

BIOENERGY AND AGRICULTURE: PROMISES AND CHALLENGES

Overview

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In recent years bioenergy (see box for definitions) has drawn attention as a sustainable energy source that may help cope with rising energy prices, address environmental concerns about greenhouse gas emissions, and offer new income and employment to farmers and rural communities around the world. For many countries in the Organisation for Economic Cooperation and Development (OECD), the benefits to farmers are also perceived as a good way to reduce the costs and market distortions of their existing farm support policies, which now total about US\$320 billion a year. Moreover, whereas oil and coal are unevenly distributed among countries, all countries could generate some bioenergy from domestically grown biomass of one type or another, thereby helping to reduce their dependence on imported fossil fuels.

Total global energy consumption is huge—about 400 EJ (exajoules) per year—and is expected to grow 50 percent by 2025. Most of the increase will occur in developing countries, especially China and India. Most of this demand is currently met by fossil fuels, particularly oil. Rapid growth in oil demand, finite oil supplies, and political instability in many of the major oil-exporting countries are pushing up oil prices and making them more volatile. This trend seems destined to continue. As a result, many importing countries are looking to expand and diversify their energy sources and are looking at bioenergy as a potentially attractive prospect within their broader energy portfolios. Already, bioenergy accounts for 10 percent of world energy sup-

plies (see box), and the potential to better exploit many unused crop residues and to grow dedicated energy crops is enormous. Bioenergy's potential will also increase as second-generation technologies come on line, enabling more efficient conversion of cellulose-rich biomass to transport fuels and electricity. Technology advances will not only help make bioenergy more competitive with fossil fuels on price, but will also expand the range of feedstock that can be used, some of which (like fast-growing grasses and trees) can thrive in less fertile and more drought-prone regions that are less competitive with food and feed than current feedstock like sugarcane, maize, and rapeseed.

Many developing countries with tropical climates may have a comparative advantage in growing energy-rich biomass and could become major exporters. Even Africa has the biophysical potential to become an important producer and exporter of bioenergy.

In developing countries, biomass is also the main source of household energy in rural and urban areas. Urban households primarily use wood and charcoal for cooking and heating, and with continuing rapid growth in urban populations, finding sustainable ways of meeting this large and growing demand is also a challenge.

Adding to the interest in bioenergy is growing concern about global climate change and the need to reduce greenhouse gas emissions. As the Kyoto Protocol has shown, many countries now seem willing to take steps to cut their emissions, even if this has associated economic costs. Bioenergy is attractive because it is a renewable

Definitions and Background Information

Bioenergy is energy generated through biofuels. Traction energy provided through human or animal work, important in many countries, is excluded in this context. Biofuels are fuels of biological and renewable origin, such as fuelwood, charcoal, livestock manure, biogas, biohydrogen, bioalcohol, microbial biomass, agricultural waste and by-products, energy crops, and others (see <http://www.fao.org/sd/EGdirect/EGre0055.htm>). The main sources of bioenergy are (1) agricultural residues and wastes, (2) purpose-grown crops, and (3) wild vegetation. In their raw form, these sources are usually called biomass, though the term “energy feedstock” is also used, mostly for purpose-grown energy crops.

Unlike oil, biomass can be produced in just about every country. Bioenergy already accounts for nearly 10 percent of total world energy supplies. It accounts for 33 percent of energy use in developing countries but only 3–4 percent in industrial countries. There are also large differences between developing regions: biomass accounts for more than 60 percent of final energy use in Africa, 34 percent in Asia, and 25 percent in Latin America.

Most biomass in industrial countries is converted into electricity and heat in industrial-scale plants, whereas in developing countries it is mostly burnt by rural households as a source of energy for cooking and heating. Biomass is in fact the main source of household energy use for between 2 and 3 billion people in the developing world. Agriculture's own consumption of energy is relatively small—about 4–8 percent of total energy use in developing countries and 3–5 percent in OECD countries. This share has also declined over time as gains in efficiencies have reduced energy needs.

