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Power Farming: Ohio State Tests Bioenergy Crops for Fuel, Combustion

COLUMBUS, Ohio -- All across Ohio, a variety of grasses, shrubs and trees are being grown and analyzed to see how well they can produce something that is always in high demand: energy.

For the past few years, researchers with Ohio State University's College of Food, Agricultural, and Environmental Sciences (CFAES) have been evaluating a number of so-called "bioenergy crops" for their suitability to different regions of the state, their biomass yield and their potential to become value-added crops for farmers.

"These crops can grow on marginal land and will not take away good land from food production," said Rafiq Islam, a soil, water and bioenergy specialist with Ohio State University South Centers at Piketon.

"Our idea is to use all the degraded soils and marginal land not suitable to grow food crops for bioenergy production. We are even pursuing the Ohio Department of Agriculture, the Ohio Department of Transportation and the governor's office to use highway right-of-ways for growing biomass energy crops in Ohio."

Research at OSU South Centers

Islam leads several bioenergy crop trials in Piketon in southern Ohio, which along with the eastern part of the state has plenty of hilly terrain and strip-mined land that could be utilized to grow these new crops. Plants being studied there include switchgrass, various prairie grasses, miscanthus, hybrid willow, Sudan sorghum grass, sweet sorghum and guayule.

One of the projects, supported by grants from Mendel Biotechnology (a California-based developer of energy crops), involves the study of seven varieties of miscanthus --

Ekrem Aksakal, a posdoctoral fellow at Ohio State, stands in front of miscanthus plots growing at the OSU South Centers at Piketon.

seeded versus hybrid -- and three varieties of switchgrass on a total of five acres.

"Miscanthus is a warm-season grass from Asia that is getting a lot of attention across the Midwest because of its adaptability to many different soil types, low-nutrient requirements, fast-growing nature, confined growth, and lack of dispersal ," Islam said. "Miscanthus grows 15-18 feet tall and has a high biomass output that can be used for combustion or conversion to cellulosic ethanol or butane."

The miscanthus planted at Piketon yields 9.6 tons of biomass per acre, according to Islam.

Switchgrass, meanwhile, is a prairie grass native to North America that typically grows 3-6 feet tall. However, Mendel Biotechnology switchgrass species can grow 10-12 feet tall, Islam said. Just like miscanthus, switchgrass can be converted to fuel or burned to produce energy.

Both miscanthus and switchgrass are propagated via rhizome division or plugs, which can make their initial establishment difficult. But because they are perennial crops, they can produce biomass for many years before the stands need to be replanted.

A desert shrub, guayule is now being grown successfully in Piketon.

Another project at OSU South Centers, funded by the U.S. Department of Energy's NortheastSunGrant Initiative, involves growing miscanthus, switchgrass and big blue stem grass on a one-acre plot of degraded pastureland where corn and other food crops cannot grow. Researchers are applying municipal biosolids from the cities of Piketon and Waverly and gypsum from coal-fired power plants to the soil to increase its fertility, biological activity and drainage, as well as to measure their impact on crop productivity.

Additionally, Piketon researchers are studying the nitrogen requirements of a mixture of prairie grasses (switchgrass, Indiangrass and others), and how many times a year the crop can be harvested depending on the amount of nitrogen applied. Fast-growing hybrid willow trees are also being researched in a half-acre plot.

"These trees are growing in waterlogged, high-clay, high-acid and overall bad soil," Islam said. "Trees may not provide as much biomass as grasses because it takes several years to harvest them, but they can be planted in areas where nothing else will grow and they can also help improve the soil."

Taller than corn and capable of producing 18-25 tons of biomass per acre, Sudan sorghum grass has been growing at

OSU South Centers for the past eight years, Islam said. A related crop, sweet sorghum, was planted for the first time in 2012 at Piketon as part of a collaborative project with the University of Nebraska.

"We can't grow sugar cane in Ohio, but sweet sorghum can produce the same amount of sugar as sugar cane and requires half the nutrients as corn," Islam said. "It is also drought resistant and produces three types of energy: sugar for ethanol or butane, cellulosic alcohol, and biomass that can be used as animal feed or pelletized for combustion."

The last bioenergy crop being investigated at Piketon is guayule, a woody shrub native to the southeastern U.S. Guayule produces hypoallergenic rubber and a hydrocarbon that can be converted into a diesel-like transportation fuel.

"Last year, we successfully managed to grow guayule for the first time outdoors in Ohio," Islam said. "This plant is cold-tolerant, but it doesn't like standing water, so we are growing it in raised beds. We are testing this method of growing guayule so that in the future farmers can produce this crop on the hills of southern Ohio."

Research at other Ohio locations

OSU South Centers at Piketon is not the only location where CFAES scientists are learning more about bioenergy crops. For the past nine years, Rattan Lal, a soil scientist with the School of Environment and Natural Resources and a Distinguished University Professor, has been researching bioenergy crops at several research sites throughout the state.

Plots of switchgrass, hybrid poplar and hybrid willow have been established at the Northwest Agricultural Research Station in Hoytville (Wood County), the Western Agricultural Research Station in South Charleston (Clark County), and the Jackson Agricultural Research Station (Jackson County). These stations are part of the Ohio Agricultural Research and Development Center, the research arm of CFAES.

Lal, whose research deals with soil health and fertility and soil carbon sequestration, said he is interested in bioenergy crops as alternatives to keep corn residue from being used as biomass for energy production.

"Leaving crop residue on the ground is good to increase soil fertility, prevent erosion issues and reduce the impact of drought," Lal said. "I'm looking at various bioenergy crop possibilities for various parts of the state and soil conditions. That way we will able to provide growers and policymakers with a menu of alternatives."

Rattan Lal stands in a switchgrass plot in western Ohio.

Lal said switchgrass was difficult to get to grow at the beginning, but once established it has proven to be a good producer, yielding 8-10 tons per acre. His research team has also learned that switchgrass requires some additional nitrogen fertilization and that, because its root grow deep in the ground, it can survive drought.

In the case of poplar and willow, which have been harvested once during the research project, Lal said they produce about 2-3 tons of biomass per acre per year of growth. It's a lot less than what switchgrass yields, he said, but these trees can grow in places where grass crops won't and provide additional environmental benefits.

"Another goal of this project is to help restore degraded land," Lal said. "Trees can help to do this, because they can put carbon deep in the soil. Switchgrass may also be good for this purpose because of its deep roots."

In 2012, Lal added a fourth bioenergy crop research site at the Waterman Farm on Ohio State's Columbus campus. It includes miscanthus, Indiangrass and a mixture of prairie grasses. He said the miscanthus is now well established and has luxurious growth, although the crop has shallow roots that may give it a hard time during drought conditions. Lal added that his team is yet to learn about the nutrient requirements of miscanthus as well as management practices needed for optimal growth.

Lal is also collaborating with Yebo Li, an Ohio State biosystems engineer, on a project that involves growing miscanthus for use as a feedstock to produce biogas through anaerobic digestion.

Several acres of miscanthus will be grown in Coshocton County and at The Wilds, a wildlife conservation center in Muskingum County, beginning this year. Along with other crop biomass and organic waste, the miscanthus will be processed at the Zanesville anaerobic digester run by quasar energy group, a Cleveland-based bioenergy company and a partner in the project.

The miscanthus, Lal said, will be grown on strip-mined land not suitable for traditional crops, using nutrient-rich "digestate" left over from the anaerobic digestion process. The idea is to evaluate the effectiveness of the digestate as a fertilizer and to reduce the carbon footprint of growing miscanthus via utilization of this byproduct.

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