

## A Clear Look at Biofuels

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Booz & Company

05/06/2008

# A Clear Look at Biofuels

Myths abound regarding the pros and cons of biofuels. Here is a scorecard to separate truth from fiction.

by Bill Jackson, Eric Spiegel, and Leslie Moeller

In the flood of media attention that biofuels have received, it is difficult to distinguish the facts from the fanfare. Generally made from corn, sugarcane, soy, and other crops, biofuels for powering automobile engines have been hailed as a panacea that will arrest global climate change, reduce dependence on fossil fuels, ensure energy security, and turbocharge agricultural economies. Yet biofuels have also been denounced by critics who claim they will do more harm than good to the environment and they are not economically sustainable absent government protection. To determine who is right, we spoke to dozens of experts in government, corporate, academic, and nonprofit organizations — people such as Prabhu Pingali, director of the agricultural and development economics division of the Food and Agricultural Organization (FAO) of the United Nations; Miguel Pestana, vice president of global external affairs for Unilever PLC; venture capitalist Vinod Khosla, founder of Khosla Ventures; and Greg Stephanopoulos, Bayer Professor of Chemical Engineering at MIT — and reviewed studies on the growth and viability of the biofuels market. Based on this research, we explored the truth of prevalent assumptions regarding both biofuel's promise and its impact on markets and the environment.

**Perception:** Substituting biofuels for petroleum will

substantially reduce greenhouse gas (GHG) emissions.

**Reality:** At least in the short term, biofuels offer minimal GHG benefits.

At first glance, biofuels appear to leave a much smaller carbon footprint than oil because energy crops (like all crops) extract carbon from the atmosphere. Indeed, studies such as the International Energy Agency's 2004 "Biofuels for Transport" report indicate that "well-to-wheel" GHG savings from biofuels range from 20 percent with corn ethanol to 80 percent or higher with sugarcane ethanol or cellulosic ethanol (produced from grass, plant residues, and woody crops). Corn ethanol generates more GHG emissions than cellulosic ethanol because the corn must be cultivated and distilled, processes that require extensive use of fertilizer, diesel, coal, and natural gas.

However, the well-to-wheel savings fail to take into account the impact of farming land that was, or would otherwise revert to, grassland or forest. Clearing land to convert forest or grassland into energy crops results in a substantial deposit of carbon dioxide into the atmosphere. The magnitude of that deposit depends on the type of property. For example, clear-cutting and burning a forest releases more carbon dioxide than harvesting grass. And two studies recently published in *Science*

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found that when this initial carbon dioxide deposit is taken into account, depending on the type of land used for agriculture and the type of crop grown, ethanol's contribution to GHG emissions could break even with that of petroleum in anywhere from a couple of decades to a few centuries.

That said, some emerging biofuel technologies, such as cellulosic and algaeic, require less-active cultivation of land. Consequently, peering further into the future, the environmental hope for biofuels is not a complete chimera.

**Perception:** Biofuels are not economically viable as a substitute for petroleum.

**Reality:** Biofuels offer a competitive alternative to petroleum.

Although break-even costs for different biofuel technologies vary significantly, in Brazil sugarcane ethanol is already commercially viable. Introduced there in the 1970s, cane ethanol was nurtured as an infant industry and backed by public subsidies for many years. Brazil's government financed new ethanol plants, directed the state-owned oil company Petrobras to install ethanol tanks and pumps throughout the country, and mandated that carmakers design and manufacture vehicles that could run on pure ethanol.

About a decade ago, Brazil phased out the subsidies, but with a thriving, efficient cane ethanol industry in place, car manufacturers had to find an inexpensive way to make vehicles that could burn both ethanol and gasoline. Today, 85 percent of autos sold in Brazil feature flex-fuel power trains, and cane ethanol supplies a significant portion of the automotive fuel pool based on its

economic merit. Thanks to the large number of flex-fuel vehicles, consumers can opt for whichever fuel is cheaper, which ultimately varies based on the relative prices of crude oil and sugar.

Globally, corn ethanol is still much more expensive than petroleum and will be until oil prices rise another 20 percent or so. Cellulosic ethanol, although still in the early stage of development, will likely break even with petroleum when the former is around US\$55 per barrel without government incentives — about half the price of oil now and a little below the International Energy Agency's 2007 forecasted oil price of \$62 a barrel in 2030.

