Quang V. Cao in the LSU AgCenter's School of Renewable Natural Resources has developed a new way to predict growth rates in forest stands. His "model" takes into account that young trees grow faster than older trees and that sparse stands grow faster than crowded trees.

Photo by John Wozniak

LSU AgCenter Scientist Develops New 'Model' To Predict Timber Production

Timberland owners and managers use statistical models to predict growth and yield of their forests. Quang V. Cao in the LSU AgCenter's School of Renewable Natural Resources has developed a new predictive model that promises to improve on current ones.

Current models start with an inventory of trees in a stand and then use three variables – the age of the trees, the density of the stand and the quality of the site – to predict tree growth and yield 5 or 10 years in the future. The shortcoming of this type of model, Cao said, is that it implies constant growth. But that just isn't so.

Annual predictions of individual tree survival and growth have always been difficult because trees are not measured every year but usually once every five or 10 years. The method used by most models assumes constant diameter and height growth rates along with constant survival probability during the growing period.

"We know that young trees grow faster than older trees and that sparse stands grow faster than crowded trees," Cao said. "So over time, growth rates change. Inaccurate models can lead to poor decisions that might result in substantial losses to timber companies."

Cao said his forest growth and yield model should help forest managers select appropriate strategies to enhance economic returns.

"We developed a new, flexible method that allows these growth rates to vary from year to year and therefore should track growth and survival of trees much better than the old method," Cao said.

Cao developed his model from trees measured each year for 21 years. He used two plots, each with 171 loblolly pine trees, in the Lee Memorial Forest in Washington Parish. The results of his observations confirmed the variability.

"The trees don't fit the predictions of average growth but fit every-year growth," he said.

So using statistical methods, Cao developed a mathematical equation – or model – to predict tree growth over time.

Tree diameter and stand density no longer follow straight-line growth, but growth is measured on a curve that starts out steep and flattens out over time.

Quang V. Cao is one of the professors in the School of Renewable Natural Resources who teach at Lee Memorial Forest in Washington Parish. An eight-week teaching session is held during the last half of spring semester at Lee forest for students with junior standing. A two-week course for wildlife majors is offered between spring and summer semesters.

"Tree survival is toughest to estimate," Cao said. "It's an either-or situation."

The generally accepted model assigned an annual life-expectancy value that remained constant over time. The result was more trees were expected to die than actually occurred.

Cao fitted the tree growth equations to the annual data, then fitted the same equations to intervals of two, three, four, five and six years. The results were finally plotted on a graph.

"The tremendous improvement over the old method is evident from the graphs, as the new method produced consistent growth and survival curves while growth intervals vary from one to six years," Cao said. He added that the model provides similar growth estimates regardless of length of the intervals.

The individual-tree model takes each tree as a unit. Cao said forest modeling can also be done by using whole-stand models, which treat all the trees together as a unit.

"Whole-stand models are relatively simple, whereas individual-tree models are complicated, simulation models," Cao said. "There are advantages and disadvantages for each type of model."

He said use of individual-tree models to predict stand-level results typically suffers from accumulation of errors and subsequently poor accuracy and precision. On the other hand, outputs from whole-stand models are often better behaved but lack detailed information.

"We investigated approaches to combine the high resolution of the individual-tree model and the reliability of the whole-stand model by adjusting outputs from an individual-tree model to match predictions from a whole-stand model," Cao said. "We expected that these methods were compromises between an individual-tree model and a whole-stand model."

The results exceeded his expectations. The new methods provide superior predictions of stand survival, basal area – the area of the cross section of a tree at a height of 4.5 feet above the ground – and volume.

"The methods under evaluation performed much better in predicting stand attributes while providing comparable predictions of tree diameter, height and survival probability," Cao said. "The results show promise in the on-going effort to link growth models having different resolutions."

For more information on Cao's improved model, people may contact him directly at (225) 578-4131, or qcao@agcenter.lsu.edu.

■ **Rick Bogren**