Genetic techniques to speed tree improvement

by Glenn Howe & David Stauth

Corvallis - A new move toward "marker based breeding" with economically important forest tree species is expected to improve and speed up the identification of trees with desirable traits – to achieve faster growth, drought resistance, wood quality or other useful characteristics.

Forestry scientists at Oregon State University will collaborate with other leading forest research institutions around the nation on this project, which is being partly funded by a recent $6 million grant from the U.S. Department of Agriculture.

The crux of the problem, experts say, is that trees take a very long time to grow, and conventional breeding with them is logistically complex, time consuming and expensive. The same types of cross-breeding and genetic advances that have been possible with many agricultural crops take much longer with conifer trees – it might take decades to learn if a particular tree or cross has any special value or not.

"We're really in just the second or third generation of breeding with a critical species like Douglas-fir," said Glenn Howe, an associate professor of forest genetics at OSU. "We've made progress, probably a 25 percent increase in volume of wood produced, and that's good. But there's a great deal more we could do and we think that genetic markers will help us reach those goals more quickly and efficiently."

The idea, Howe said, is to better understand exactly what individual genes and their "alleles," or different forms, are responsible for – what tree characteristics they control. Conceptually, it's a little like the human genome project, in which an understanding of the genome helps medical researchers understand the diseases associated with certain genes. In plants, once genes have been mapped and their functions are understood, it should be possible to better select or combine the alleles that are responsible for desirable traits.

These programs, researchers say, do not involve genetic engineering, which is the intentional change of genetic structure or introduction of novel genes into plants, and an approach that has also met significant public resistance and regulatory hurdles.

The new type of "association genetics" resembles traditional crop selection and breeding, but with a more detailed understanding of what genes are involved and what they are doing. It's like having a good road map, instead of driving aimlessly for 20 years until you happen across what you're looking for.

In a recently formed "Conifer Translational Genomics Network," led by the University of California

at Davis, OSU will do most of the studies on Douglas-fir, while scientists elsewhere in the nation study other important species such as loblolly pine and slash pine. Collectively, these are the backbone of a $50 billion forest products industry in the United States, and part of a global forestry enterprise estimated to be worth more than $350 billion a year. The value of tree products equals or exceeds that of every other U.S. crop, while healthy forests perform countless other environmental and ecological functions as well.

"Fast growth and disease resistance is part of what we'll be looking for, but in modern forestry a lot of the current interest is also in wood quality, things like density or stiffness," Howe said. "Certain other characteristics might have value if wood is to be used for producing biofuels. And with the advent of climate change, we need to know more about which trees could adapt to changing conditions, such as temperature changes and drought."

Conifers actually have a very complex genome with a wide range of genetic variation, experts say, and should lend themselves well to this effort. Much of what is learned by focusing on the three conifer species of particular interest in the U.S. should also have value in other important conifers grown around the world.

The national push in this field, Howe said, aims to have genetic markers incorporated into tree breeding programs within five years. The work will also have major educational and Extension components so that the findings can be spread to the tree breeding and forest products industry, which uses 1.3 billion seedlings every year to get the forests of the future off to a healthy start.

In related work, OSU will collaborate with the U.S. Department of Energy Joint Genome Institute, University of Georgia and other universities to sequence thousands of genes from a diverse collection of conifers, including Douglas-fir.

OSU is also participating in a new "Center for Advanced Forestry Systems" that is being organized by North Carolina State University under the National Science Foundation Industry/University Cooperative Research Center Program. The center will develop projects ranging from ecology and biotechnology to remote sensing and improved silviculture.

Taken together, these three new projects will contribute substantially to genomics research on Douglas-fir and its application to tree breeding and forest genetics in the Pacific Northwest.

In all these efforts, students will be educated in the newest technologies, genetic techniques and other forestry innovations.

Expanded forests, improvements in forest health and more efficient breeding of tree species could also allow

for greater carbon sequestration and reduction in greenhouse gases, experts say.

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