Filling a Need

Forest Plantations for Bioenergy in the Southern United States

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Hardly a day passes in the southern United States without an announcement of a new bioenergy facility or expansion of an existing one. This list includes, but is not limited to, wood pellet, cellulosic ethanol, biodiesel, cogeneration, and biomass combustion. A number of these facilities are running at capacity with plans to expand. Others are in the permitting or early construction phase with plans to "go live" in the coming years.

The forest products industry in the U.S. is already the nation's largest producer of renewable energy and the southern region is no exception. Over many decades, the forest products industry has been utilizing harvesting and manufacturing residues in boilers and kilns for both on-site energy usage as well as selling excess energy into the grid. This trend is increasing given recent and expected future volatility in other energy sources such as coal and natural gas.

Against this backdrop are a number of published studies on logging residuals "available" for bioenergy. What is increasingly obvious is that the amount of truly available logging residues will nowhere near supply the current and announced bioenergy processors in the southern United States. This indicates that appropriate technology for short rotation bioenergy plantations must be rapidly developed to fill this growing need.

The Forest Plantation Concept—Tried and Tested

Forest plantations have been sustainably grown in many parts of the world. While exact records do not exist, it is understood that the Japanese have been planting forests since the 10th century! Forest yields continue to increase on these sustainably managed acres.

In the southern United States, the history of forest products and forest plantations is long and successful. It is projected that more than one half of the wood harvested for processing will be obtained from planted forests in this region. This long success story could not have been possible without the utilization of outreach, education, and research from the land grant universities, United States Forest Service, state forestry services, private and state forestry associations, and the participation of literally millions of private landowners as well as the large timber land companies.

The typical forest plantation today in the southern United States is loblolly pine (Pinus taeda L.) planted on average at 600 seedlings per acre, on a 25-year rotation, with a thinning at an age of 15 years. The thinning typically removes trees for pulpwood, while the final harvest is for sawtimber and pulpwood. This management scheme has been derived to fill the wood needs of current processors in pulp and lumber. In addition, plantation acres have been established to other conifer or hardwood species in the southern United States.

This work is supported by, amongst others, highly trained forestry and log-

▶ Sweetgum growing in South Carolina. Age six years.

ging professionals and land grant universities that yearly mint more than 100 masters and doctoral students.

Growing Bioenergy in a Forest Plantation—Novel but not New

Bioenergy forest plantations have been practiced in the southern United States since the early oil embargoes in the 1970s. In countries such as Brazil and South Africa, eucalyptus plantations have been managed for bioenergy production for decades. What makes the current Southern United States situation novel is the short timetable given to develop existing genetic improvement programs and their required silvicultural systems for widespread early adaptation. A forest bioenergy plantation can take 18 months to 8 years to reach financial maturity and the sooner it is planted, the sooner it will be ready for commercial harvest.

The tried and tested forest plantation concept in the Southern United States is to produce conifer wood since this is the backbone of the forest products industry for both pulp and lumber. The bioenergy plantation is going to be more complex. Does the bioenergy stream allow bark, branches, leaves, and wood or is only wood preferred? Does the bioenergy stream need higher lignin content typical for certain species and tree ages? What will be the usage of the ash in co-generation or single source biomass combustion? How will the development of enzymes change the tree species or rotation age? What are the logistics of harvesting and transporting feedstock cost effectively?

At this time, a number of landowners, research institutions, and government entities are researching forest bioenergy plantation management schemes. Early phase testing is also underway on feedstock suitability for wood pellets, cellulosic ethanol, and combustion. These research efforts are

◀ ***Eucalyptus sp.*** **growing in Florida. Age 24 months.**

rapidly expanding due to both research funding and private company research interests.

The forest bioenergy plantation will have more trees per acre, possibly 1,000 to 2,000, and shorter rotations. In fact, for hardwood species that re-sprout (coppice) after harvest, the rotation lengths can be 18 to 36 months. New harvesting systems are being developed for this smaller material, and most of these have an on-site chipping or grinding capacity so that the delivered feedstock is ready to be processed directly into bioenergy.

One type of forest plantation takes both traditional and bioenergy concepts to a non-conventional system. This utilizes one row of wide spacing high value genetics for sawtimber (lumber) while the adjoining row is a tightly spaced row for bioenergy. This system will work with loblolly pine with a bioenergy harvest at 6 to 8 years and a sawtimber final harvest at 18 to 22 years, allowing farmers and forest landowner to increase the possibility of positive cash flow in the first years, capturing new markets for bioenergy, and retaining existing markets for sawtimber.

The authors believe that the region's seedling nursery capacity, genetic improvement programs, and land management technologies (silviculture) are robust and more than adequate for developing highly productive forest bioenergy plantations. Two areas are in need of continued investment. First, those organizations involved in bioenergy processing need to share their findings on what is and will be the desired biomass processing characteristics, such as whether softwood or hardwood is preferred, as well as the most suitable species for biofuels. Sharing this with the landowner is crucial to their forest management decisions. Second, additional effort is needed on financial modeling of the various forest bioenergy plantations systems as to species, trees per acre, rotation lengths, and harvesting systems.

North Carolina State University (NCSU) in partnership with state and federal institutions, private companies, and other universities is actively working to identify the most promising biomass for biofuel production and the most profitable pathways. The NCSU Wood and Paper Science Department is performing complete analysis of the supply chain with strong technical basis in processes design while also accurately measuring the financial impact. From current research the major features identified for ideal biomass for biofuel are:

- Maximum delivered cost of $62 per bone dry tone of biomass.
- Carbohydrate content of 65 to 70 percent on dry mass basis (mostly true for chemical pathways for biofuel production).
- A crop that may be harvested and supplied year-round (instead of a three to five month harvesting window for switch grass and sweet sorghum, requiring further logistic and storage)

Fast-growing, short-rotation forest plantations can fulfill these requirements and be used for bioenergy, including but not limited to electricity generation, wood pellets, and biofuels.

Final Thoughts

The increasing scale of forestry biomass for bioenergy will only be possible with developments in forest bioenergy plantations as there will be insufficient feedstock from logging residuals for all announced and planned facilities. Existing technologies can be utilized to rapidly establish forest bioenergy plantations and research is underway to expand these possibilities. Bioenergy processors and forest plantation managers must continue to interact to insure that woody feedstock demand does not exceed supply.

About the Authors

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