AGROFOREST SYSTEMS-OPPORTUNITIES FOR ENVIRONMENTALLY SUSTAINABLE BIOFUEL FEEDSTOCK PRODUCTION IN THE LOWER MISSISSIPPI ALLUVIAL VALLEY

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TAKE HOME MESSAGE

The Lower Mississippi Alluvial Valley (LMAV) because of its climate, well-developed agricultural infrastructure, central location within the United States, and access to shipping in major river systems could economically produce substantial quantities of biofuel feedstocks. This region in the past decade has also received substantial efforts to restore ecosystem services lost through historic conversion of forests to agricultural land and other forms of land development. These efforts have focused on reforesting marginal agricultural lands (low productivity and wet soils). Approximately 1.04 million acres of private agricultural land in the region has been planted to forests through various government programs such as the Wetlands Reserve or Conservation Research Programs. Conservation organizations and agencies are concerned that the increased demand for biofuel feedstock production could reduce the land available for reforestation as well as provide stimulus for landowners to convert land enrolled in these programs to biofuel crops. The use of agroforests (systems that contain a mix of agricultural crops and trees) could be a cropping system that would allow biofuel feedstock production while providing important ecosystem services such as wildlife habitat, carbon sequestration, improvement of water quality, as well as the maintenance of aquifer levels and restoration of other key ecosystem processes.

LMAV BACKROUND

The LMAV extends from the confluence of the Ohio and Mississippi River to the Gulf of Mexico (Figure 1). It is between 30 to 110 miles wide and contains approximately 22-24 million acres. Temperatures range between 50-60 ºF during the winter and 70-80 ºF during the summer. Annual precipitation is between 44 and 60 inches annually.

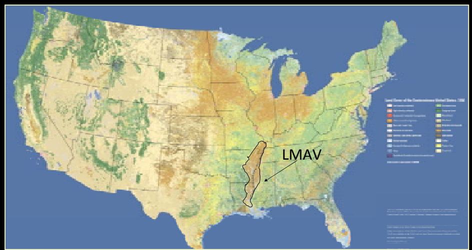


Figure 1. 1992 National Land Cover Dataset developed by USGS in cooperation with EPA. Outline of LMAV by authors of the poster.

The LMAV is an extremely important ecosystem. It is estimated that 60% of the bird species occurring in the United States and 40% of the waterfowl in North America migrate through this region (U.S. EPA 2007). Bottomland hardwood forests dominated the landscape of the LMAV at the time of European settlement (Schoenholtz et al. 2001). Only 25% of the original forest remain with the majority of the land converted to agriculture. These changes in vegetation and the increase in intensive cultivation have decreased wildlife habitat quality (Gardiner and Oliver 2005), increased soil loss, and increased nutrient additions to waterways (Burkhart and James 1999). A number of conservation organizations and agencies have in the past two decades initiated reforestation projects to improve wildlife habitat and protect water quality. Restoration efforts through programs such as the Wildlife Reserve Program implemented by the Natural Resources Conservation Service has enrolled more than 680,000 acres (King et al. 2006) and it is estimated that at least 350,000 acres (Leininger, personal communication) have been enrolled in the Conservation Reserve Program. Rising crop prices associated with increased value of and demand for biofuel feedstock could have a significant impact on the desire of landowners to enroll land or maintain land in these types of conservation programs. Conversion of afforested lands or agriculture lands that are currently growing low resource input crops to biofuel crops, such as corn that require irrigation, significant herbicide use, and high nutrient inputs; may lead to further degradation of water quality, reduction of groundwater levels, and decreases in wildlife habitat in the LMAV. Biofuel feedstock cropping systems need to be developed that have a more acceptable environmental impact than current biofuel crops.

