A billion tons of biomass a viable goal, but at high price, new research shows

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A new study from the University of Illinois concludes that very high biomass prices would be needed in order to meet the ambitious goal of replacing 30 percent of petroleum consumption in the U.S. with biofuels by 2030.

A team of researchers led by Madhu Khanna, a professor of agricultural and consumer economics at Illinois, shows that between 600 and 900 million metric tons of biomass could be produced in 2030 at a price of $140 per metric ton (in 2007 dollars) while still meeting demand for food with current assumptions about yields, production costs and land availability.

The paper, published in the American Journal of Agricultural Economics, is the first to study the technical potential and costs associated with producing a billion tons of biomass from different agricultural feedstocks – including corn stover, wheat straw, switchgrass and miscanthus – at a national level.

According to the study, not only would this require producing about a billion tons of biomass every year in the U.S., it would also mean using a part of the available land currently enrolled in the Conservation Reserve Program for energy crop production, which could significantly increase biomass production and keep biomass costs low.

"Most studies only tell you how much biomass is potentially available but they don't tell you how much it's going to cost to produce and where it is likely to be produced," Khanna said.

"Our economic model looks at some of the major feedstocks that could produce biomass at various prices."

Khanna and her team concluded that high-yielding grasses such as miscanthus are needed to achieve the 30 percent replacement goal, "but even then it's going to be a fairly expensive proposition," she said.

When miscanthus is added to the mix, the goal of 1 billion tons of biomass can be achieved, but at a cost of more than $140 per ton.

"Most studies consider costs in the range of $40 to $50 per ton, which is fine when we're talking about biomass production to meet near-term targets for cellulosic biofuel production," Khanna said. "But if we really want to get to the 30 percent replacement of gasoline, at least with the current technology, then that's going to be much more costly."

According to Khanna, miscanthus has been excluded from previous studies because it's a crop that has yet to be grown commercially, and most of the research about it is recent and still considered experimental.

"But across the various scenarios and prices our model considered, miscanthus has the potential to provide 50 to 70 percent of the total biomass yield," she said. "In most parts of the U.S., miscanthus is cheaper to produce than switchgrass, making it a very promising high-yield crop."

The study also contends that the economic viability of cellulosic biofuels depends on significant policy support in the form of the biofuel mandate and incentives for agricultural producers for harvesting, storing and delivering biomass as well as switching land from conventional crops to perennial grasses.

"Unless biomass prices are really high, these perennial grasses are going to have a hard time competing with crops like corn, soybean and wheat for prime agricultural land," Khanna said. "The economics works in favor of using the marginal, less productive lands, where corn and soybean productivity is much lower. But even then there are limits as to how much we would like to use that land for biomass. The more efficiently we can use the land, the better."

With biofuels, there's also the common perception that there's an unavoidable trade-off between fuel and food, Khanna said.

"That concern is much more prevalent when we talk about first-generation biofuels like corn-based ethanol," she said. "But for second-generation fuels, you can use crop residues as well as dedicated energy crops that can be grown on marginal land. This reduces the need to divert cropland away from food crop production. I'm optimistic that we can get considerable amounts of biomass without disrupting food production."

But relying on crop residues alone won't be sufficient to scale production up to levels set by the Energy Independence and Security Act of 2007, which limits the production of corn ethanol to 56 billion liters after 2015, and mandates the production of at least 80 of the 136 billion liters of ethanol from non–corn starch–based cellulosic feedstocks by 2022.

"Crop residue yields tend to be relatively low per unit of land – 2 to 3 tons per hectare," Khanna said. "That can get costly pretty quickly. There are also concerns about how much you want to take away because at some point it has a negative effect on soil productivity as well as water quality because it affects run-off. So there are limits to crop residues, which is why we have to take a closer look at energy crops."

Because even marginal land is costly and has some alternative use, both now and in the future, using it as efficiently as possible means focusing more on the highest-yielding energy crops, Khanna said.

"Clearly the way to go is with the high-yielding grasses, which means switchgrass and miscanthus, but what we found is that it's not going to be a single feedstock but really a mix of feedstocks," she said.

Different regions of the country have a comparative advantage in different types of feedstocks.

"Corn stover is more common in the upper Midwest and West, whereas miscanthus is more prevalent in the southern part of the country and switchgrass in the real northern and southern areas," Khanna said.

Provided by University of Illinois at Urbana-Champaign

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