

Changes in Farm Landscape with the Introduction of a Biomass Market

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Introduction

- Cellulosic ethanol will require biomass
- Perennial switchgrass and/or annual biomass crops like forage sorghum are expected to provide feedstock
 - Irrigation and fertilizer intensity
 - yield potential and moisture
 - seasonality and speed of supply response
- Local technological and socioeconomic details associated with land use decisions
- Need information on where and at what prices biomass could be available with changing market conditions

Objectives

- Use county specific information to determine crop acreage allocation
- Validate model with 2007 data
- Estimate spatial supply function for biomass
- Sensitivity analysis on fertilizer and fuel cost
 - 2007 vs. 2008 vs. 2008 x 1.5 and x 2
- Track irrigation water and labor use

Data

- Switchgrass B/E price (2007, 2008), round baled and stacked (per dt)
 - Cropland (\$18.60, \$19.95)
 - Hayland (\$22.28, \$23.88)
 - Pasture (\$23.62, \$25.38)
- Opportunity Cost per acre for Switchgrass across counties
 - 2007 (\$30.36 – \$116.64, simple county avg. \$52.21)
 - 2008 (\$35.00 – \$285.82, simple county avg. \$98.35)
- Forage Sorghum B/E price (2007, 2008), standing in the field (per dt)
 - Irrigated (\$28.41, \$30.62)
 - Dryland (\$29.74, \$32.61)
- No yield adjustment across counties
- At \$35/dry ton, irrigated forage sorghum takes over

Model

- Maximize Arkansas net returns above total specified expenses (NR) to 18 crop, hay, pasture and CRP land use choices in 75 counties as follows:

$$\text{Maximize } NR = \sum_{i=1}^{75} \sum_{j=1}^{18} (p_j \cdot y_{ij} - c_{ij}) \cdot x_{ij}$$

where

- p_j – July futures prices as of previous year
- y_{ij} – '04 – '07 average county crop yields
- c_{ij} – county and crop specific total specified costs

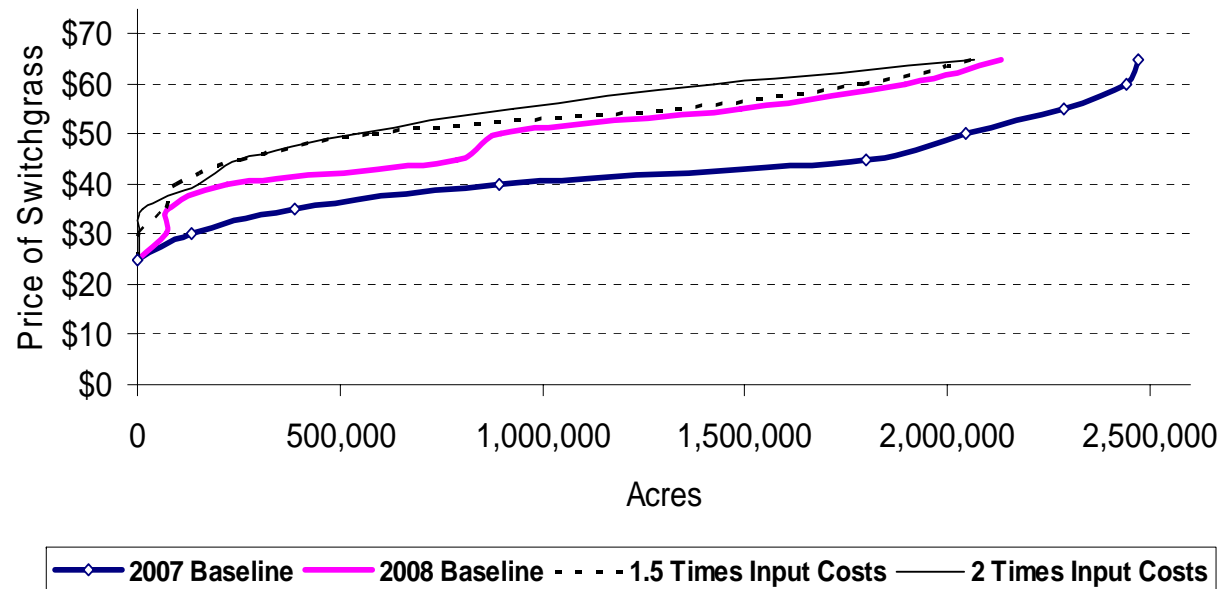
Subject to: crop, hay and pasture acreage min and max
irrigation acreage min and max
irrigation quantity restriction