AGROFORESTS

Agroforests have the potential to be an environmentally attractive alternative to present biofuel feedstock production systems in the LMAV. Agroforest systems are among the most productive and environmentally benign agricultural systems. They are also designed to optimize the use of growing space, water, light, as well as nutrients. As such, agroforests are associated with numerous economic and environmental benefits which include: (1) greater total yields, (2) risk mitigation, (3) product diversity, (4) low fertilizer and herbicide costs, (5) improved soil nutrient usage and recycling, (6) improved soil and water quality, (7) enhanced plant, animal, and microbial biodiversity, and (8) greater sequestration of atmospheric carbon dioxide than conventional agricultural cropping systems and forests (Garrett and McGraw 2000, Jose et al. 2004, Sharrow and Ismail 2004). Agroforests have been developed to provide an assortment of management alternatives for combining trees and grasses (e.g., silvopasture systems in which trees are managed within pastures) and combining trees with annual or perennial crops (e.g., alley cropping systems where crops are planted between rows of trees). The combination of this diversity of crops in agroforests is economically advantageous. Since annual harvesting of the annual or perennial crops are included with this system, the length of time that occurs before landowners receive returns from the initial investment for agroforest establishment is shorter than for other forest management systems. In addition tree harvesting schedules are more flexible than that for other agricultural crops. Thus, landowners are better able to take advantage of fluctuations in product markets.

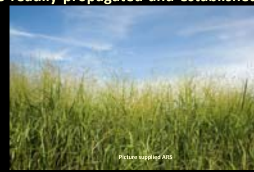
Loblolly pine and hay meadow (ARS-Booneville,AR)

Silvopasture in the Gulf Coastal Plain (LSU AgCenter)

Alley cropping with corn. (Picture courtesy Manfred Mielke, USDA-FS, Bugwood.org)

AGROFORESTS FOR BIOFUEL FEEDSTOCK PRODUCTION

Combining fast growing trees with other crops could provide both biofuel feedstock production and important ecosystem services. Switchgrass and cottonwood trees are among the most promising species for these types of production systems (Thorton et al. 1998; Stanturf et al. 2000). Switchgrass can be established from seed at low cost, be grown with minimal fertilization, produce high yields on marginal or suboptimal soils, and tolerate both drought and flooding (BFDP 2006). The ethanol production potential of switchgrass is more than twice that of corn, and current breeding efforts aim to further enhance energy output. Since cottonwood is a common native tree throughout the southern portion of the United States and has high biomass growth potential which exceeds that of most annual crops, it is perhaps one of the best woody species for biofuel production. Numerous varieties and clones of cottonwood have been developed to provide superior growth over a wide portion of its range (Land et al. 2001). In addition it can be readily propagated and established through cuttings.



Switchgrass crop

Mature cottonwood plantation

Cottonwood cuttings establishment

Use of cottonwood-switchgrass agroforests could reduce nutrient inputs to waterways. Comparisons of the N concentrations in soil water or N fluxes in runoff between energy crops and traditional agricultural crops in the Southern US have frequently shown lower N losses from energy crops such as cottonwood or switchgrass than from agricultural crops (Tolbert et al. 2000). Combining cottonwood and switchgrass in an agroforest system may enhance this N retention potential. Carbon sequestration may also be enhanced by energy crops or agroforest practices. Sharrow and Ismail (2004) found higher C storage in silvopastures than in tree plantations or pastures. The amounts and rates of C sequestration for switchgrass in temperate climates in the U.S. have been reported to be 20-30 times greater than for more traditional agricultural row crops (McLaughlin and Walsh 1998).

Wildlife species diversity (Schiller and Tolbert 1996), and, in particular, species dependent on early successional trees (Wesley 1981) would benefit from the presence of cottonwood trees in these systems. Inclusion of trees in biofuel cropping systems would enhance the vertical structure. Increased vertical structure can promote niche differentiation (Brokaw and Lent 1999), resulting in increased numbers of species that can utilize the areas dedicated to feedstock production. Therefore, a range of switchgrass and cottonwood agroforest mixtures could provide biofuel enterprises, landowners, and natural resource professionals with a diversity of management strategies for producing biofuels and providing important ecosystem services.

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