WOODS INSTITUTE
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The Impacts of Large-Scale Biofuel Use on Water Resources

Clean, fresh water is essential to public health and the health of our environment and economy. Outdated water management policies that misallocate fresh water supplies, and changes in once-predictable weather patterns threaten the availability of fresh water. Water pollution adversely affects ecosystem habitats and commercial industries, recreation and tourism; for example, nutrient runoff from agricultural operations in the Mississippi River watershed has severely compromised commercial and recreational fishing in the Gulf of Mexico.

1. **Over the next five years, large-scale use of biofuels could further degrade water quality.**

   In the short term, the impact of biofuels on water quality is simply the impact of intensified and expanded corn production on water quality. The increase in demand for energy crops over the next few years – and the resulting rise in crop prices – will spur farmers to grow more corn by replacing soy and wheat with more profitable corn crops, and taking measures to increase crop yields. High corn prices also will encourage farmers to expand the total acreage of land under cultivation, possibly into lands set aside for erosion control and habitat protection. In the absence of strict enforcement of best management practices, and a close focus on ensuring yield gains are not achieved at the expense of environmental quality, each of these actions is likely to increase sediment erosion and contaminated runoff into streams, rivers and oceans.

   A further increase in erosion could occur if high corn prices dampen the attractiveness of financial incentives offered to farmers for putting erosion prevention plans in place as part of USDA's Conservation Security Program.

2. **Over the next twenty years, the effects of large-scale use of biofuels on water quality likely will depend on which feedstocks are favored.**

   Ethanol made from cellulose-rich organic material is expected to be commercially viable within the next 5 to 15 years. As cellulosic technology develops, ethanol feedstock likely will shift away from corn kernels, to agriculture and forestry residue, grasses and woody crops, and the organic portion of industrial and municipal solid waste.

   Water quality could improve if the emergence of cellulosic technology results in a shift (a) away from mass-produced corn toward energy crops that are less water-, pesticide-, and fertilizer-intensive such as native grasses and perennials; or (b) toward utilizing biomass not specifically produced for energy such as agricultural and forestry residue, and industrial and municipal waste.

   But water quality improvements in a cellulosic world are not guaranteed: different cellulosic feedstocks could have dramatically different effects on water quality. For example, while using perennial grasses and trees as energy feedstocks could help prevent erosion and restore lands degraded by human impacts, using corn stover (a likely first-generation cellulosic feedstock) could exacerbate erosion if farmers remove too much stover from the ground after harvest.

3. **Large-scale biofuel use could alter the distribution of water locally, regionally, and globally.**

   The expansion of corn croplands into areas requiring irrigation and the installation of water-intensive biorefineries in areas of water scarcity could intensify existing water allocation problems, or create problems in areas without a history of water quantity problems.

Recommendations for Further Research

The following ideas and issues should be investigated further:

- **Development of bioregional centers**. Building on state extension services for farmers, bioregional centers that can manage conversion of uncultivated lands and oversee management practices at the watershed scale can be created. Management at the regional level is important since the impacts of land conversions, crop choice, and various management practices depend on site-specific factors such as soil type, slope, and climate. The centers should take a multidisciplinary approach, with ecologists, energy, agriculture, and rural development experts on staff. Centers could provide farmers with resources and incentives to select sustainable management practices suited to particular regions.
- **Creation of incentives for farmers to follow best management practices**. For example, USDA could require ethanol plants receiving federal subsidies to accept corn only from farms that have a nutrient management plan in place. Critical to any program requiring or providing incentives for best management practices is the creation of a certification system which would enable documentation of, and then allow credit for, such practices.
- **Encouragement of scientists, working to optimize corn yield for energy feedstock, to take into account environmental factors**. Public grants and subsidies to research institutions working to develop high-yield corn for use as energy feedstock should encourage the development of corn varieties that are not heavily dependent on high levels of product inputs such as fertilizer and water. To the extent possible, new varieties should reflect a balance between high corn yield and environmental sustainability.

Other key research areas include:

- **The effects of management practices**. Better information is needed on the environmental effects of various agricultural practices. Research should be conducted specific to region and land characteristics since effects differ depending on soils, slopes, water availability, climate, and current land use.
- **The development of technologies that could alleviate the pressure for agricultural expansion associated with ethanol, including**:
  - Sustainably achieved crop yields. More research is needed to improve conventional feedstock crop yields while minimizing the use of chemical inputs and water. Such research should incorporate genetics, soil science, and real-time irrigation scheduling. (See K. Cassman, V. Eidman, E. Simpson, "Convergence of Agriculture and Energy: Implications for Research and Policy", QTA 2006-3; http://www.cast-science.org)
  - Cellulosic ethanol. Accelerate efforts to make cellulosic technology scalable.
  - Variable-feedstock processors. Currently, research and development of cellulosic conversion technologies focuses on developing processors that can accept a single type of feedstock. Research is needed to develop processing facilities able to accept a variety of feedstocks. Such facilities would enable processors to take advantage of the flow of a variety of biomass, encouraging a more water-friendly feedstock menu of perennial grasses and trees. (B. Paulos, G. Bonfert, "The Machine in the Garden"; http://www.ef.org/biofuels)