Liquid biofuels for transport (mostly bioethanol—usually abbreviated to ethanol—and biodiesel) are still relatively minor sources of energy use and are produced in just a few countries. Brazil and the United States are the largest producers of ethanol for transport, accounting for about 90 percent of world production. Both countries currently produce about 16 billion liters per year, and ethanol has displaced 40 percent of gasoline use in Brazil but only 3 percent in the United States. The primary feedstock for ethanol is sugarcane in Brazil and maize in the United States. The European Union, especially France and Germany, is the largest producer of biodiesel, accounting for 88 percent of world production, followed by the United States, which produces 8 percent. Globally, biodiesel production is only about one-tenth of total ethanol production. Rapeseed is the primary feedstock for biodiesel in the European Union. Other than Brazil, few developing countries have sizable biofuels programs at present. The main players are China, Colombia, India, and Thailand, but many others are interested in initiating (or have initiated) small pilot programs.

energy source that has the potential to significantly reduce or at least slow growth in carbon emissions without involving much change in the way energy is used (for instance, it can be used in internal combustion engines and combustion-fueled electric power plants). This is because plant biomass captures carbon from the air, and its subsequent release when generating energy (when burnt in a car engine or power station, for example) simply returns the carbon back to the air to complete the cycle.

Finally, with a chronic global oversupply of most agricultural commodities, diverting some agricultural resources to the production of bioenergy offers an attractive way of helping farmers, especially in rich countries. For example, the diversion of part of the maize crop to ethanol production in the United States helps maintain the maize price, reducing the need for price compensation and export subsidies.

All this seems very promising, but just how realistic are these hopes and expectations? And what are their implications for the poor and the environment? Bioenergy uses resources (land, water, and labor) that compete with food and feed production. This would lead to higher food prices in many poorer countries, but also around the globe if major food-exporting countries like the United States, the European Union, or Brazil were to significantly divert agricultural resources to bioenergy production. Higher food prices would hurt poor people, who are net buyers of food, while benefiting farmers. Yet the poor would gain from cheaper energy. In those countries that grow more biomass, the rural poor might also gain from greater employment and income in the bioenergy sector. For example, small farmers might grow feedstock for bioenergy, and rural workers might be employed in its transportation and processing, especially if the processing can be conducted at small scales and in rural areas. But how would all these pros and cons balance out, and what would be the net impact on the poor?

While international trade could in principle create opportunities for some countries to develop new exports and for importing countries to diversify their energy supplies, trade in biofuels still faces important barriers that are not on the current agenda of the trade negotiations sponsored by the World Trade Organization. Unless changed, these barriers will retard development of the bioenergy sector in countries with a comparative advantage (often developing countries with tropical climates) and encourage the development of protected and more costly bioenergy production in many rich countries. Removing these barriers now, during the early stages of bioenergy development, should be much easier than trying to remove them once powerful national interests have become entrenched.

Although bioenergy is in principle a carbon-neutral source of energy that could do much to reduce carbon emissions, it also

requires fossil fuels for growing, transporting, and processing the feedstock and for refining and distributing of the biofuel. Depending on the type of feedstock, and on where and how it is grown and used, the net carbon balance can vary widely. Net carbon and energy savings are not at all assured. Some current first-generation feedstock and technologies have carbon balances not much better than oil, although some (like ethanol from sugarcane) are much better. Second-generation feedstocks and technologies promise to bring large improvements. For example, many fast-growing trees and grasses are perennials and require little cultivation once established, while sequestering much more carbon than alternative land uses. Part of this carbon will be retained in the soil on a long-term basis. Beyond issues related to carbon balances, bioenergy crops and plantations present their own local environmental challenges for soil, water, and biodiversity management.

In sum, despite the exciting prospects for bioenergy, many important questions remain unresolved about its implications for the poor, the environment, and international trade. Moreover, because most of the environmental and social benefits and costs of bioenergy are not priced in the market, leaving bioenergy development entirely to the private sector and the market will lead to bioenergy production and processes that fail to achieve the best environmental and social outcomes. To ensure better outcomes, the public sector has important roles to play. But what are these roles, and what policies, technologies, and investments are needed to ensure that bioenergy is developed in ways that are economically efficient as well as compatible with reducing poverty and global warming?

This set of briefs attempts to answer these questions, with a special focus on the issues for developing countries. The key issues are discussed in more detail, drawing on past experiences in the European Union, the United States, and Brazil and other developing countries to highlight policy options for the future. The briefs also analyze the potential trade-offs between bioenergy production and food in terms of food prices, explore some of the technology options and research priorities for the future, and discuss ways in which carbon payments schemes might be harnessed to promote bioenergy production. ■

For further reading see “The Energy and Agriculture Nexus,” Environment and Natural Resources Working Paper No. 4 (Rome: Food and Agriculture Organization of the United Nations [FAO], 2000); M. Kojima and T. Johnson, *Potential for Biofuels for Transport in Developing Countries* (Washington, D.C.: World Bank, Energy Sector Management Assistance Program [ESMAP], 2005); and P. P. Bhojvaid, ed., *Biofuels: Towards a Greener and Secure Energy Future* (New Delhi: The Energy and Resources Institute [TERI], 2006).

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