The Emerging Global Biofuel Industry: The Biofuel Situation and Policies in Developing Countries

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This article summarizes a consensus of views emerging from the conference—The Biofuel Situation and Policies in Developing Countries—sponsored by the Giannini Foundation of Agricultural Economics and the Energy Biosciences Institute (EBI), which convened in Berkeley, California, on May 7–8, 2009.

Agriculture in the 21st century faces two huge challenges. The first is the "traditional" challenge of feeding people. The world population is growing and more importantly, as the populations in developing countries get richer, they demand more meat. The feed required for these animals multiplies the demand for grain. The second "new" challenge to agriculture is to satisfy the demand for biofuels. The demand for liquid fuels for vehicles is growing even more rapidly than demand for food, and the size of the fuel market is enormous. The extraction of oil is increasingly difficult and expensive. The uncertainties about oil supply and prices, the growing, stricter constraints on fossil fuel emissions, and the success of Brazil in producing biofuels from sugarcane have created a demand for clean liquid fuels.

In the recent past agriculture has been able to meet the challenge of the increased demand for food, fiber, and beverages. In the early part of the 20th century, that challenge was met through expanding the area under agricultural production. In the latter part of that century, production increased primarily due to increased yield per acre. These yield increases can be attributed to the application of science to develop new fertilizer and water-responsive varieties of crops, new management practices, along with the application of industrial inputs such as farm machinery, irrigation equipment, fertilizers, and chemicals. However, since 2006, the increased production of biofuels was correlated with a rapid increase in food prices, which raised concerns that agricultural supply cannot keep up with these increased demands.

The Potential

The good news is that there is potential to dramatically increase agricultural supply. The productivity of existing animals, such as swine and cattle, and crops, such as rice, wheat, corn, oil palm, and sugarcane, is likely to increase because of new knowledge about the biology of plants, animals, disease, plant pests, and soils. There is evidence of substantial progress in productivity growth of sugarcane in Brazil and oil palm in Malaysia. Also, major investments are being made in genomics, molecular breeding, and tissue culture to ensure that these productivity increases continue.

In addition, studies have identified vast genetic potential for productivity increases in production of biofuels with crops that have not yet been exploited such as miscanthus, jatropha, and algae. Farmers and scientists in China already have considerable experience with miscanthus and have found extensive biodiversity that can be exploited. Likewise, researchers on jatropha in India discovered an enormous amount of genetic variation, and both the public and private sectors are carrying out major efforts to develop the best cultivars and management practices for efficient cultivation of the crop. Recent advances in biotechnology enable improving the productivity of these new crops at a faster rate than was feasible in the past.

The other good news is that there is land available for expanding production of food and biofuels, some of which had been cultivated in the past but abandoned for political or economic reasons. From an environmental perspective, this land is attractive for biofuel (and food) investments because its carbon debt has already been paid. Other lands are being cultivated in very extensive types of agriculture and could be more intensively cultivated with the addition of irrigation, fertilizer, and/or better management. In addition, major areas of Africa, Latin America, the former Soviet Union, and Southeast Asia have not been cultivated for a variety of reasons, including low population densities, wars and political instability, lack of infrastructure, soil problems (aluminum toxicity in the savannas of Brazil and Africa, salinity in some Asia soils), and disease and pest problems. Improved political situations and new methods will allow expansion of farming to some of these uncultivated lands. However, in some areas, it may be necessary to use rangeland or even forests to meet our agricultural needs.

To be economically viable and overcome regulatory constraints, new biofuels need to utilize low-cost feedstock and biomass, relying on economical conversion technology requiring relatively low quantities of energy (below 30% of the energy content of the fuel produced). Companies (Amyris), public/private research partnerships (EBI), and public institutions

(Chinese Academy of Sciences) are currently developing conversion technology using various approaches, and they report promising results.

Necessary Investments and Institutional Changes by the Private Sector

Taking advantage of the opportunities for expansion of food and biofuel production through increasing agricultural productivity, land cultivation, and increasing biofuel conversion will require private firms, governments, and civil society to make a number of difficult decisions.

