Experiment on the pine family tree

Arkansas firm tests seedlings grown to be 'genetically elite'

BY NANCY COLE ARKANSAS DEMOCRAT-GAZETTE

EL DORADO — Anthony Forest Products Co. is conducting a test.

In January, the El Doradobased company planted 30,000 loblolly pine seedlings — 10,000 each in its south Arkansas, north Louisiana and east Texas timberlands.

These aren't ordinary seedlings. They're "genetically elite" seedlings developed by CellFor Inc., a Vancouver, Canada-based company that claims its trees will produce more and better wood, increasing harvestable yields by up to 33 percent. Formed in 1999, CellFor sold its first seedlings in 2003.

Steve Barham, Anthony Forest's general manager of forestry, said he plans to carefully monitor these seedlings, comparing them with others that were planted alongside them at the same time.

"If it's not economically feasible, then we will make a decision after four or five years not to do that anymore," Barham said.

Although most pine seedlings cost 3 to 4 cents each, CellFor's seedlings cost about eight to 10 times as much because they are produced with the aid of proprietary technology.

Anthony Forest's investment in elite seedlings would have been unheard of just a few years ago. But with 82,000 acres of timberland that provide about 15 percent of the logs used at the company's two sawmills, in Urbana, Ark., and Atlanta, Texas, and two chip mills in Plain Dealing, La. and Troup, Texas, tree improvement — especially improvement gained through the use of biotechnology — is seen as one way to boost forest productivity.

Anthony Forest is not alone in its thinking. The May issue of the Southern Journal of Applied Forestry was devoted entirely to the issue of genetic impacts on the productivity of Southern pine forests

Like many seedlings that have been planted during the last 50 years in Southern pine plantations, CellFor seedlings are genetically improved. They are produced from parent trees that have been selected for such desirable traits as rapid growth, superior form, wood strength, disease resistance and tolerance to environmental stresses like drought. "Faster, straighter, stronger" is the motto of Weyerhaeuser's Southern pine nurseries.

The traditional method of genetic improvement is to sexually cross parents to produce progeny that are superior to either parent, and then crossbreed the progeny with other superior progeny, creating yet another generation of improved trees. One problem, however, is that trees are quite promiscuous, shedding lots of pollen over long distances. As a result, some seedlings in crossbreeding programs never reach their full potential because they receive genetic material from the wrong parents.

TRICKING THE TREES

Vegetative, or nonsexual, propagation offers a solution by making it possible to produce clones — identical copies of individual trees with no genetic variation. Gardeners and farmers have cloned plants for millennia, rooting cuttings to start new plants such as grape vines. The Romans planted cloned poplars along their roads more than 2,000 years ago, said Bob Kellison, president of the Raleigh, N.C.-based Institute of Forest Biotechnology.

"We've had clonal forestry for centuries," Kellison said, but cloning pine trees has proven to be a special challenge.

Barry Goldfarb, head of the forestry and environmental resources department at North Carolina State University in Raleigh, works on the vegetative propagation of pine trees. Rooted cuttings can be made from natural pine trees through only about the first year of their lives, so trees must be "tricked" by continually pruning them into a hedge, Goldfarb said.

"You can never do any better than what you're starting with," he said. "What we're trying to do is to pick the very best small number of individuals from within the natural population and make more copies of them. So we're just applying selection."

But even Goldfarb's hedges age over time and lose their ability to produce young cuttings, so some researchers have turned to a new method of vegetative propagation, which involves a seed-cloning technique known as somatic embryogenesis.

Somatic embryogenesis literally means the formation of embryos from cells derived from the body of an organism rather than from reproductive cells.

CellFor seedlings come from somatic embryos. Their embryogenic tissue is cultured in a laboratory and allowed to

multiply and mature. Like cuttings, these mature embryos are identical genetic copies of the original seed and they can be used to produce seedlings.

Greg Hay, CellFor's Conwaybased western region manager, says somatic embryogenesis is not new.

"The problem has been ramping up to mass produce operational quantities of trees using this process, and that's where CellFor has made some breakthroughs," Hay said.

One advantage embryogenic tissue has over cuttings is that the tissue can be stored indefinitely at extremely low temperatures, making it possible to produce millions of identical embryos when and as needed. CellFor also has figured out a way to preserve seeds indefinitely.

FOREST GENETICS

David Neale, a geneticist at the U.S. Forest Service's Institute of Forest Genetics and a professor at the University of California at Davis, studies the loblolly pine. By mapping the tree's genes and associating them with specific traits, genetic markers can be provided to plant breeders to assist them with their selections, he said.

In traditional plant breeding, "The best individuals were selected based on their phenotype, the outward tree type — big trees, trees with good wood, that sort of thing," he said.

Now, with the aid of genomics and molecular biology, "We would hope to select on the individual genes themselves, not on the outward phenotype of the plant," he said.

The strategy is analogous to efforts being made to improve agricultural crops. But trees are more challenging because of their long life cycles, which require many more years for their progeny to reach sexual maturity and for researchers to assess their genetic worth. As a result, biotechnology and tools like genetic markers actually may become more important in forestry than in agriculture, Neale said.

Eventually, forest biotechnology may proceed to bioengineering or genetic modification, involving foreign genes being inserted into trees. Much like Bt cotton, which is engineered to resist insects through the insertion of the soil fungus Bacillus thuringensis, trees in the future may be genetically transformed to resist life-threatening insect defoliation.

Just as Roundup-Ready soybeans have been genetically modified to resist the herbicide glyphosate, trees may one day be modified through the insertion of genes that could alter their cellulose-to-lignin ratio, thus facilitating the manufacture of paper.

ArborGen LLC, a Summerville, S.C.-based company, already is working on modifying lignin, the "glue" that holds wood together, to reduce the amount of chemicals and energy needed to make paper.

But some foresters fear genetic engineering in their field could draw more opposition than it has in agriculture because of the multiple roles that trees and forests play in environments, cultures and societies. One particular concern of opponents is that trees bred to emphasize narrowly defined genetic traits might propagate beyond plantations and reduce the biodiversity of natural forests

Don Doering, a senior associate with Winrock International, says that's a big part of the reason why the forest-products industry has not embraced biotechnology wholeheartedly.

"They're not sure how it can help their industry. On the other hand, they know there is a lot of potential. They don't want to be left out," Doering said.

Ideally, plantations will produce more trees so natural forests can be preserved, he said.

"Just because a farm in Arkansas gets more pulp or timber out of their land doesn't necessarily mean that a natural forest in Arkansas doesn't get logged. But one would hope that someday those things would be related to each other," Doering said.

Barham said one reason for Anthony Forest's experiment with CellFor seedlings is the Canadian company's certification through the Sustainable Forestry Initiative. Launched in 1995 by the American Forest & Paper Association, the initiative seeks to protect forests by ensuring their long-term health and productivity.

"One of the performance indicators in the SFI program is to support research and development into new and better ways to manage your forests ," Barham said.

Geneticist Neale says forestry researchers are making great progress.

"The question is if the forest industries are going to stay in the [United States] or go offshore," he said.

Arkansas Democrat-Gazette/STEPHEN B. THORNTON Robert Garland (left), an Anthony Forest Products Co. vice president, and Doug VanDevender, the company's procurement manager, examine one of the "genetically elite" pine seedlings they have planted south of El Dorado.