Chilean Forestry Practices and Their Application in the Southeastern United States

—Derek Dougherty

ABOVE Torres del Paine. Courtesy of William M. Ciesla, Forest Health Management International, Bugwood.org.

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We in the United States can learn a lot about forestry practices from the country of Chile, one of the more advanced forestry production centers in the world. This long, narrow country located well south of the Equator on the western coast of South America, is a major producer of eucalyptus hardwood pulp, radiata pine clear-wood and knotty sawtimber, radiata pine pulp, and natural hardwood timber. While there are many private producers present, the bulk of Chile's forests production comes from 2.1 million acres of plantations managed primarily by three large integrated forest product companies.

In 2007, the Forest Nutrition Cooperative sponsored a tour of Chilean forestry operations that demonstrated Chile's progressive forestry practices, outlined herein, that are relevant to forestry practices in the southeastern United States.

Eucalyptus

There are many Eucalyptus species in the world and many are used in the production of commercially-grown forest products. In other parts of South America, *Eucalyptus grandis* and *Eucalyptus urophylla* hybrids are the preferred species for producing high quality pulp. These species can be grown in six- to eight-year rotations. However, in Chile because of colder temperature regimes, the two primary species used for commercial forest production are *Eucalyptus nitens* and E*ucalyptus globulus*. *Eucalyptus nitens* is capable of withstanding temperatures as low as negative seven degrees Celsius. In Chile, *E. nitens* and *E. globulus* are managed on 10- to 12-year rotations. Rather than rotation lengths being set by volume or growth limitations, rotation lengths are generally set by the age that specified wood density requirements (500+ g/cm^3) are met. Wood density is important because it affects both product quality and pulp yield.

In Chile, eucalyptus species are generally planted at around 560 trees per acre. A quality establishment regime includes a chemical site preparation treatment, a mechanical ripping treatment, machine or hand planting, phosphorus and boron fertilization, and multiple herbaceous weed control treatments following planting. The planting stock is generally containerized, mass-control pollinated seedlings. Varietal lines are currently being tested.

Radiata Pine

When most think of the radiata pine forests, they think first of New Zealand and Australia, but Chile is also a major grower of *Pinus radiata*. Compared to loblolly or other southern U.S. pine species, radiata pine is generally considered to have lower strength ratings, and thus it is often used for appearance markets. Production potential is comparable to that of intensively managed *Pinus taeda* (loblolly pine) in the southeastern U.S. The establishment regime is very similar to that described above for *E. nitens* and *E. globulus,* with the addition of a biological tip-moth control treatment. There has been substantial investment made for the genetic improvement of the species, and the current seedlings used are now a mix of open-pollinated and mass-control pollinated. Like eucalyptus in the area, varietal lines are currently being developed with initial block plantings now being established.

The operational planting density generally ranges from 455 to 560 seedlings per acre. To encourage and provide for the production of "clear-wood" the trees are pruned to 18 to 25 feet between age 4 and 8. The pruning process cuts off all branches flush with the bole of the tree, up to the specified height. The target diameter outside stubs measurement (dos—basically the diameter of the core with limb knots) is around 6 inches, and the wood produced outside that diameter is clear, knot-free wood. The plantations are thinned around age 8 to around 280 trees per acre and then later second thinned to around 160 trees per acre, before a final harvest at age 23 to 24. Value at the time of final harvest may be as high as $10,000 per acre.

ABOVE Cultural Practices. Courtesy of Leonard Newell, USDA Forest Service, Bugwood.org.

The harvesting methods used in Chile are a mixture of manual and mechanized approaches. The social responsibility of creating work opportunities is balanced with the productive potential of the most mechanized equipment. While many of the thinnings are currently conducted using a mixture of hand and animal labor, the final harvests are often completed using fully mechanized cut-to-length systems running around the clock with lights, on three eight-hour shifts per day. Harvesting also includes biomass chipping of the decks and scattered residuals to create energy. Residual harvesting leaves the planting site in a reasonably clean state and burning is avoided. With current gas prices at around $6 per gallon in Chile, residual biomass harvesting is considered very positive.

Productivity Potential

Chile's varied climates and soils provide a great place for tree growers and researchers to get an understanding of the environmental factors that can limit and affect tree growth. There are five primary soil types, including metamorphic, volcanic ash, sandy, granitic, and clay soils. Each of these soil types differ in water holding capacity, cation exchange capacity, and organic matter. Variation in these factors translates into large differences in productivity potential. To add to this challenge, variation in rainfall amount and duration of rainfall across the tree growing regions in Chile are dramatic. In the northern section, there is a Mediterranean-type climate, with limited total rainfall distributed primarily during one half of the year. In the southern section, rainfall is much greater and well distributed throughout the year.