The demand for more food and biofuels, coupled with new and more productive crops and available lands for agricultural production, presents important opportunities for small and large firms alike to increase their incomes. Recent studies show evidence that sugar mills, sugarcane farmers, and laborers in Brazil have all benefitted from the expansion of biofuels production. Simulation studies of the impacts of increased biofuel production in China and Mozambique predict that small farmers could obtain substantial benefits from biofuel production in those countries. However, the extent of the benefits depends on the type of crops and the structure of landholdings.

The development of new biofuel products requires investments in research and technology development in various components of the supply chain. Private firms need to make major investments in feedstock and biofuel production, biofuel transport and storage facilities, and biofuel distribution capacities. Indeed, BP is making investments in biofuel production in the United States, Brazil, and the UK, partnering with universities and specialized firms. The oil palm industry in Southeast Asia has established an organization for sustainable oil palm production, which will conduct research to develop sustainable practices and will work to certify plantations as sustainable.

The introduction of biofuels is leading to the development of new industrial structures, which integrate different types of industries. These new structures are evolving, in search of efficient ways of linking a range of operations, from farms to filling stations. As part of this restructuring, oil companies are buying into agricultural production firms, and BP is forming a joint venture with Brazilian sugar mill companies to build two ethanol production facilities in Brazil.

A particular challenge is the design of institutions for expanding feedstock production. Should feedstock be produced in plantations, which may be most efficient and most attractive to foreign investors, or should they be produced by contracting with smallholders? Contracting may sacrifice some efficiency, but will be more appealing to consumers and environmentalists in the developed countries and more attractive to politicians in the developing countries who would have to approve these investments. Maybe some sort of hybrid, such as a nucleus estate with smallholders surrounding it, would work best. A Mozambique study suggests that contracting with smallholders has a more direct impact on reducing poverty than a plantation, but that plantations also would benefit small farmers through various types of spillovers.

Important Government Investments and Policies

Governments have the unenviable role of balancing the goals of food security, energy security, social equity, and an improved environment. To meet the food and energy security goals, governments have to make decisions on investments in infrastructure, farm and biofuel subsidies, and research on agricultural productivity and biofuels. For example, weak rural infrastructure such as roads and communication are major constraints to food and biofuel production in Africa. Subsidies can induce major increases in food and biofuel production and farmer incomes, but they do so at the expense of taxpayers and other potential government programs. Investments in biofuel production research are necessary, as are investments in food crop research and programs to train scientists working on both food and biofuels so that new funds for biofuel research from the private sector do not overrun local scientific capacity.

Governments and the societies that they represent will have to deal with a range of contentious issues. Should they provide subsidies and tax breaks to encourage biofuel production? Many people applied for, and were approved to receive, biofuel subsidies and tax breaks in Malaysia, but only a few went into production (and most of these are currently idle due to low oil prices). Should governments implement biofuel mandates? Mandates are now on the books in many countries in Africa, Latin America, and Asia. However, with the exception of China, these policies have not been implemented, and even in China they have had limited impact because the government has permitted only five biofuel production facilities to start operating.

Should governments try to pick winning technologies and support them by handing out subsidies or grants to investors? In earlier fuel crises, the U.S. government supported numerous wind power companies—all of which are out of business now. Recently, U.S. corn ethanol producers such as VeraSun and Northeast Biofuels have filed for bankruptcy after years of government support. Brazil's choice to push a sugarcane-based ethanol industry is a rare example in which the government actually did pick a winner.

Should food crops even be used for biofuel production? The governments of China, India, and South Africa have announced that they will not support the use of food crops for biofuel production. Consumers in these societies generally support these policies, as do

the consumers of biofuels in developing countries. Farmers, however, producing crops such as sugarcane, corn, and oil palm do not support such restrictions, and where they are politically strong, such as in Malaysia and Brazil, no such restrictions exist.

