Increase in Ethanol Production from Corn May Significantly Impact Water Quality and Availability

If projected increases in the use of corn for ethanol production occur, the harm to water quality could be considerable, and water supply problems at the regional and local levels could also arise, according to a report from the National Research Council. The committee that wrote the report examined policy options and identified opportunities for new agricultural techniques and technologies to help minimize effects of biofuel production on water resources.

Recent increases in oil prices in conjunction with subsidy policies have led to a dramatic expansion in corn ethanol production and high interest in further expansion over the next decade, said the report. In last year's State of the Union address, President Bush called for the production of 35 billion gallons of ethanol by 2017, which would equal about 15% of the U.S. liquid transportation fuels.

A National Research Council committee was convened to look at how shifts in the country's agriculture to include more energy crops, and potentially more crops overall, could affect water management and long-term sustainability of biofuel production. Based on findings presented at a colloquium last July, the committee came to several conclusions about biofuel production and identified options for addressing them.

In terms of water quality, the committee found that agricultural shifts to growing corn and expanding biofuel crops into regions with little agriculture, especially dry areas, could change current irrigation practices and greatly increase pressure on water resources in many parts of the United States. The amount of rainfall and other hydroclimate conditions from region to region causes significant variations in the water requirement for the same crop, the report said. For example, in the Northern and Southern Plains, corn generally uses more water than soybeans and cotton, while the reverse is true in the Pacific and mountain regions of the country. Water demands for drinking, industry, and such uses as hydropower, fish habitat, and recreation could compete with, and in some cases, constrain the use of water for biofuel crops in some regions. Consequently, growing biofuel crops requiring additional irrigation in areas with limited water supplies is a major concern, the report said.

Even though a large body of information exists for the nation's agricultural water requirements, fundamental knowledge gaps prevent making reliable assessments about the water impacts of future large-scale production of feedstocks other than corn, such as switchgrass and native grasses. In addition, other aspects of crop production for biofuel may not be fully anticipated using the frameworks that exist for food crops. For example, biofuel crops could be irrigated with wastewater that is biologically and chemically unsuitable for use with food crops, or genetically modified crops that are more water efficient could be developed.

Increased fertilizer and pesticide use for biofuels could impact the quality of groundwater, rivers, and coastal and offshore waters, the report said. High levels of nitrogen in stream flows are a major cause of low-oxygen or "hypoxic" regions, commonly known as "dead zones," which are lethal for most living creatures and cover broad areas of the Gulf of Mexico, Chesapeake Bay, and other regions. The report said that there are a number of agricultural practices and technologies that could be employed to reduce nutrient pollution, such as injecting fertilizer below the soil surface, using controlled-release fertilizers that have water-insoluble coatings, and optimizing the amount of fertilizer applied to the land.

A possible metric to gauge the impact of biofuels on water quality could be to compare the amount of fertilizers and pesticides used on various crops, the committee said. For example, corn has the greatest application rates of both fertilizer and pesticides per acre, higher than for soybeans and mixed-species grassland biomass. The switch from other crops or non-crop plants to corn would likely lead to much higher application rates of highly soluble nitrogen, which could migrate to drinking water wells, rivers, and streams, the committee said. When not removed from water before consumption, high levels of nitrate and nitrite (products of nitrogen fertilizers) could have significant health impacts.

Nutrient and sediment pollution in streams and rivers could also both be attributed to soil erosion. High sedimentation rates carry financial consequences as they increase the cost of often mandatory dredging for transportation and recreation. The committee observed that erosion might be minimized if future production of biofuels looks to perennial crops (like switchgrass, poplars, or willows) or prairie polyculture, which could hold the soil and nutrients in place better than most row crops. The committee also identified other ways that farming could be improved, such as conservation tillage and leaving most or all of the cornstalks and cobs in the field after the grain has been harvested.

For biorefineries, the water consumed for the ethanol production process—

NIST Posts Online Database of Cryogenic Materials Properties

www.cryogenics.nist.gov

In response to numerous inquiries from academia, industry, and other government laboratories, the National Institute of Standards and Technology (NIST) recently published a new database on the properties of solid materials at temperatures ranging from cryogenic (as low as 4 K, which is –269ºC or –452ºF) to room temperature. Officially known as NIST Standard Reference Data Database #152, the Cryogenic Materials Properties Database is available online, free of charge. It is also a work in progress, with new materials and properties added as data becomes available.

Cryogenic temperatures place extreme demands on materials. The properties data have been collected by various organizations over many years, published in various formats, such as internal reports, and often have not been publicly available. NIST researchers located the data, evaluated and validated it, resolved any conflicts resulting from different test methods and sources, then re-plotted and correlated the data over a wide temperature range using standardized equations.

The database covers a wide range of materials from traditional engineering stainless steels to fiberglass epoxy (found in magnetic resonance imaging systems, for example), exotic regenerator materials (used in cryogenic refrigerators), and Kevlar (may be combined with carbon fibers in containers used in space). The materials might be used in medicine (e.g., cryosurgery), energy applications (e.g., storage of liquid methane or liquid natural gas), electronics (superconducting microwave filters for cellular phones), transportation (liquid hydrogen fuel storage), space exploration (fuel storage), environmental research (thermal mapping and imaging of oceans), weather forecasting (infrared thermal imaging of the atmosphere), and defense (infrared guidance systems).