Perhaps the biggest endorsement of biofuels as an economically viable alternative to petroleum has come from the Organization of the Petroleum Exporting Countries (OPEC) itself. Abdalla El-Badri, secretary-general of OPEC, noted in June 2007 that the consortium was considering cutting its investment in new oil production in response to moves by the developed world to create and use more biofuels. "If we are unable to see a security of demand... we may revisit investment in the long term," El-Badri said.

**Perception:** Global energy markets are so vast that biofuels cannot hope to alter the balance of petroleum supply and demand.

**Reality:** If agricultural supply expands at historical rates, biofuels can make a significant contribution to the transportation fuel pool, resulting in an oversupply of petroleum.

It's important to note that although biofuels are the best and most cost-efficient hope for an alternative to petroleum, biofuel production still represents less than 1 per-

cent of total global fuel demand. However, if agricultural improvements continue apace, biofuels can eventually equal or surpass current OPEC exports without jeopardizing the world's food supply.

With rare exceptions, for the last half century, advances in plant breeding, soil study and fertilizer use, water management, weed and pest control, and infrastructure development have increased crop yields and agricultural productivity. Farming also produces more food using less labor, capital, chemicals, and land.

New techniques, such as more sophisticated genetic approaches to breeding, may well accelerate the rate of improvement in agricultural productivity. By 2030, we anticipate that crop yields will increase by some 55 percent and that food crop prices will have fallen to roughly half of 2005 levels. At that time, if the International Energy Agency's crude oil price predictions are accurate, we expect biofuel production would cost-effectively offset between 40 and 50 million barrels of oil per day, or about 40 percent of the total global need. If agricultural supply increases at half that rate, biofuel volumes would drop to roughly half that level. This supposes, of course, that the agricultural supply base develops as we've assumed and the biofuel infrastructure continues to expand.

**Perception:** Biofuel crops will crowd out food crops, driving food prices up and food consumption down in the developing world.

**Reality:** If crop yields and agricultural productivity improve at historical rates, future food prices need not be higher than they are today.

Some in the media have blamed biofuels for the recent run-up in food prices — for corn in the U.S., tortillas in Mexico, pasta in Italy. Although biofuels are a contributor, current volumes are too small to account for these recent regional commodity price spikes. Other factors such as droughts and inventory levels have had a significant impact.

Despite this evidence, critics maintain that over time biofuel production will almost certainly outpace that of food crops, resulting in greater malnutrition, particularly in poorer parts of the world. These arguments are persuasive, but the developing world's food woes cannot be laid entirely at biofuels' door. Farmers in these markets are already at a disadvantage when it comes to accessing the latest agricultural practices and information on yield improvements. In addition, gov-

ernment policies, lack of infrastructure, political instability, and cheaper imports from the U.S. and Europe further depress crop yields in these areas, causing global consumers to lose up to 30 percent of their potential agricultural production today.

Replacing the appetite for petroleum with a taste for biofuels would no doubt result in the consumption of substantial agricultural resources. However, there is significant additional rain-fed land in the world available for agricultural production, according to the FAO and other global authorities.

In short, food prices in a world with biofuels will be higher than in a world without biofuels, but they will not necessarily be higher than they are today.

**Perception:** Biofuel development robs water-stressed countries of their most precious natural resource.

**Reality:** Although biofuel development does place additional strain on water resources, there are major agricultural zones in the world that suffer water scarcity regardless.

The vast majority of the globe's agricultural regions can rely on the natural rain cycle for water. Two rather urgent exceptions are India and northern China. In these countries, not only is water quantity a problem, but so is water quality. China and India's brisk economic growth will only exacerbate this crisis, as their growth is fed by ever-increasing amounts of food and fuel. Petroleum supply cannot keep up with demand even now; both countries are already dependent on imported oil. Meanwhile, water availability limits their domestic production of food. Imports will increasingly be a requirement, forcing a choice between food and fuel security.

Agriculture consumes more water, by far, than any other sector. Biofuel production requires water, but growing feedstock consumes much more. In other words, it is agricultural activity — not biofuel development per se — that diminishes the quantity and quality of available water in India and northern China. The solution to the water crisis in these regions will be found in sound policy and the development of a reliable and diversified portfolio of import sources for both food and fuel.

