SMART FORESTRY

Genetics and Silviculture for Emerging Markets



An interview with Graham Ford, Founder and Principal Consultant, Ford Linkage Group LLC

TREE IMPROVEMENT is the application of forest genetics principles to improve timberland productivity and health. The goal is to develop trees with desired traits, such as increased tree volume (the amount of wood fiber in a tree), greater resistance to diseases, and lower incidence of stem defects.

Partnerships between the forest industry and universities (tree improvement research cooperatives) exist across the U.S., including the Tree Improvement Program at North Carolina State University.

By Jessica Ireland, Director of Education Programs, NCFA

From its beginnings with hybrid poplar experiments in the 1920s, to the application of forest genetics to meet growing timber demands in the 1950s, to today's advancements towards genomic selection, tree improvement has driven significant developments in forest productivity and health in the U.S. Considering the decline of pulpwood markets in the southeastern U.S. and looking at projections for future markets, tree improvement combined with appropriately adjusted silvicultural techniques is critically important.

We had the opportunity to speak with Graham Ford, PhD, on this topic. Ford is the Founder and Principal Consultant with Ford Linkage Group, a forestry consulting firm specializing in forest tree improvement, timberland investment strategy, and science-based forest management.

Ford grew up hunting and fishing in the forests of North Carolina. Inspired by his father's forestry education at Wayne Community College, he chose the same field. He received a Bachelor of Science in Forest Management and a Master of Science and a Doctor of Philosophy in Forestry from North Carolina State University (NCSU). Prior to founding Ford Linkage Group, Ford worked for the NCSU Tree Improvement Program, as well as timber and seedling companies. "I really enjoy tree improvement and forest genetics research because of the broad impacts it has across our forestry industry. Ultimately, everyone depends on tree improvement technology in one aspect or another," said Ford.





Above: A machine plants control-pollinated, containerized seedlings on an upland Coastal Plain site. By deploying an excellent genetic family at 415 trees per acre, this rotation will produce greater proportions of solid wood products.

Left: Loblolly pinecones of a known, thoroughly tested family are staged after being harvested from a seed orchard. These are ready to go to the processor. Once extracted, the seed inside these cones will be sown at a nursery to produce seedlings for reforestation efforts.

Foundations of Tree Improvement

Tree improvement is a complex field of research. Ford describes it as "the practice of selecting, breeding, and testing forest trees to identify genetic families that have the suite of adaptability, growth, and quality attributes that we need for deployment in forest management regimes."

As Ford explains, the fundamentals of tree improvement are no different than methods of improvement in any other crop, such as corn, soybeans, or dairy cattle. In tree improvement for loblolly pine, specifically, trees are selected based on expression of desirable traits, such as height, stem volume, straightness, disease resistance, and branching. These selected genotypes are bred among one another in breeding orchards, and their offspring are planted in tightly controlled field test environments. Data from these tests are carefully collected and analyzed to estimate the breeding values of the parent genotypes. The parent selections that produce offspring with the most desirable profile of important traits are scaled up for seed production through grafting into seed orchards.

Mass production of controlled crosses has been a key tool in loblolly-pine-seed orchard programs for about 25 years. The breeding process begins by enclosing female flowers in pollen exclusion bags in late winter to keep outside pollen from pollinating the flowers. The flowers develop in the bags and are manually pollinated with pollen from another specifically chosen elite selection.

As Ford explains, "We are intentionally combining the genetics of two thoroughly tested parents through this controlled crossing work. These seedlots that share the same biological mother and father are where we see the greatest operational genetic gains. The seedling offspring produced can have excellent volume, straight stems, low incidence of fusiform rust, and decreased forking — attributes necessary for successful outcomes for tomorrow's pine plantations."

The Implications of Evolving Markets

Ford emphasizes that characteristics of the planting site and surrounding market metrics should dictate silvicultural practices for southern pine plantations. Historically, southern pine silviculture has primarily oriented stand management towards maximizing total volume per acre. However, the shutdown of 11 regional pulp mills since 2022 has rapidly strained markets for small-diameter wood.

"I don't think there is anywhere in the Southeast that is totally safe from the impacts stemming from the loss of pulpwood markets. I recommend making decisions towards the next phase of plantations — as markets have drastically changed, our management needs to drastically change as well, and immediately." Ford notes that there is good news amidst these market challenges. "We have the technologies and the insight to be able to implement modified approaches in the next generation of plantations."