Analysis

- Ran the model using input prices for
 - 2007 (baseline)
 - 2008
 - 2008 with fertilizer and fuel x 1.5
 - 2008 with fertilizer and fuel x 2
- Captured labor and irrigation water use
- Mapped county biomass production at three different switchgrass price levels to determine plant locations
- Estimated supply functions for Arkansas

Results

Figure 1. Combined Switchgrass and Forage Sorghum Acreage



- in the \$35 to \$60 price range ~ 50,000 acres / \$1 regardless of year and input cost
- \$10 more between 2007 and 2008

Spatial Supply -- 2007 Baseline

Switchgrass

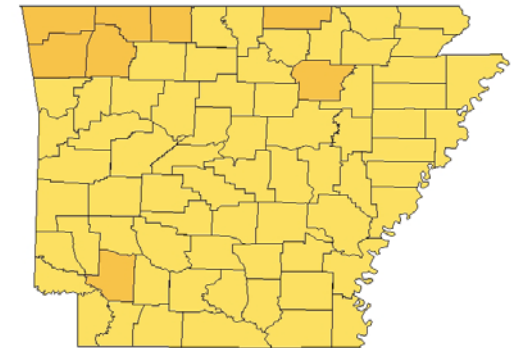
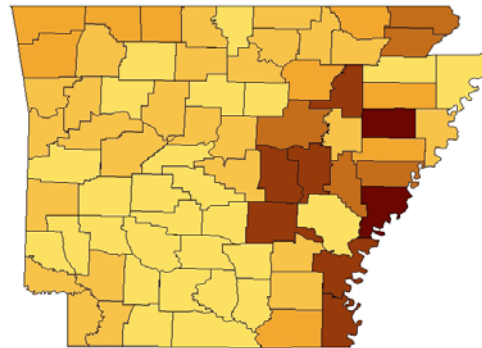
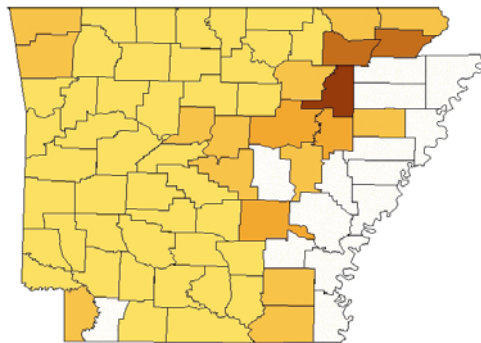
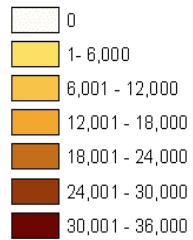
$P_s = \$35/dt$

