Natural Prairie Holds Key to Sustainable Fuels

THE BEST SOURCE OF BIOMASS WILL BE FIELDS WITH DIVERSE PLANT SPECIES

by Deane Morrison

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Ecologist David Tilman says a diversity of plant species will likely produce the most biomass for making sustainable fuels.

As gas prices inch higher, the search is on for renewable, plant-based fuels that don't require fertilizer or pesticides, which both require energy to produce. A solution may be at hand, from University of Minnesota ecologist David Tilman and two colleagues: Instead of growing a single fuel source crop, grow many species together because such plantations will yield more total vegetation—and do it more reliably—than any growing just one species.

The most cited ecologist in the world, Tilman has long been singing the praises of biodiversity, as the coexistence of many species is called. In May, he and two colleagues (University forest resources professor Peter Reich and Johannes Knops of the University of Nebraska) published a paper in the journal Nature in which they sum up 12 years of experiments at the University's Cedar Creek Natural History Area. The longest-running experiment of its kind, it shows unequivocally that plots of land with numerous species produce much more "biomass" and suffer less from fluctuations in productivity than plots with only one or a few species. This makes diverse plantings the likeliest candidates to drive the "bio" revolution.

The paper is a call to everyone who wants to extract energy from biomass to start thinking in terms of species diversity. Biomass can be either burned for energy or refined to produce concentrated energy in the form of biofuels such as ethanol or synfuel gasoline and diesel. The greater the yield of biomass per acre the better, and data from Cedar Creek show that diverse plantings fill the bill.

"Diverse prairie grasslands are 240 percent more productive than grasslands with a single prairie species," says Tilman, a Regents Professor of Ecology in the College of Biological Sciences, which operates the Cedar Creek field station. "That means that if a plot with one or two plant species produces 100 pounds of vegetation a year, a plot with 16 species [the most diverse plots planted at Cedar Creek] will produce 340 pounds. This huge advantage comes when you plant numerous grasses and legumes and various prairie flowers together."

Findings from Cedar Creek suggest that plantings of multiple species of prairie plants will produce fuels, such as ethanol, with greater net energy gains per acre than corn, soybeans, or even switchgrass, which has been touted as a promising source for biomass. But the higher energy gains aren't just from higher productivity; diverse plantings require little or no inputs of fertilizer or pesticides, both of which require lots of energy to make and apply. Experiments now under way in Germany and the Netherlands are noting similar effects of diversity on yields, says Tilman, even though they use totally different species. Also, because prairie plants are perennial, they would not have to be replanted year after year. Farmers would need only mow their fields in the fall. If burned, biomass could replace some of the coal that now pumps carbon dioxide and mercury into the atmosphere.

"You can burn prairie grass using the fluidized bed technology of existing coal-fired power plants, and can mix it in with coal," says Tilman. "The energy density of biomass is 60 to 70 percent that of coal. If power plants wanted to buy

biomass and farmers wanted to grow it, it could happen, but it will take much work to get there."

Now that the value of biodiversity has been shown, the next step should be an economic analysis, says Tilman. It remains to be seen whether biomass farmers, along with energy producers and the people who transport biomass from one to the other, can each make money if they put the vision that he and his colleagues have into practice. For optimal results, each region of the country and the world would have to be studied to determine what mix of plant species would work best in that particular soil and climate.

"In Minnesota there are over a million acres of abandoned farmland in the Conservation Reserve Program," says Tilman. "That land is mainly planted with just a few grass species" and so may hold potential as a future site of biomass plantations.

Planting more species should allow not only bigger yields of vegetation, but more predictable yields. As the Cedar Creek experiments show, yields of vegetation fluctuate less from season to season if the vegetation contains many species. This kind of reliability is important because no one wants to see boom and bust years in the energy supply.

"This paper suggests there might be an unsuspected benefit to restoring land to a more native condition," Tilman says. "Restoring land so it can produce biofuels is a new idea, but there are many reasons to do it. We need a stable and productive source of bioenergy. Biodiversity can give us this on abandoned agricultural land around the world, and it doesn't have to be just grasses. As we get away from fossil fuels, we're going to have to have a diversity of approaches."