What types of land can be used for biofuels and who can use it? The central governments of China and India say that biofuel production should be restricted to wastelands. However, there is evidence in both countries that provincial governments are considerably less restrictive and welcome the use of forests, pastures, or agricultural land for biofuels. Malaysia has very strict regulations on the use of forests for oil palm plantations. Indonesia has similar regulations, but has a much more difficult job of enforcing these standards. Land-use conversion to biofuel production may cause a significant net increase in greenhouse gas (GHG) emissions. Should governments establish conversion criteria based on these emissions or other measures of societal net benefits?

Who should be allowed to invest in biofuel and food production and under what conditions? Should governments approve investments by oil companies (BP, Shell), foreign sugar companies, sovereign wealth funds, and major foreign concerns (the Daewoo Corporation, China National Cereals, Oils and Foodstuffs Corporation (COFCO))? Or should governments restrict investments to large government oil companies, local private companies, and large local plantations? Will these companies be allowed to buy land, buy local food companies, or become joint venture partners? The recent political turmoil in Madagascar following the decision to lease 3.2 billion acres to Daewoo for agricultural development shows how contentious this issue is.

The economics of biofuels and energy are affected by trade and agricultural policies. For instance, the U.S. import tax on ethanol has enhanced corn ethanol production in the Midwest and reduced imports from Brazil. The Brazilian biofuel sector is likely to thrive under a free trade regime, while protectionist policies in the United States and Europe may reduce overall biofuel production and, in the short run, lead to local expansion of biofuel crops, replacing food crops in these developed countries.

Biofuel policies are forcing countries to deal with a number of key environmental trade-offs. All policies, even the status quo, have environmental impacts. A business-as-usual scenario implies extensive GHG emissions from fossil fuels and from agriculture (particularly animal agriculture). We could stop consuming palm oil, which could save orangutans in Indonesia, but greatly increase soybean production in Brazil and reduce the Brazilian rainforest. Biofuels could lead to a reduction in GHGs by replacing part of the fossil fuels, but now studies have shown that biofuels can contribute to GHG accumulations if they are not produced in an efficient, low-impact manner. Furthermore, biofuels can directly and indirectly lead to the destruction of the rainforests of Borneo and the Amazon, and the biodiversity in those rainforests. So, the choice is not whether or not to have environmental impact, the choice is what environmental impact is society willing to tolerate in order to have food, fuel, and reduced GHGs.

Not all biofuels are alike; some may generate more GHG emissions than they save, so regulation of the environmental side effects of biofuels matters. Researchers compare three policy regimes. One is cap and trade in GHG emission permits that will price fuels and give cleaner fuels an edge. Another is a low-carbon fuel standard (like California's standard aiming to reduce emissions by 10%), which considers both the direct and indirect GHG effects of various fuels and discriminates in favor of sugarcane biofuels versus corn biofuels, and Arabian oil versus oil produced from tar sands. A third policy is developing biofuel standards and setting a mandate of a certain percentage of fuel use dedicated to biofuels. This policy does not discriminate between cleaner and dirtier biofuels or oils, and may, in the long run, increase the GHG emissions per unit of energy as the fraction of oils produced from tar sands and shale increases. The likely choices of environmental regulation influence research, crop management, and conversion technology selection as new biotechnologies are introduced in the United States, Brazil, and Malaysia.

What Does It Mean to California?

Biofuels expand the range of agricultural products, and will lead to integration of the agricultural and energy sectors, as well as the emergence of integrated sets of agricultural, environmental, and energy policies. Renewable fuel and carbon regulation in California are in the forefront of these policies, both in the United States and globally. California agriculture is not likely to be a major producer of biofuel crops, but California forest, and perhaps rangeland, may be utilized to produce biofuel products in the future, once cellulosic conversion technologies are fully established. However, the primary gain to California will stem from its relative advantage in the knowledge sector, which places it in the forefront of development of improved genetic material for biomass production and new conversion technologies for biofuels. Thus, development of biofuels and expansion of their use, as part of a strategy to reduce dependence on fossil fuels, are likely to be important elements of an emerging renewable energy sector in the state.

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