focus B

Biofuels: the promise and the risks

Biofuels offer a potential source of renewable energy and possible large new markets for agricultural producers. But few current biofuels programs are economically viable, and most have social and environmental costs: upward pressure on food prices, intensified competition for land and water, and possibly, deforestation. National biofuel strategies need to be based on a thorough assessment of these opportunities and costs.

Biofuels could become big markets for agriculture—with risks

With oil prices near an all-time high and few alternative fuels for transport, Brazil, the European Union, the United States, and several other countries are actively supporting the production of liquid biofuels (ethanol and biodiesel).[1] The economic, environmental, and social impacts of biofuels are widely debated. As a renewable energy source, biofuels could help mitigate climate change and reduce dependence on oil in the transportation sector. They may also offer large new markets for agricultural producers that could stimulate rural growth and farm incomes. On the downside are environmental risks and upward pressure on food prices. These impacts, which depend on the type of feedstock (raw material), production process, and changes in land use, need to be carefully assessed before extending public support to large-scale biofuel programs.

Of the global fuel ethanol production of around 40 billion liters in 2006, about 90 percent was produced in Brazil and the United States, and of over 6 billion liters of biodiesel, 75 percent was produced in the EU—mainly in France and Germany (figure B.1). Brazil is the most competitive producer and has the longest history of ethanol production (dating back to the 1930s), using about half its sugarcane to produce ethanol and mandating its consumption. With tax incentives, subsidies, and consumption mandates for biofuel production, the United States used 20 percent of its maize crop to produce ethanol in 2006/07 (forecast).[2]

New players are emerging. Many developing countries are launching biofuel programs based on agricultural feedstocks: biodiesel from palm oil in Indonesia and Malaysia, ethanol from sugarcane in Mozambique and several Central American countries, and ethanol from sugarcane and biodiesel from such oil-rich plants as jatropha, pongamia, and other feedstocks in India.[3] Although assessments of the global economic potential of biofuels have just begun, current biofuels policies could, according to some estimates, lead to a fivefold increase of the share of biofuels in global transport energy consumption—from just over 1 percent today to around 5 to 6 percent by 2020.[4]

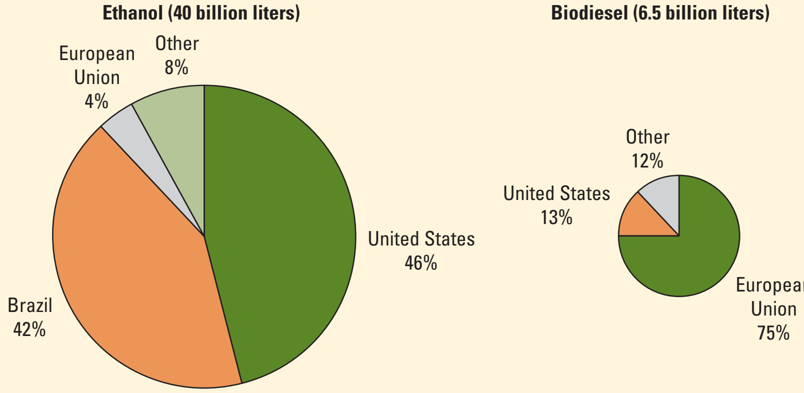
Economic viability of biofuels and the impact on food prices

Governments provide substantial support to biofuels so that they can compete with gasoline and conventional diesel. These supports include consumption incentives (fuel tax reductions), production incentives (tax incentives, loan guarantees, direct subsidy payments), and mandatory consumption requirements. According to recent estimates, more than 200 support measures costing around $5.5–7.3 billion a year in the United States amount to $0.38–0.49 per liter of petroleum equivalent for ethanol and $0.45–0.57 for biodiesel.[5] Even in Brazil, sustained government support through direct subsidies was required until recently to develop a competitive industry, despite uniquely favorable sugarcane-growing conditions, a well-developed infrastructure, and a high level of synergy between sugar and ethanol production. Domestic producers in the European Union and the United States receive additional support through high import tariffs on ethanol.

Are biofuels economically viable without subsidies and protection? The breakeven price for a given biofuel to become economical is a function of several parameters. The most important determining factors are the cost of oil and the cost of the feedstock, which constitutes more than half of today's production costs.

Biofuel production has pushed up feedstock prices. The clearest example is maize, whose price rose by 23 percent in 2006 and by some 60 percent over the past two years, largely because of the U.S. ethanol program.[6] Spurred by subsidies and the Renewable Fuel Standard issued in 2005, the United States has been diverting more maize to ethanol. Because it is the world's largest maize exporter, biofuel expansion in the United States has contributed to a decline in grain stocks to a low level and has put upward pressure on world cereal prices. Largely because of biodiesel production, similar price increases have occurred for vegetable oils (palm, soybean, and rapeseed).[7] Cereal supply is likely to remain constrained in the near term and prices will be subject to upward pressure from further supply shocks.[8] Provided there is not another major surge in energy prices, however, it is likely that feedstock prices will rise less in the long term as farmers respond to

Figure B.1 Fuel ethanol and biodiesel production is highly concentrated



Source: F.O.Licht Consulting Company, personal communication, July 17, 2007.
Note: Percentages of global production of fuel ethanol and biodiesel in 2006.

higher prices (chapter 2), and biofuels production will be moderated by lower profits because of higher feedstock prices.[9]

Rising agricultural crop prices from demand for biofuels have come to the forefront in the debate about the potential conflict between food and fuel. The grain required to fill the tank of a sport utility vehicle with ethanol (240 kilograms of maize for 100 liters of ethanol) could feed one person for a year, so competition between food and fuel is real. Rising cereal prices will have an adverse impact on many food-importing countries. Even in the short term, higher prices of staple crops can cause significant welfare losses for the poor, most of whom are net buyers of staple crops.[10] But many poor producers could benefit from higher prices (chapter 4).

