EASTERN COTTONWOOD AND BLACK WILLOW BIOMASS CROP PRODUCTION IN THE LOWER MISSISSIPPI ALLUVIAL VALLEY UNDER FOUR PLANTING DENSITIES

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"Wood is an obvious alternative energy source": Johnson and others (2007) declare the potential of short-rotation intensively-managed woody crop systems to produce biomass for energy. While obvious as an energy source, costs of production need to be measured to assess the economic viability of selected tree species as woody perennial energy crops. Further, an energy budget must be established to assess the economic viability of particular species grown using particular methods for energy crops. Such a budget compares the costs of planting stock, site preparation, establishment, tending, and harvests to the benefits of bioenergy production (Stanturf and Portwood 1999).

Eastern cottonwood (*Populus deltoides* W. Bartram ex Marsh.) and black willow (*Salix nigra* Marsh.) are native species of the Lower Mississippi Alluvial Valley (LMAV) with potential to provide significant biomass production under short-rotation growth and harvest regimes (Francis and Baker 1981, Kopp and others 2001, Mohn and Randall 1973, Ruark 2006, Volk and others 2006). As these species are perennial, production can be quite varied in the timing of biomass removal ranging from intervals as short as 2 years to harvests delayed for a decade or more.

Land area actually available for production needs to be considered. Soils selected for experimentation should represent a substantial potential resource. The statement contained in the Mississippi Biomass and Bioenergy Overview (Jackson 2007), "...on Conservation Reserve Program (CRP) land alone, … 3.8 million dry tons of willow and hybrid poplar could be produced each year" is indicative of one such resource. Lands not suitable for annual crop production are often selected for entry into CRP rolls. These lands that are considered marginal for agriculture represent a significant base for energy crop production. Producers considering retirement of land from annual cropping may be reluctant to invest resources in intensive cultural treatments, so it is reasonable to examine a system with low inputs of chemicals, including herbicides and fertilizers, as well as reduced irrigation.

Costs and benefits will be dependent on the species selected, the method of production, and the land available. While substantial experience with the native species exist with regard to their potential in energy cropping systems, little quantitative evidence is available on the effect a range of harvest intervals has on the production of these two species deployed in the LMAV on soils considered marginal for agriculture. An experiment (Study Plan USDA FS-SRS-4155-2011 on file with: Southern Research Station, Center for Bottomland Hardwoods Research, 432 Stoneville Road, Stoneville, MS 38776) designed to assess the costs, benefits, and their timing is underway to evaluate two species, black willow and eastern cottonwood, and four planting densities and harvest regime combinations. Four planting densities each with a distinct harvest regime include: (1) plant 4,100 trees per acre (tpa) with harvests in years 2, 4, 6, 8, and 10; (2) plant 2,489 tpa with harvests in years 4, 7, and 10; (3) plant 807 tpa with a thinning in year 3 followed by a complete harvest with re-establishment in year 5; and (4) plant 302 tpa with a complete harvest in year 10. With replication, a total of 24 experimental units (two species x four regimes x three replicates) are required. A total of 24 plots, each 2.5 acres in size with rectangular dimensions of 660 feet

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long and 165 feet wide, are arranged in a randomized complete block design.

Establishment by hand planting approximately 120,000 cuttings of these species was conducted February 27, 2012 on marginal agricultural land located near Hollandale, MS. The land acquired by the U.S. Army Corps of Engineers is composed predominantly of Sharkey clay soil (Morris 1961). Figure 1 is an aerial image delineating the physical layout of the research installation.

Figure 1--Google Earth[TM] imagery dated November 12, 2012 clearly delineates the physical layout of the 24 experimental units located in Washington County, MS on U.S. Army Corps of Engineers land situated near the eastern boundary of Leroy Percy State Park, the wooded area on the left edge of the picture. Each of the 24 units is 2.5 acres in size with rectangular dimensions of 660 feet long and 165 feet wide. The image (© 2013 Google Inc. All rights reserved) is centered approximately on the coordinates 33° 09' 11.81" N latitude 90° 54' 26.09" W longitude.

The full 10 years of measurements including fuel energy inputs, bioenergy outputs, and impacts on soil properties over complete rotation periods will provide the necessary basis to determine the net energy production and soil effects of this cropping system. Here, initial establishment results of this study are presented (table 1). Early experience indicates chemical weed control is probably necessary to produce conditions that allow trees to perform well as they mature. Mechanical weed control did not provide adequate control in a zone near each planting spot to prevent over-topping of cuttings following their initial growth flush in the spring. Though first-year survival was not impacted by this competition, it is obvious that a more aggressive weed-control strategy must be employed for black willow to capture growing space, while the genetically improved stock available from established breeding programs for eastern cottonwood seemed to dominate the weed competition.

Table 1--Initial establishment results of two species, eastern cottonwood and black willow, planted under four spacings. Spacing (between row and within row distances are measured in feet) is inversely related to density.[ab] Averages of the three plots for each species and planting density combination are presented. Each plot was evaluated by counts of cuttings planted in 10 randomly selected row sections; each section was 66 feet in length. Both sprouting and survival success is considered to be uniformly good in all the treatments

Species	Treatment spacing	Sprouting	Survival
		----------*percent*----------	
Cottonwood	3 x 3	98.32	95.85
	7 x 2.5	99.62	99.23
	9 x 6	100.00	100.00
	12 x 12	100.00	100.00
Willow	3 x 3	100.00	92.43
	7 x 2.5	99.63	99.25
	9 x 6	100.00	99.09
	12 x 12	100.00	100.00

[a]3 x 3 = 4,100 trees per acre (tpa); 7 x 2.5 = 2,489 tpa; 9 x 6 = 807 tpa; and 12 x 12 = 302 tpa.

[b]Sprouting success of the cuttings following planting measured May 14, 2012. First-year survival measured October 24, 2012.

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