**Perception:** Government mandates and subsidies provide the necessary foundation for the development of the biofuel industry.

**Reality:** Government intervention can trigger unintended consequences, negating the intended benefits of biofuels.

Governments around the world have offered favorable tax treatment, low-cost loans and research funds for the development of biofuels, and a biofuels infrastructure chiefly to promote energy security, reduce GHG emissions, and protect domestic agriculture. Over time, however, greater government emphasis on biofuels puts upward pressure on food commodity prices, and tariffs and quotas have shut out economically viable options in favor of local alternatives. For example, protectionist policies in the U.S. have effectively eliminated imports of Brazilian cane ethanol.

In certain instances, regulatory support of biofuels has had obvious deleterious effects. European mandates supporting biofuel production prompted certain Southeast Asian countries to burn forests and peat lands to produce palm oil for ethanol. The resulting GHG emissions were dangerously high.

Policies can furnish the necessary impetus to develop valuable new technologies and establish new infrastructure; the Brazilian government's promotion of cane ethanol is the perfect example. However, policymakers must walk a fine line in promoting long-term beneficial behaviors to avoid short-term detrimental consequences. They need to pave the way to an orderly transition by introducing incentives that are broad enough to encompass long-term optimal technologies and specific enough to focus on those with the most potential.

After separating truth from fiction, our conclusion is that with sound policies in place and healthy innovation, we can expect biofuels to become a viable alternative to fossil fuels in the long term. And as we look toward the world's biofueled future, government leaders and economists should be mindful of the consequences and implications of various policy solutions:

- Current agricultural rules in Organisation for Economic Co-operation and Development (OECD) countries, including farmer subsidies and restrictions on imports, lower world food prices and reduce the incentive for developing countries to develop their own agricultural supply.
- Biofuel subsidies, tax exemptions, and blending mandates exacerbate biofuels' upward pressure on food prices.
- Infant-industry support may provide the required incentive to establish the infrastructure necessary for biofuels, such as flex-fuel power trains, fueling stations, and transportation infrastructure.
- Political stability, land rights, and infrastructure are

necessary prerequisites to developing functioning agricultural markets in developing countries.

- Availability of capital and know-how is essential for developing countries to establish a biofuels industry.
- Reliable and diversified import sources can address food and fuel security issues in water-stressed countries.

With careful attention to these issues, business and government leaders around the world can develop a sustainable approach to biofuels that makes the most of biofuel's economic and environmental advantages.+

## Resources

Fengxia Dong, "Food Security and Biofuels Development: The Case of China", Iowa State University Center for Agricultural and Rural Development, Briefing Paper No. 07-BP 52, October 2007: The background, history, and current state of biofuels development in China, and implications for other developing countries. (PDF) [www.card.iastate.edu/publications/DBS/PDFFiles/07bp52.pdf](http://www.card.iastate.edu/publications/DBS/PDFFiles/07bp52.pdf)

Richard Doornbosch and Ronald Steenblik, "Biofuels: Is the Cure Worse than the Disease?" Organisation for Economic Co-operation and Development Roundtable on Sustainable Development, September 2007: A report on the facts and myths surrounding biofuels. (PDF) <http://media.ft.com/cms/fb8b5078-5fdb-11dc-b0fe-0000779fd2ac.pdf>

"Biofuels for Transport: An International Perspective", International Energy Agency, April 2004: The costs and benefits of biofuels as a replacement for petroleum around the world. (PDF) [www.iea.org/textbase/nppdf/free/2004/biofuels2004.pdf](http://www.iea.org/textbase/nppdf/free/2004/biofuels2004.pdf)

"Potential Contribution of Bioenergy to the World's Future Energy Demand", International Energy Agency Bioenergy, 2007: A summary of biomass resources and associated issues of market development, international bioenergy trade, and how these resources stack up against other energy options. (PDF) [www.idahoforests.org/img/pdf/PotentialContribution.pdf](http://www.idahoforests.org/img/pdf/PotentialContribution.pdf)

World Resources Institute's EarthTrends Web site: A collection of facts, articles, and documents relating to environmental trends and concomitant social and economic issues. <http://earthtrends.wri.org/>

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is published by Booz & Company Inc..  
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or call 1-877-829-9108.

Originally published as "A Clear Look at Biofuels," by  
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