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Alternative Perennial Grasses for Bioenergy

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By John Guretzky

In the 2006 State of the Union Address, President George W. Bush proposed the Advanced Energy Initiative to reduce U.S. dependence on foreign oil through accelerated development of domestic, renewable alternatives to gasoline and diesel fuels. A goal of the initiative was to make ethanol derived from cellulosic biomass (crop residues, fast-growing trees and grasses) cost competitive with grain ethanol by 2012. Transportation fuels derived from cellulose - the fibrous material of plants - offer an attractive alternative as an abundant, domestic and renewable resource.

The U.S. Department of Energy identified switchgrass as a model cellulosic crop because it combined more attributes desirable for bioenergy production than other grasses. Among these attributes, switchgrass was a seeded, perennial grass native throughout North America. It was widely distributed and productive across a wide geographical range.

In research at Ardmore, we have found biomass yields of switchgrass (cultivar "Alamo") to average 6.5 tons per acre. Multilocation experiments were initiated in 2007 to evaluate the response of switchgrass to nitrogen, phosphorous and potassium fertilization rates, and biomass harvesting. Data is limited or sometimes nonexistent on biomass yields of other perennial grasses for bioenergy production in Oklahoma.

A number of perennial grasses can be produced in Oklahoma that may provide substantial net benefits to the national goal of making cellulosic ethanol cost competitive. These grasses include, among others, giant reed, weeping lovegrass, miscanthus, Indiangrass, big bluestem, bermudagrass and Johnsongrass. In some trials conducted in Europe and North America, biomass yields of miscanthus have averaged 10 tons per acre compared to 5 tons per acre for switchgrass. Research in Alabama has reported biomass yields of giant reed to reach 15 tons per acre. Giant reed frequently can be found growing as an ornamental in residential neighborhoods in Oklahoma. Indiangrass and big bluestem, in addition to switchgrass, are tall, perennial grasses native to Oklahoma. They are characteristic of productive rangelands. Weeping lovegrass is a perennial, warm-season grass adapted to Oklahoma that grows particularly well on sandy soils.

A number of concerns exist while evaluating any of these grasses as a bioenergy feedstock. First and foremost, the grasses will have to produce a lot of biomass at a low

cost. Large biomass yields are necessary to reduce transportation distances and improve the economy of scale for a biorefinery. A second concern is their nitrogen fertilizer and water use efficiencies. As nitrogen fertilizer costs continue to rise and water supplies increasingly become limited, it will be important that these feedstocks produce biomass with less water and nitrogen. Third, establishment costs need to be low. Switchgrass has an advantage because seed is generally available. We have found establishment costs of switchgrass to range from $75 to $150 per acre. A disadvantage of miscanthus and giant reed is that they must be propagated vegetatively. Planting of root, rhizome and stem cuttings to achieve stands has been estimated to increase establishment costs to $350 to $500 per acre.

Additional concerns with these grasses are their invasiveness and resistance to pests. Johnsongrass is commonly considered a weed. Some have expressed concerns about miscanthus and giant reed escaping managed croplands to become weeds in natural lands. Another concern that exists with any of the grasses is their resistance to disease and other pest outbreaks when planted as a monoculture crop. Being clones and having less genetic diversity, miscanthus and giant reed may be susceptible to increased risk from disease and insect pressures.

Stay tuned. The Noble Foundation will be initiating research in 2008 to evaluate some of these alternative perennial grasses as bioenergy feedstocks.