Biofuels Reassessed

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Biofuels Reassessed

It is understandable that biologists would hope to see their field put to use creating new sources of energy. The idea of fuels created by living organisms—while they take carbon dioxide out of the atmosphere!—has appeal. But thoughtful critics have pointed to a raft of problems that quickly arise, mainly because it takes a lot of land, a lot of water, and a lot of energy to produce biofuel crops and convert them into usable fuels. The displacement of food crops by biofuels has already increased food prices, and many have argued that such effects will put limits on the biofuel enterprise. Yet, enthusiasts hold out the hope that improved crop varieties and management techniques will allow for a major expansion of biofuels without the whole world having to be plowed over.

The enthusiasts are right that improvements are possible; few human endeavors cannot be made more efficient, and the seriousness of the looming energy crisis—only partly ameliorated, at substantial environmental cost, by fracking—argues for the continuation of such efforts. Still, viewing the world through rose-tinted glasses can obscure threats as well as improve mood. It is important to understand biofuels' limitations.

The study by W. Kolby Smith and his colleagues that starts on p. 911 provides some important answers. Smith and his coauthors address the question of how much biofuel can be produced globally. They avoid, however, following in the tracks of studies in which production rates were extrapolated from specific areas. Rather, they use satellite-derived net primary productivity data, together with some additional access and land-use constraints, to establish an upper limit of what might be possible under a variety of scenarios.

The results are, as a tabloid might put it, a shocker. The authors estimate maximum primary bioenergy potential to range from 35 percent to 108 percent of 2009 global primary energy consumption. But realistically, only a third of that is achievable, which means a bottom line roughly four times lower than several previously published estimates. All these numbers exclude losses due to manufacturing the fuel.

The chief source of the difference was that previous authors assumed generally improving biofuel yields and management practices (including an increased use of fertilizer and irrigation), but Smith and his colleagues argue persuasively that such improvements must be restricted to small, intensively farmed areas. Actual current global primary productivity suggests strongly that biofuels have less promise than many had thought.

It gets worse. According to an article published by James Hansen and two coauthors in the *Proceedings of the National Academy of Sciences* in August (doi:10.1073/pnas.1205276109), recent heat waves and extreme summers are increasing in frequency and area, most likely because of global warming. Given the devastation such events inflict on crop yields in the world's major bread baskets, it seems that even the sobering estimates of Smith and colleagues might be overoptimistic. Yields could fall from current levels, not increase, if the frequency of extreme weather events continues to grow.

Some new biofuels may yet alleviate the human predicament, but nobody should be under any illusions about the constraints that nature—ultimately, through the laws of thermodynamics—has put in the way.

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