Learning from the Brazilian biofuel experience

In the article ‘The ethanol program in Brazil’ [1] José Goldemberg summarizes the key features of Brazil’s sugarcane ethanol program—the most successful biofuel program in the world so far. In fact, as of 2005, Brazil was the world’s largest producer of fuel ethanol. In addition to providing 40% of its gasoline market with ethanol, Brazil exports a significant amount of ethanol to Europe, Japan, and the United States. The success of the program is attributed to a variety of factors, including supportive governmental policies and favorable natural conditions (such as a tropical climate with abundant rainfall and high temperatures).

As the article points out, in the early stages of the Brazilian ethanol program, the Brazilian government provided loans to sugarcane growers and ethanol producers (in most cases, they are the same people) to encourage sugarcane and ethanol production. Thereafter, ethanol prices were regulated to ensure that producers can economically sustain production and consumers can benefit from using ethanol. Over time, Brazil was able to achieve a price for ethanol that is lower than that for gasoline, on the basis of energy content. This lower cost is largely driving the widespread use of ethanol instead of gasoline by consumers in Brazil. In the United States, if owners of E85 flexible-fuel vehicles (FFVs) are expected to use E85 instead of gasoline in their FFVs, E85 will have to be priced competitively against gasoline on an energy-content basis.

Compared with corn-based or sugar beet-based ethanol, Brazil’s sugarcane-based ethanol yields considerably more favorable results in terms of energy balance and reductions in greenhouse gas emissions. These results are primarily due to (i) the dramatic increase of sugarcane yield in Brazil in the past 25 years and (ii) the use of bagasse instead of fossil fuels in ethanol plants to provide the heat needed for ethanol plant operations and to generate electricity for...
export to electric grids. Advancements in technology associated with both sugarcane farming and ethanol production have definitely played an important role in yielding the significant benefits associated with sugarcane ethanol.

The United States produced about 4 billion gallons of ethanol from corn in 2005. Production was expected to increase to about 5 billion gallons by 2006. Corn-based ethanol achieves moderate reductions in greenhouse gas emissions. In the long run, the great potential of fuel ethanol lies in its production from cellulosic biomass, which is abundant in many regions of the world and can yield much greater reductions in greenhouse gas emissions and energy benefits.

Figure 1 presents reductions in greenhouse emissions of several ethanol production pathways that were evaluated at the Argonne National Laboratory. Bagasse, a cellulosic biomass type already available in sugarcane ethanol plants, will certainly offer an opportunity for economically co-producing cellulosic ethanol and sugarcane ethanol in existing sugarcane ethanol plants.

Despite the encouraging progress of Brazil’s ethanol program some issues will still need to be addressed. Figure 4 of [1] shows a significant drop in ethanol production in the 2000/2001 season. A steady supply of ethanol will be a key factor for the success of a fuel ethanol program. Consumers are not going to tolerate fluctuations in ethanol production. Instead, they will turn to conventional fuels for fueling their FFVs as a result of supply fluctuations, which can be detrimental to the success of the ethanol program.

In addition to this, other environmental effects of biofuels in general, and sugarcane ethanol in particular, need to be assessed. Some have debated and speculated that Brazil’s sugarcane ethanol program has caused (i) soil erosion and biodiversity problems by converting rainforests into sugarcane plantations and (ii) local air pollution problems as a result of burning in plantations before harvest. Also, as interest in biofuels heightens worldwide, environment-conscious practices are needed to avoid adverse environmental effects of biofuel production and use. For instance, if feedstock production (sugarcane in Brazil, corn in the United States, and palm oil in Malaysia [for biodiesel production]) moves into virgin or marginal land, carbon in both soil and vegetation could be decreased and diminish the benefits associated with biofuels, and cause other environmental problems, such as soil erosion. Societies need to pay close attention to these potential detrimental environmental effects to ensure that biofuel production will, indeed, be on a sustainable path.

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References

[1] Goldemberg J 2006 The ethanol program in Brazil Environ. Res Lett. 1 014007 (doi:10.1088/1748-9326/1/1/014008)