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## Bio-oil Production in the Field

In the editorial "Green Plants, Fossil Fuels, and now Biofuels" (*BioScience* 56: 875), David Pimentel and Tad Patzek argue that bioethanol is a nonsustainable way to produce fuel from biomass. Their main argument is that the amount of energy from fossil fuel required to produce ethanol is larger than the energy contained in the ethanol, at least with current technology. The authors recommend giving priority to energy conservation and solar energy.

However, we want to call attention to a more sustainable method of biofuel production. Flash pyrolysis is a thermochemical process in which biomass is converted to bio-oil in an oxygen-free atmosphere. The energy requirement for heating is less than 15% of the heating value in the processed biomass. The flash pyrolysis process developed at the Technical University of Denmark is optimized to produce bio-oil from cereal straw directly in the field (Bech and Dam-Johansen 2006). This means that the high energy consumption for transportation of biomass to the processing plant is avoided, and approximately 55% of the energy from the processed straw ends up in the bio-oil. The remaining organic material is turned into char and distributed in the field together with most nutrients. Char is generally very resistant to microbial degradation, which means that this carbon is sequestered in the soil. Some South American soils (*terra preta,* or dark earth), amended thousands of years ago with large amounts of anthropogenic char, currently contain up to 9% carbon, compared with 0.5% for plain soil from nearby areas (Marris 2006). In addition, the char has a long range of positive effects on factors associated with soil quality, which can help amend some of the detrimental effect that the removal of biomass has on soil quality. Hence, by integrating flash pyrolysis of biomass with char amendment, sustainable bio-oil can be produced, carbon can be sequestered, and soil fertility can be improved.

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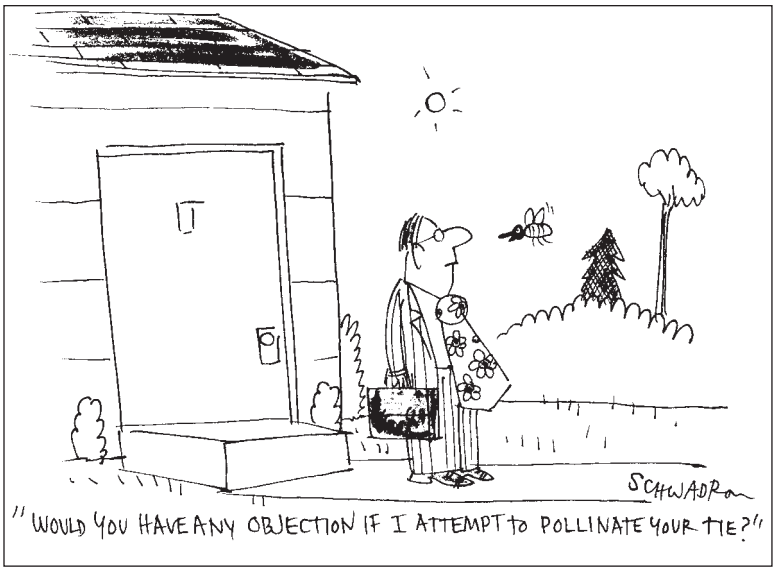




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