Future biofuels technology may rely on dedicated energy crops and agricultural and timber wastes instead of food crops, potentially reducing the pressure on food crop prices and contributing to the supply of more environmentally friendly supplies of liquid biofuels. But technology to break cellulose into sugars distilled to produce ethanol or gasify biomass is not yet commercially viable—and will not be for several years.[11] And some competition for land and water between dedicated energy crops and food crops will likely remain.

Nonmarket, context-specific benefits need to be evaluated

Whether the financial costs, efficiency losses, and the tradeoffs between food and fuel associated with these various support measures are justified depends on the environmental and social benefits and risks of biofuels and their contribution to energy security.

Potential to enhance energy security: Current-technology biofuels can only marginally enhance energy security in individual countries because domestic harvests of feedstock crops meet a small part of the demand for transport fuels, with few exceptions (for example, ethanol in Brazil). In 2006/07, around one-fifth of the U.S. maize harvest was used for ethanol but displaced only about 3 percent of gasoline consumption.[12] According to recent projections, 30 percent of the U.S. maize harvest would be used for ethanol by 2010, but it would still account for less than 5 percent of U.S. gasoline consumption.[13] Second-generation technologies could potentially make a higher contribution to energy security.

Potential environmental impacts: Global environmental benefits from using renewable fuels—reducing greenhouse gas emissions (GHGs)—are frequently cited as reasons for policy support to biofuels. Although possibly significant, those benefits cannot be assumed. The emissions from growing feedstocks (including emissions from fertilizer production), manufacturing biofuels, and transporting biofuels to consumption centers, as well as those from changes in land use, also have to be evaluated.[14]

Using existing crop land, Brazilian sugarcane is estimated to reduce gasoline emissions by about 90 percent. Biodiesel is also relatively efficient, reducing GHGs by 50 to 60 percent. In contrast, the reduction of GHGs for ethanol from maize in the United States is only in the range of 10 to 30 percent.[15] In such cases, demand-side efficiency measures in the transport sector are likely to be much more cost-effective than biofuels in reducing GHGs. The cost of reducing one ton of carbon dioxide (CO_2) emissions through the production and use of maize-based ethanol could be as high as $500 a ton, or 30 times the cost of one ton of CO_2 offsets in the European Climate Exchange.[16]

According to the 2006 EU Biofuel Strategy, a change in land use, such as cutting forests or draining peat land to produce feedstocks such as oil palm, can cancel the GHG emission savings "for decades."[17] Reducing potential environmental risks from large-scale biofuels production could be possible through certification schemes to measure and communicate the environmental performance of biofuels (for example, a Green Biofuels Index of GHG reductions).[18] Similar standards exist for organic products and for the sustainable production of forest products (Forest Stewardship Council). But the effectiveness of certification schemes at reducing environmental risks from biofuels will require full participation from all major producers and buyers as well as strong monitoring systems.

Benefits to smallholders: Biofuel can benefit smallholder farmers through employment generation and higher rural incomes, but the scope of these impacts is likely to remain limited. Ethanol production with current technologies requires fairly large economies of scale and vertical integration and may do little to help small-scale farmers. In some parts of Brazil, however, producer cooperatives have succeeded in ensuring smallholder participation.[19] Second-generation biofuels using cellulosic technologies are likely to require even larger economies of scale, with investment costs in the hundreds of millions of dollars just to build one plant.

Although most biofuel production is large in scale, small-scale production of biodiesel with current technologies could meet local energy demand (for example, biodiesel use in stationary electricity generators). For wider markets and for biodiesel use for transportation, meeting consistent quality standards in small-scale production is a problem.[20]

Defining public policies for biofuels

To date, production in industrial countries has developed behind high protective tariffs on biofuels and with large subsidies. These policies are costly to those developing countries that are or could become potentially efficient producers in profitable new export markets.[21] Poor consumers may pay higher prices for food staples as grain prices rise in world markets. Food prices may rise directly because of the diversion of grain to biofuels or indirectly because of land conversion away from food when induced by distortionary policies.

Can developing countries, apart from Brazil, benefit from production of biofuels? Favorable economic conditions and large environmental and social benefits that justify significant subsidies are probably uncommon for the first-generation technologies. In some cases, such as landlocked countries that are importers of oil and potentially efficient producers of sugarcane, the high costs of transport could make biofuel production economically viable even with current technologies.[22] The much higher potential benefits of second-generation technologies, including for small-scale biodiesel production, justify substantial privately and publicly financed investments in research.

The challenge for developing country governments is to avoid supporting biofuels through distortionary incentives that might displace alternative activities with higher returns—and to implement regulations and devise certification systems to reduce environmental risks. Governments need to carefully assess economic, environmental, and social benefits and the potential to enhance energy security. Other often more cost-effective ways of delivering environmental and social benefits need to be considered, especially through improvements in fuel efficiency.