Can Agriculture Fuel the World?

by Patrick J. Bohlen

Agriculture is being called upon to fuel the world. Given the success of agronomy in contributing to unprecedented improvements in crop yields and production technologies of the past century, it is no wonder that many agronomists accept this challenge with enthusiasm. No discipline is better equipped to address the technical challenges of developing biofuel cultivars, improving processing technologies, and growing biofuel crops.

However, the biophysical, economic, and social constraints on biofuel production are great. Humans appropriate around 40% of global terrestrial net primary productivity. Massive biofuel production could push that total beyond 50%. As Rattan Lal, Past President of SSSA, and others have pointed out, massive diversion of biomass to fuel production deprives soil microbes and other wild heterotrophs of energy and reduces the critical recycling of organic matter in agricultural systems.

A major biophysical limitation to biofuels is their low energy density. The most efficient biofuels produce a net energy equivalent of 0.5 W/m^2. By comparison, the most efficient photovoltaic cells produce 30 W/m^2. The low energy density of biofuels prompted Vaclav Smil to conclude in his recently published book *Energy in Nature and Society* that "Proposals for massive biomass energy schemes are among the most regrettable examples of wishful thinking and ignorance of ecosystem realities." They are also based on ignorance of economic realities.

Rise in Input Prices

Agricultural producers are already paying dramatically higher prices for inputs linked to energy. Fertilizer prices have doubled or even tripled in the past few years. Transportation costs have also increased dramatically. Livestock producers and food processors are paying more for grain. These costs are being passed on to consumers who are paying more for bread, meat, eggs, and dairy products. Skyrocketing food prices and global grain shortages raise serious ethical questions about using food crops to produce biofuels. Some of these increases may be temporary, but a permanent increase in energy prices is likely to occur given increasing global demand for oil, and eventual declines in oil supply, with no ready substitutes on the horizon.

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The wisdom of corn ethanol production already faces heated debates, both within the scientific community and at the highest level of government. Most people agree that corn ethanol is not a long-term solution, but many see it as a necessary step towards cellulosic ethanol. Cellulosic ethanol may provide better energy returns, have lower environmental impacts, and cause fewer disruptions in food supply than corn ethanol, but it still faces the same biophysical limitations of any biofuel.

Biofuels will not reduce the energy dependence of agriculture. The great increase in food production over the past century relied on huge energy inputs. Since 1900, the energy harvested in crops increased 6-fold but required an 85-fold increase in energy inputs. Tripling of irrigated agriculture since WWII has expanded agriculture's energy dependency and vulnerability. Because of this dependence on high energy inputs, agriculture is more likely to become a victim of decreasing energy supplies than it is to become a producer of significant energy substitutes.

More Comprehensive Approach May be Needed

These issues are not trivial because they hugely influence research and funding priorities, as well as public perception of agricultural science. If we succeed at achieving the goal of producing 30% of our liquid fuel needs by 2030 or even 2050, agronomists can share credit for this success. However, if massive biofuels production turns out to be wishful thinking, as suggested by some of our most insightful analysts, then we might be wiser to direct our limited resources towards a more comprehensive approach to energy and agriculture.

We cannot foresee the future with certainty. Biofuels clearly have a place in that future. However, we need a much broader approach that recognizes the need to develop more energy efficient production systems and faces the huge challenge of sustaining agricultural production in a world with higher energy prices and lower availability of high density fuels. Our sciences can meet these challenges, but it will require a major restructuring of our agricultural systems and refocusing of our priorities to do so.

Do you have an opinion on an important issue that you would like to share with members? If so, email it to news@agronomy.org. Articles should be 700 words or less. Acceptance for publishing will be determined by our review panel.

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