$P_s = \$45/dt$

$P_s = \$55/dt$

Legend

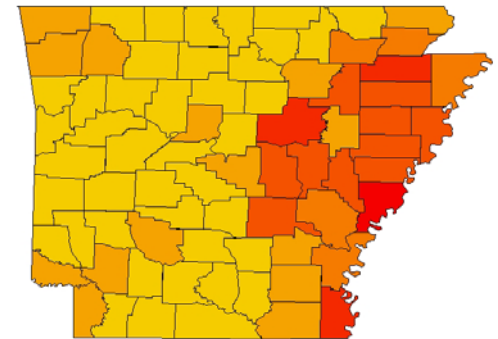
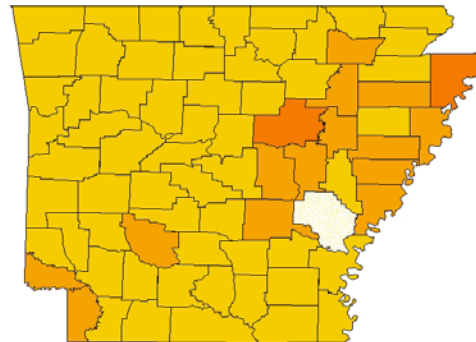
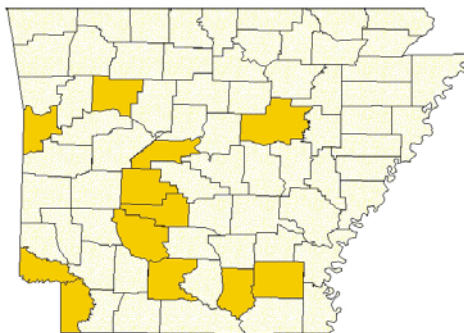
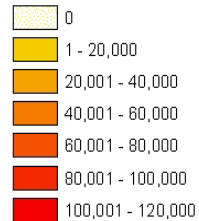
Acres Planted



Forage Sorghum

Legend

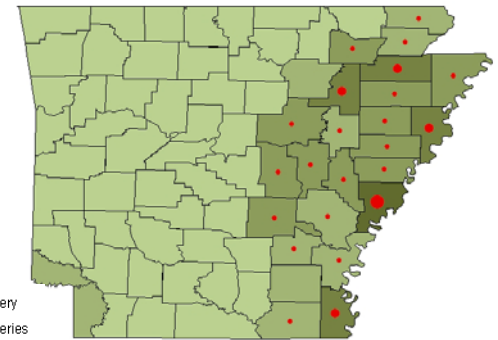
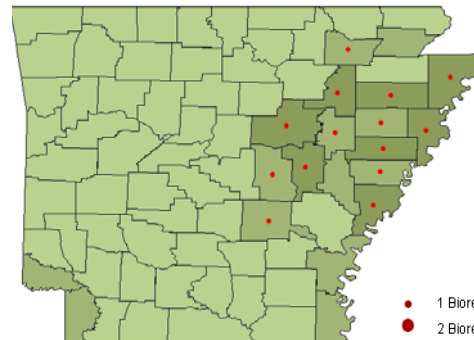
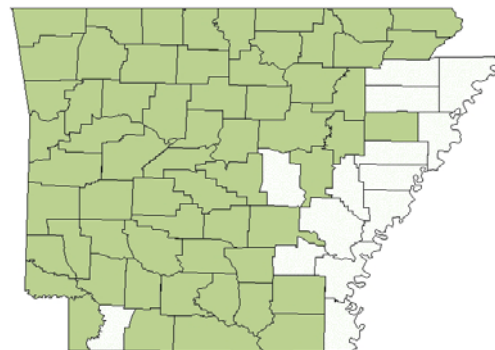
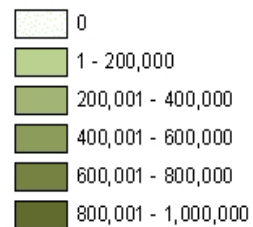
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Biomass Production

