# Biomass Energy Cropping Systems: Biomass Yield and Soil Quality Implications

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## Rationale

- Biofuels are an alternative source of transportation fuels produced by organic materials
- Second generation biofuels will come from cellulosic materials from dedicated biomass crops
- An understanding of the impact these crops have on the soil is extremely important in terms of the sustainability of growing fuels from dedicated biomass crops

Image 1. Switchgrass in mid-summer, 2011 at Jonesboro, AR.

## Objectives

- Determine the effect of various biomass energy crops and various nutrient sources on soil health properties such as soil organic carbon pools, microbial activity, and aggregate stability
- Determine the effect of nitrogen source and crop species on biomass yield

## Treatments

### Biomass species

- switchgrass (*Panicum virgatum*)
- switchgrass mix with big bluestem (*Andropogon gerardii*)
- eastern gamagrass (*Trispsacum dactyloides*)
- photoperiod sensitive high biomass sorghum (*Sorghum bicolor*)
- high biomass sorghum rotation with soybean (*Glycine max*)

### Nitrogen sources

- urea
- poultry litter
- municipal biosolids
- no nitrogen

### Experimental design

5 plant species by 4 nitrogen sources with 4 replications

## Methods

- Plot size: 27 by 7 m at Jonesboro, AR
- Perennial crops established in spring 2009
- Annuals planted May of each year
- Perennials harvested after first frost
- Perennials receive 68 kg N/ha; P&K applied based on soil test levels
- Sorghum receives 136 kg N/ha; P&K applied based on soil test levels
- Winter wheat cover crop in the annual systems
- Soil samples 0-10 cm (Aggr. Stab. 0-5 cm)

## Analyses

- Soil organic matter: Loss on ignition
- Enzyme activity: β-glucosidase
- Aggregate stability: wet sieving 3 minutes
- Active carbon: potassium permanganate (Weil)

Image 2. Sampling of high biomass sorghum, October 2013.

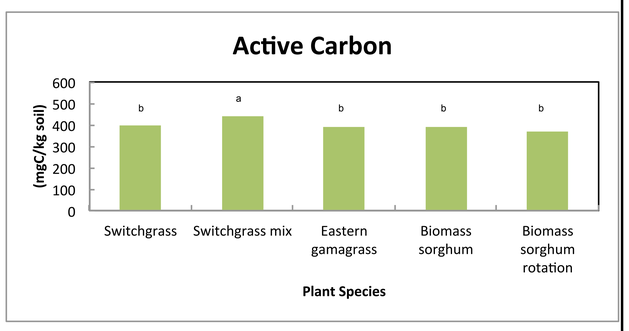


Figure 1. Active carbon in soils (0-10 cm) under bioenergy cropping systems. Samples taken in spring 2013 at the beginning of the 5th year in production. Treatments with the same letter are not significantly different at the 0.05 level of significance. N source and interaction were not significant factors.

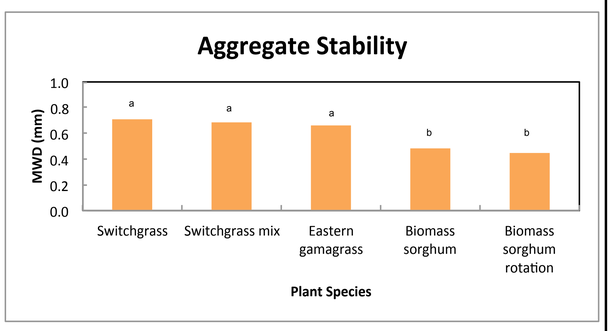


Figure 2. Aggregate stability in soils (0-5 cm) under bioenergy cropping systems. Samples taken in spring 2013 at the beginning of the 5th year in production. Treatments with the same letter are not significantly different at the 0.05 level of significance. N source and interaction were not significant factors.

Image 3. Eastern gamagrass, mid-summer 2012.

Table 1. p-values from Analysis of Variance on soil quality parameters for species, N source and species*N source.

| Factor | p-value | | | |
|---|---|---|---|---|
| | Active C | Aggr. Stab. | β-gluco | O.M. |
| Species | 0.0268 | 0.0000 | 0.2612 | 0.0005 |
| N Source | 0.0936 | 0.2427 | 0.0012 | 0.2215 |
| Species*N Source | 0.3032 | 0.7987 | 0.3955 | 0.5807 |

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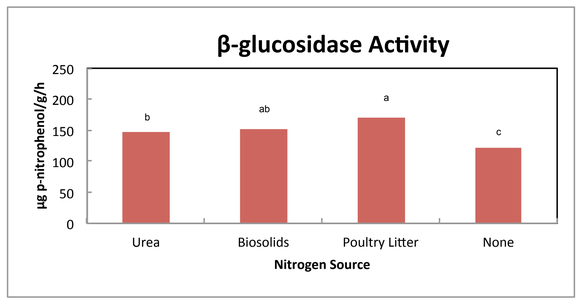


Figure 3. β-glucosidase activity in soils (0-10 cm) under bioenergy cropping systems. Samples taken in spring 2013 at the beginning of the 5th year in production. Treatments with the same letter are not significantly different at the 0.05 level of significance. Plant species and interaction were not significant factors.

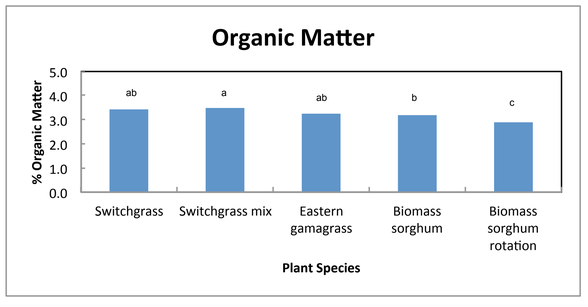


Figure 4. Organic matter in soils (0-10 cm) under bioenergy cropping systems. Samples taken in spring 2013 at the beginning of the 5th year in production. Treatments with the same letter are not significantly different at the 0.05 level of significance. N source and interaction were not significant factors.

## 2012 & 2013 Biomass Yields

2013 Sorghum: 19.2-21.5 Mg/ha; not significant for N source

2013 Perennials will be harvested later in November

2012 due to drought, only perennials were harvested

- Both plant species and N source showed significance at $p<0.05$ with N applied greater than no N and switchgrass (10.25 Mg/ha) greater than eastern gamagrass (6.89 Mg/ha)