# Woody Biomass Production in the South: *A Vision and a Need*

As a nation, we face a serious challenge in building and integrating renewable natural resources in a manner that is not only sustainable but meets future demands for energy, liquid fuels, and food systems. This is both a technological challenge and a paradigm shift, as the United States and the world move from a fossil fuel-driven economic system to a renewable natural resources-based economy.

The use of woody biomass for bioenergy and biofuels will play a critical role as the United States seeks to become energy independent. The US Department of Energy (DOE) believes the Southeast will play a major role in the production of biomass.

The DOE report, better known as the *Billion-Ton Report* and later as the *Billion-Ton Report Update,* stated that biomass production of annual crops and forest tree species is favored in the Southeast due to a favorable climate and excellent growing conditions. This report described forest resource biomass as logging residues, excess biomass from forestlands, primary and secondary wood processing mill residues, pulping liquors, and urban wood residues (http://www1.eere.energy.gov/biomass/pdfs/billion_ton_update.pdf).

The resilience and productivity of the southern United States has played a key role in the development of the region. From forests, we produce a wide variety of products including lumber, chemicals, pulp and paper, and specialty products. Today the Southern forest covers more than 200 million acres; however, recent estimates suggest that more than 12 million acres will likely be lost by 2020, primarily due to urban expansion (Treasure et al. 2008).

The use of woody biomass for energy and fuel has been discussed since the first oil embargo of the 1970s, but only a limited amount of research and development has taken place. Very few operational biofuels production systems are actually in place today.

It is critically important that research and development in the field of biomass utilization and conversion not only continues but increases to ensure the use of wood as an economical feedstock. Woody biomass will become an increasingly important renewable source for both bioenergy and biofuel production. Besides the sources described above, woody biomass should also include dedicated energy plantations, logging residues (especially from natural hardwood stands), thinnings from traditional plantations, and salvaged material from disasters.

Some of the benefits of woody biomass include:

- Less capital-intensive conversion technologies employed for exploiting the energy potential.
- Attractive opportunity for local and regional energy self-sufficiency.
- Viable alternative to fossil fuel use.
- Reduction in greenhouse gas emissions.
- Opportunities for local farmers, entrepreneurs, and rural populations to make use of its sustainable development potential (Zafar 2008).

While advanced second-generation fuels (i.e., those resulting from lignocellulosic technologies) seem to be on the horizon, this process has not been commercially employed. Fortunately, second-generation fuels can also be made from a technology known as pryolysis. This is the thermochemical decomposition of organic material at elevated temperatures in the absence of

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oxygen. This work has been a major focus of research at Mississippi State University and has proven its worth for developing various biofuels, such as boiler fuel, green gasoline, jet fuel, and biodiesel.

Producing second-generation biofuels is complex, and producing billions of gallons of biofuels will require millions of tons of cellulosic feedstock. Moving that feedstock efficiently, safely, and with as little impact on infrastructure and the environment as possible will be a major challenge in the years ahead (Kram 2008).

Research suggests development and deployment of woody tree biomass resources have distinct energy, economic, and environmental advantages over traditional agricultural crop sources. These advantages are:

- Year-round availability and numerous sources of material.
- Second-generation fuels derived from woody biomass have a positive net energy ratio.
- Physical and chemical characteristics of hardwoods are fairly consistent even when supplied from multiple sources.
- The forest products industry has developed effective technical and engineering competencies to manage woody biomass.
- Sustainably harvested forest biomass can provide at least 368 million dry tons of wood per year.

## Dedicated Biomass Plantations

It is apparent that logging residues alone will not be enough to meet the future needs of the bioenergy and biofuels industry of the southern United States. Forest plantations dedicated not only to production, but also to maximization of biomass will play a major role in meeting the future needs for woody biomass. Following are optimal traits for a biomass species:

- Ease of vegetative propagation so that genetically superior selections of any age could be easily cloned and quickly placed into large-scale plantings.
- Rapid juvenile growth rates that allow for expected harvest in 2 to 3 years;
- Ease of coppice (i.e., regeneration from stumps of harvested trees), eliminating replanting costs for numerous rotations.
- Adaptability across a wide variety of sites.
- Ability to spray chemicals directly over the top of the trees to control herbaceous and vine competition.

These traits would allow accelerated development of superior genetic material with substantially lower growing costs.

In the past, pine has not been considered a bioenergy crop because of its rapid early growth, difficulty in cloning, and inability to coppice. However, genetically improved pine can be planted over a very wide geographic area, and a number of chemicals can be sprayed to maintain competition control. This makes pine one of the cheaper biomass options.

In addition, pine plantations have been sustainably grown in the southern United States for nearly 90 years. Currently, pines cover more than 32 million acres. These pine plantations almost certainly will be among the biomass feedstock needed for the future production of bioenergy and biofuels.

The importance of pines is already being seen with the announcement of the KiOR plants to be located in Columbus and Newton, Mississippi, which will initially use 100 percent pine. The KiOR system takes advantage of the higher lignin content found in pines. Early thinnings and plantations with high numbers of volunteer pine seedlings are suitable candidates for providing the needed feedstock.

Fast-growth hardwood plantations are also being evaluated as a biomass feedstock source across the variety of sites in Mississippi. These species will have to be matched to a particular site. When successfully implementing this approach, the yields in tons per acre could be quite high. In addition, the number of trees per acre (800 to 2,000) for dedicated hardwood energy plantations will exceed any type of previous planting.

The hardwood species being examined include eastern cottonwood, hybrid poplar, black willow, and eucalyptus. These species are easily cloned, coppice well, and exhibit rapid early growth rates. However, these species lack wide geographic adaptability and have few chemicals that can be applied over the top of growing trees to control competition.

For example, eucalyptus could be grown only on marginal agriculture land in southern Mississippi. In contrast, black willow could be grown on heavy clay soils that exhibit poor drainage and are considered marginal agricultural sites. Like most hardwoods, both of these species can tolerate only a pre-emergent chemical applied during the early portion of the growing season to control various weed and vine competitors.

## Future Concepts

Unlike agronomic crops, forest tree species have not benefited from genetically modified individuals because of the danger of moving foreign genes (i.e. genes not found in the native population or plants) into the native species. With biomass plantations, the concept is to harvest before trees flower, which would greatly lower the possibility of gene movement. Genetic modification holds great economic and production promise.

Approving the use of genetically modified trees would increase the adaptability and lower the cost of hardwood biomass plantations. However, there are two problems: it is expensive to go through government deregulation, and society may not be willing to accept this new technology.

Eucalyptus species currently undergoing testing are a combination of non-genetically modified species and a tropical species that has a gene inserted to allow the tree to tolerate cold. This genetically modified tree would guard against any mortality from cold events and allow the tree to grow rapidly.

As previously mentioned, one of the challenges of dedicated hardwood energy plantations is the lack of chemicals that can be applied directly over the top of growing trees to control competition. Introduction of a herbicide-resistant gene could dramatically lower the expense of hardwood plantations, making these systems much more economical.

To date, no genetically modified forest species has been approved for use in the United States. However, this technology should be more closely examined for dedicated energy plantations as the length of rotation likely will be between 1 and 3 years.

## Management Implications

As the bioenergy and biofuels industry expands, the use of woody biomass will become paramount. Although Mississippi has considerable forested acreage, landowners will be asked to produce more to meet the demands of both traditional wood products and the renewable bioenergy and biofuels industry.

A number of systems are currently being examined to produce bioenergy and biofuels. Various processes will dictate species, type of feedstock, and geographic areas. It is highly probable that dedicated energy plantations, because of their ability to maximize yields, will be the feedstock source of the future.

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