Ford recommends managing for larger commodities, such as chip-n-saw, sawtimber, and poles. This means enacting excellent silviculture and the best-available genetic families planted at lower trees per acre than historically seen. "If emerging markets need wood volume, larger stems can be used, but this does not work in the reverse," Ford said. "That is, if you are producing an abundance of small trees, you have fewer options because you are constrained by the need to prioritize stand health and vigor."





Above: A productive upland pine plantation is managed for sawtimber production. Once this stand is harvested, the next rotation has the potential for even greater volume and value production, if the right preparation and genetic family are instituted.

Right: Loblolly pine "flowers" are being quickly checked for development during operational controlled pollination. Pollen exclusion bags keep flowers shielded from the diverse mixture of pollen in the open air. Once the flowers are receptive, a single pollen lot is shot into the bags. Cones that develop from these flowers have seeds where both the mother and father parents are known.

LOBLOLLY PINE PRS™

Loblolly Pine Performance Rating System (PRS™) data are available to all full and contributing members of the NCSU Tree Improvement Program. Members can also assist landowners in making decisions about appropriate seedling families to plant and meet their objectives. Landowners have options for replanting to find families to optimize their management plans.

SCAN HERE TO LEARN MORE ABOUT THE PRS™.

Integrating Silviculture and Genetics

Ford underscores that genetic family decisions are vital to stand-level performance and trait expression, and manipulating site resources through silviculture is paramount. "You must invest in good site resource management if you hope to see a return on your genetics investment. Conduct good site preparation, adjust drainage and fertility needs, plant good-quality seedlings early in the planting season, and perform follow-up monitoring."

Conversations on the needed genetics and appropriate trees per acre are occurring all across the Southeast, and it's important to be progressive. Reducing trees per acre increases growing space per tree, resulting in greater stem diameter and live crown retention during the rotation. Consequently, this helps overall stand health while shortening the timeframe to high-value chip-n-saw and sawtimber products. Forest managers can be successful in producing such high-value trees by employing silviculture to direct site resources into trees of the right genetic families.

It may seem daunting to balance decisions on trees per acre, intensive silviculture, and investing in the best genetic families, but attention to the details will result in stands having better performance and value. "You don't optimize by accident. You should be very forward-thinking with planning and decision-making on genetics, site preparation, and subsequent treatments. Once you plant a tree, you cannot change its genetics. You can more than pay for the move upwards in genetics through improved stem volume, quality, and stand health," said Ford.

Key Takeaways for Landowners

Given today's forest market trends, Southern U.S. timberland owners need to think critically about how a combination of silviculture and genetics can help them grow forests viable for future markets. Ford left us with these key takeaway messages.

1. Get insights from experts

- Landowners should work with a forester/team of foresters that are making scientifically backed decisions regarding silviculture and insights regarding genetics using the most current data.

2. Implement site-specific silviculture

- Thorough, site-specific resource management must be implemented for genetics to make an impact.
- Potential production depends on site location, growing season length, temperature maximums and minimums, rainfall regimes, soil type, depth, drainage, and nutrient limitations.
- If you must be strategic with your funds, put money towards silviculture on the sites that will be responsive.

3. Determine appropriate trees per acre

- By decreasing trees per acre, stem diameter will be larger earlier in the stand rotation, aligning with trends of market demands.
- Planting ~550-600 trees per acre will produce more pulpwood early in the rotation, and chip-n-saw and sawtimber later in the rotation.
- Dropping trees per acre to ~350-400 will result in lower proportions of pulpwood and greater amounts of chip-n-saw and sawtimber during a rotation.
- As you plant fewer trees per acre, it is imperative to deploy only the best possible genetic families (preferably control-pollinated) and ensure high seedling survival.

4. Move up the ladder on genetics

- Plan early — don't wait until you are a few months out from planting to order your seedlings. There is only so much of the best and most applicable genetic material available.
- Be specific and have a complete understanding of what genetic families you are planting.
- Use control-pollinated families that have been through rigorous trials — this way, you have a high level of confidence regarding how the stands will perform.

"The genetics input will change what the stand will be, what it will do, how you can manage it, and what value it will bring," Ford said. "Combined with good management decisions, the genetics investment will pay off and, ultimately, that land will stay in active forest management."

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