The database is available at www.cryogenics.nist.gov.

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although modest compared with the water used growing biofuel crops—could substantially affect local water supplies, the committee said. A biorefinery that produces 100 million gallons of ethanol a year would use the equivalent of the water supply for a town of about 5,000 people. Biorefineries could generate intense challenges for local water supplies, depending on where the facilities are located. However, use of water in biorefineries is declining as ethanol producers increasingly incorporate water recycling and develop new methods of converting feedstocks to fuels that increase energy yields while reducing water use, the committee said.

The report, *Water Implications of Biofuels Production in the United States*, can be obtained from the National Academies Press at www.nap.edu.

European Commission Promotes Development of Hydrogen Technologies

The European Commission has adopted two proposals that will mark a step forward in the development and marketing of clean and safe hydrogen vehicles. The first is the setting up of the Fuel Cells and Hydrogen Joint Technology Initiative (JTI), an industry-led integrated program of research, technology development, and demonstration activities. This public-private partnership driven by European industry will be implemented over the next six years with a financial contribution from the European Union (EU) of €470 million to be matched by the private sector. The JTI should accelerate the development of hydrogen technologies to the point of commercial take-off between 2010 and 2020. Second, a number of hydrogen cars are already ripe for market introduction. Thus, the Commission proposes to simplify their approval so that they will be seen more often on European streets. The European Parliament and the Council of Ministers will now consider both proposals.

Günter Verheugen, Commission vice president responsible for enterprise and industry, said, "The introduction of hydrogen vehicles has the potential to make Europe's air cleaner and reduce its dependency on fossil fuels. Setting common standards will support the introduction of these vehicles and ensure high safety for citizens. It will also boost the competitiveness of European manufacturers."

Commissioner Janez Potočnik, responsible for science and research, said, "Europe is facing major challenges to secure its energy supply while combating climate change, preserving the environment, and maintaining a competitive economy. Technologies such as fuel cells and hydrogen can help us tick all the boxes. The Joint Technology Initiative for Fuel Cells and Hydrogen will be a major step in bringing about the research, development, and deployment program that Europe needs to bring these technologies to the market. EU funds matched by the industrial sector will bring a sorely needed billion euro to kick-start a real change."

At the moment, hydrogen vehicles are not included in the EU vehicle type-approval system. This results in complicated and costly approval procedures and hinders vehicles being placed on the market on a uniform basis throughout the EU. The proposal will introduce these vehicles into the type-approval framework. Furthermore, hydrogen has different characteristics from conventional fuels. The proposal will guarantee that all hydrogen vehicles put on the market in the EU are at least as safe as conventional vehicles.

The second proposal is to create a public-private partnership for research, a Joint Technology Initiative, to benefit the development of hydrogen and fuel cells. The JTI will receive €470 million from the EU's 7th Framework Program, an amount that will be matched by the industrial partners.

While fuel cells are very efficient energy conversion devices, a number of technical and non-technical barriers must still be addressed before their use can become widely commercially available. Such barriers include, for example, cost and durability of fuel cells, sustainable production of hydrogen, and safe and efficient distribution and storage of hydrogen, particularly for mobile applications.

These two proposals adopted by the European Commission on fuel cells and hydrogen technologies are expected to offer long-term solutions for sustainable energy and transport systems, benefiting society by mitigating the adverse effects of climate change and toxic pollutants, and reducing dependency on diminishing oil and gas reserves.

Tekes Launches Sustainable Community Technology Program

The new sustainable community technology program by Tekes, the Finnish funding agency for technology and innovation, will invest €100 million into the development of sustainable and energy-efficient areas and building.

The real estate and construction cluster plays a key role in promoting the objectives of sustainable development because its environmental impacts and significance to the national economy are of great importance. The proportion of energy consumption by buildings amounts to as much as 40% in Finland, and where and how communities are built affects consumption and environmental loading.

Land use planning—the location of jobs, housing, and services—has a major effect on the need for mobility and the environmental impacts of traffic. In turn, the standard of construction has a major impact on the use of energy during both the construction process and the lifetime of a building.

Over the next five years, the Sustainable Community Technology Program, launched in September 2007, will invest, along with Finnish companies and organizations in the sector, around 100 million euros into the development of business activities in the building and property and environmental sectors. The program will continue until 2012.

"Sustainable community technology program aims to generate in Finland noteworthy new and renewable business activities in designing, constructing, and maintaining sustainable and energy efficient areas and buildings, as well as in repairing them. One core theme of the program is a noticeable improvement in the energy efficiency of buildings and communities, as well as the promotion of adopting renewable energy sources," said Jarmo Heinonen, Tekes program manager.

He said, "For example, slowing down climate change would call for lowering energy consumption of new buildings to one-seventh or one-eighth of the current level. In this respect, the challenge is to achieve the goal economically."

The program will encourage Finnish research institutes, universities, and companies to engage in international collaboration by exchanging information and networking companies and research groups. The program is expected to provide opportunities for research and development (R&D) projects, develop business expertise and international cooperation, and serve as a gateway to researcher groups and R&D companies in Finland. □

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