions of acres at minimal extra cost. But, if the degree of improvement is compromised or slowed, then there is significant lost financial benefit. If the genetic gain per year is reduced to any extent, the regional financial impacts are worth millions of dollars. For example, the present value of a series of continuously improved plantations[2] is esti-

mated to be $12,255 per planted acre (e.g. a non-ending series of genetically better plantations of one acre being planted each year). If these same plantations were established with the same genetic quality of seedlings each year (i.e. genetic improvement stopped so that the genetic gain is reduced from one percent per year to zero percent per year), the present value would be $10,262 per acre planted or $1,993 per acre less since all future seedlings would be the same as those planted today.

While it is not likely that tree improvement will stop, there is no question that tree improvement progress could slow down considerably. If efforts are scaled back only slightly, so that genetic gain is reduced from 1 percent per year to 0.9 percent per year, the present value loss to a landowner would be $232 per acre planted per year. For the South, where about 1.2 million acres of loblolly pine are planted each year, the loss in present value to all landowners from this slight reduction in genetic improvement would be about $290 million.

Alternatively, there is a strong economic incentive for breeders to increase efforts in tree improvement to increase the rate of genetic gain per year. The NCSU Cooperative has members who are long-term and aggressive supporters of tree improvement. With the support of new members that include large, medium, and small landowners, we are working to increase efforts in tree improvement to increase the rate of gain per year rather than watch it decrease. The Cooperative has recently initiated breeding programs and clonal testing designed specifically to increase the value of sawtimber in future years. With this investment, we estimate that gains can be increased from 1 percent per year up to 1.1 to 1.2 percent per year, with present value increases south wide of $300 to $600 million.

This analysis looks at the volume and value gains from a landowner's perspective. In the big picture, the financial gains from wood supply increases will be distributed through the wood product supply chain depending on future market conditions. A more productive forest product supply will have a positive effect on future industry capacity decisions, including, for example, decisions about biomass as a renewable power or fuel source (i.e. supply may help create more demand). While increased wood supply doesn't always benefit landowners as a whole, those landowners who have planted higher-quality, faster-growing genetic stock should have a comparative advantage over other landowners. In low-demand futures, the advantage may be the ability to sell due to offering superior quality; in high-demand futures the advantage may manifest itself as price premiums. In both cases, the higher yields will improve revenues relative to other landowners.

Conclusion

Private landowners benefit from the successes of tree improvement programs, but they will also suffer if tree improvement efforts are reduced. With the emergence of a competitively priced seedling market, there is an opportunity for landowners to have a greater stake in ensuring that tree improvement continues. Forest landowners should use consultants and managers who utilize the best genetics available and the most efficient silvicultural practices to increase value and to help meet their management objectives. For more information about the genetic improvement of loblolly pine and opportunities to get involved, visit the NCSU Cooperative Tree Improvement Program website at www.cnr.ncsu.edu/tip.

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References

[1]There are three large tree breeding cooperatives in the South; The Cooperative Forest Genetics Research Program at the University of Florida, the Western Gulf Forest Tree Improvement Program at the Texas Forest Service, and the NCSU Cooperative Tree Improvement Program.

[2]Assumptions are: 1 percent gain per year in stumpage value due to genetics, a base stumpage value of $2,500 per acre harvested at 25 years, a 6 percent interest rate, and the forestry plantation program is continuous for 100 years (effectively an infinite series of annual payments of stagnant or increasing stumpage values). ◆