Short Rotation Woody Crops

The U.S. Department of Energy (DOE) has defined forest resources biomass as logging residue, the excess biomass from forestlands, primary and secondary wood processing mill residues, pulping liquors, and urban wood residues. But residues alone cannot meet the future needs of the bioenergy and biofuels industry of the southern United States. Dedicated bioenergy plantations, which DOE originally called short rotation woody crops, are now called bioenergy feedstock. These plantations will need to produce a significant amount of biomass to meet the goals set by the U.S. government. In addition, the use of dedicated energy plantations would greatly reduce the need for harvesting our natural stands that have a wide range of social and ecological benefits that are more significant than producing biomass.

To become energy independent, the U.S. must develop and use an array of renewable resources. Renewable energy sources include biomass, sun, and wind. The use of biomass for bioenergy and biofuels is becoming more and more important. The DOE has said that the climate and growing conditions of the southeast U.S. are excellent for producing biomass in both annual crops and trees. The DOE considers short rotation woody crops an agricultural resource rather than a forestry resource. This is probably because these dedicated plantations are expected to last between one and five years.

Hardwoods for Use in Short-Rotation Bioenergy Plantations

Fast-growth hardwood species, such as eastern cottonwood, American sycamore, sweetgum, black willow, and yellow poplar, are good choices for producing biomass in dedicated bioenergy plantations. Although this is not an exhaustive list of species, these are native species that have the right characteristics to produce an economically viable biomass crop. All of the species listed grow rapidly and regenerate coppice easily, two critical factors. (Coppice regeneration is the ability of the stump to sprout after the above-ground portion of the tree has been harvested.) Other factors are also important. These include the species' rate of vegetative production and its adaptability. Table 1 gives more information about each species' suitability for biomass.

Table 1. Potential hardwood species and their potential as future biomass crops.

Species	Advantages	Disadvantages
Eastern Cottonwood	1.Propagates vegetation easily 2. Coppices well 3. Grows rapidly 4. Has been studied extensively 5. Has improved clonal material available 6. Populus genome has been completed	1. Has few weed control chemicals available 2. Is not very adaptable 3. Is susceptible to pests
American Sycamore	1. Grows rapidly 2. Coppices well 3. Propagates through vegetation 4. Has thin bark 5. Has medium wood density	1. Is susceptible to disease 2. Has few weed control chemicals available
Sweetgum	1. Coppices well 2. Can be cloned 3. Has advanced genetics 4. Is very adaptable 5. Possesses medium wood density 6. Is not susceptible to many diseases	1. Has medium growth rates 2. Offers no clonal material currently
Yellow Poplar	1. Coppices well 2. Can be grown on upland sites 3. Possesses excellent stem form 4. Has limited improved genetic stock available	1. Is drought susceptible 2. Is regenerated by seedlings

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Based on the information in Table 1, eastern cottonwood and sweetgum would be the best options for potential bioenergy plantations. However, neither species has all of the factors that would make it a clear choice. Eastern cottonwood lacks wide site adaptability and pest resistance. In comparison, sweetgum growth rates are much slower than eastern cottonwood's, and no clonal material is currently available for large-scale plantings. But sweetgum does have two advantages over eastern cottonwood: sweetgum has greater site adaptability and more herbicides available, making it a little easier to control competition.

Both American sycamore and yellow poplar may be used under certain conditions where they would outperform both eastern cottonwood and sweetgum. Sycamore is favored on sandy, alluvial sites, which lack the moisture necessary for eastern cottonwood and sweetgum. Yellow poplar would outperform the other three species noted in Table 1 on north-facing slopes where nutrient and moisture availability are higher.

Methods to Increase Yields and Lower Costs

Today there is little information available about the best spacing for bioenergy plantations of various hardwood species. Most bioenergy plantations are planted at pulpwood density spacings, which tend to be at least 81 ft^2 (9x9 ft) per tree. Spacing should be based on the growth and development of the species, of course, but there are also other factors to consider. For example, take into consideration the spacing necessary for herbaceous and vine control and the length of time to harvest. Also consider how the material will be used and the way it will be harvested. Of course, species that can coppice effectively after the first rotation will save planting costs for the later rotations. Following is a list of ways to make dedicated bioenergy plantations more profitable. The methods listed are a kind of "wish list" that would make the use of hardwoods in dedicated bioenergy forest plantations a more viable alternative for biomass production:

- Where needed, prepare the site with chemical herbicides to reduce first-year competition.
- Develop and use genetically superior clonal planting stock, selected to increase yields and reproduce easily.
- Employ optimal spacing for species and type of biomass desired.
- To control herbaceous and vine competition, develop and spray appropriate chemicals over the top of actively growing trees.
- Add nutrient amendments necessary to ensure rapid growth.
- Develop and use equipment that can efficiently harvest small-diameter material at close spacing.
- Locate your energy plantation as close to the mill as possible to reduce transportation costs.

For dedicated biomass plantations to become profitable, chemical and machinery companies would have to produce the products necessary to lower the costs of establishment and harvesting. Newer technologies, such as genetically altered, herbicide-resistant trees, could also reduce establishment costs. It may be possible to create trees that have a lower lignin content and higher cellulose content, making them easier to use in a biochemical refinery. Despite the potential advantages of genetically transformed trees for bioenergy or biofuels production, they have not been approved for use.

Conclusion

Individuals interested in growing dedicated bioenergy plantations should be fully aware of the advantages and disadvantages of each hardwood species as well as the cost to develop such a plantation. Short rotation dedicated bioenergy forest plantations will play an important role in the future of biomass production for bioenergy and biofuels. To this end, dedicated efforts must be made to develop systems that are productive and efficient.

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By Dr. Randall Rousseau, Associate Extension and Research Professor, Forestry.

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