Tree growth, at any location on the globe, is a result of the interaction between the genetic combination of the seedlings planted and the nutrient and water availability (affected by soil texture, soil depth, rainfall amount and distribution, relative humidity, temperature, and herbaceous and hardwood competition control) and the incoming radiation (affecting photosynthesis and evaporative demand).

As tree growers, we can have a major impact on the genetics and the water and nutrient availability. In Chile, with such a wide variety of sites, it is possible to get a much greater understanding of the importance of identifying and addressing the most limiting factor. On the volcanic and clay soils, nitrogen and phosphorus are rarely limited, except where soil depth is limited by past land use and the subsequent erosion. On the sandy, metamorphic, and granitic soils, phosphorus and nitrogen may be limited. On almost all sites, Boron is limiting. On the areas with limited rainfall and the soils with limited water holding capacity, water is clearly limiting. On the higher elevation sites and sites closer to the South Pole, cold or frost tolerance is the limiting factor in production.

So how much wood can be produced in Chile's forests? With a continued commitment to research and very good applied site-specific silviculture, they can produce a lot. For *E. nitens*, annual production from the previous rotation averaged around 10 tons per acre per year and from the current rotation will average around 12 to 14 tons per acre per year. Annual production on the best sites can reach as high as 25 tons per acre per year. Annual production for *P. radiata* can range from 4 tons per acre per year to 14 tons per acre per year.

How does that compare to eucalyptus and pine in the southeastern United States? Eucalyptus plantings are still primarily experimental, although the genetics company ArborGen is currently working on seedlings that may be planted in the lower south. For loblolly pine, most southeastern producers will grow 4 to 8 tons per acre per year, and producers with a commitment to reaching their potential will grow 8 to 12 tons per acre per year on the better sites.

Application for Southeastern U.S. Forest Plantation Producers

The advanced Chilean methods of forest product production have substantial application and confirmation for advanced southeastern United States forest producers.

- Identifying the factor most limiting growth is of utmost importance to meeting Chile's production potential. Research cooperatives like the Forest Nutrition Cooperative and their more active members in the southeastern U.S. have helped forest industry to recognize that nutrition in the form of nitrogen, phosphorous, and potassium represent severe limitations to potential productivity. As in Chile, Boron or other micronutrients can also be limiting on cer-

tain soils. Water availability and adoption of the use of the best genetics also represent major limitations to obtaining potential productivity on many sites in the southeastern U.S.

- Herbaceous weed control, affecting water availability, is of major importance in meeting potential of pine and hardwood species on many Chilean forest sites. It is equally important in the southeastern U.S. Historically, domestic private producers have done only a moderate to poor job of controlling herbaceous competition.
- Pruning is an effective way of improving clear-wood production and log quality. This practice is limited to only a few companies in the southeastern U.S.
- The productivity of radiata pine plantations at 34 to 37 degrees latitude in Chile, roughly the same distance below the equator as Georgia and North Carolina are above the Equator, is similar to that of loblolly pine plantations in the Carolinas and Georgia.
- A value potential for the most productive stands of $8,000 to $10,000 per acre, is possible in Chile. The same potential value is possible in the southeastern U.S. in good markets and on a range of good sites, but this potential is not widely recognized or realized.
- Thinnings at age 8 to 10 are realistic and necessary if plantation development is pushed. Similar regimes are possible in the southeastern U.S.
- Biomass harvests in Chile are positive for energy production and lowering of site preparation requirements and costs. With increased fuel prices in the U.S. and emerging technologies for converting forest biomass to biofuels, harvesting of residuals and fuel plantations will likely become a broad scale reality in the southeastern U.S.
- Embracing and applying research gained knowledge and new technology in Chile clearly has resulted in empowered and energized forest economies. This is a major challenge for the southeastern U.S. Most research surveys suggest that research capacity and technology adoption are declining in the southeastern U.S.

These observations confirm that the potential for southeastern U.S. pine growers to produce high volumes and values from their land is strong. They also reaffirm the value of supporting research, making effective technology transfer to the forest owner and manager, and adoption and application of these new technologies by the private forest landowner.

About the Author

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About the Forest Nutrition Cooperative

Started in 1969 as a cooperative designated "to determine the feasibility of forest fertilization" for loblolly pine in the southeastern United States, this group has now evolved into an internationally recognized research and education program for land managers interested in forest production, silviculture, and soils. Currently, this group is hosted and led by a partnership of North Carolina State University, Virginia Tech University, and the University of Concepcion. Other partners include members of forest industry, timber management investment organizations, forestry consultants, governmental agencies, private landowners, and others interested in intensive plantation management. Collectively, cooperative members own or manage over 24 million acres of pine and broadleaf plantations in the southeastern United States and South America.

For more information about the FNC or for obtaining membership, visit their website at www.forestnutrition.org. ◆