Legend

dmt



Spatial Supply -- 2008 Baseline

Switchgrass

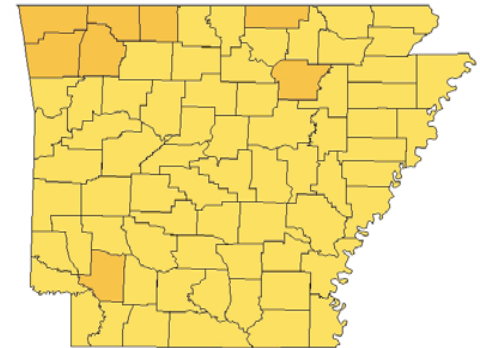
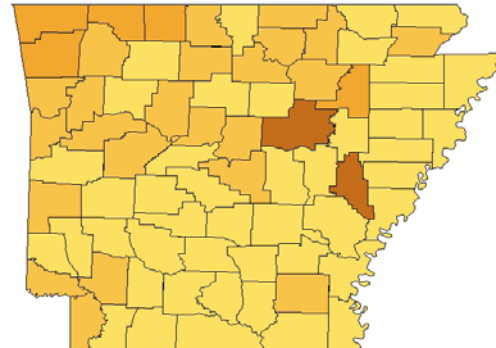
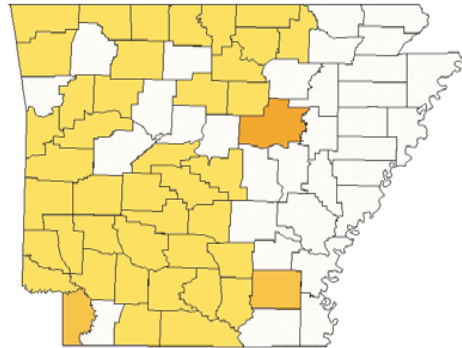
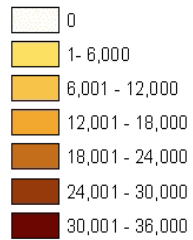
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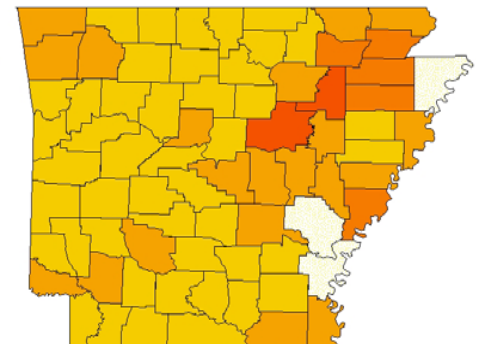
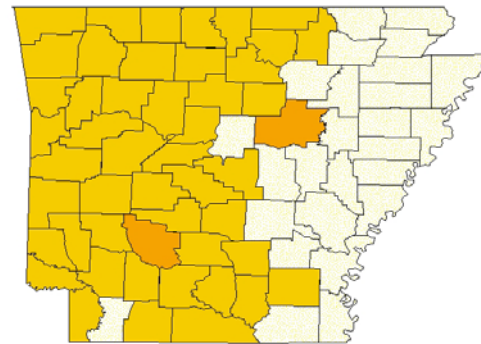
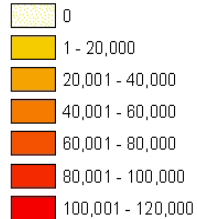
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Forage Sorghum

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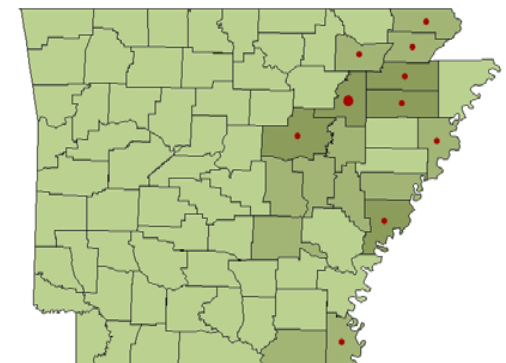
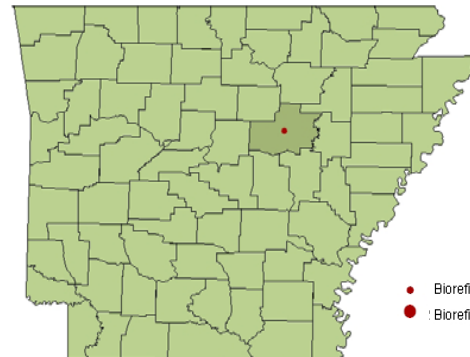
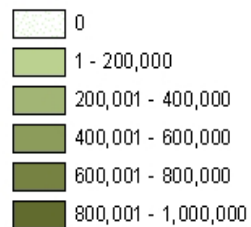
Acres Planted



Biomass Production

Legend

dmt



• Biorefinery
• Biorefineries

More Results & Limitations

- For every \$5 increase in biomass price, irrigation water use declined by 1.5% (no substantial changes in labor use)
- Plant location decisions as mapped assume sourcing from within the county
- Static analysis does not include dynamics on how perennials will enter
- More crop alternatives and residues
- Need to update with 2007 census data