AN INTRODUCTORY GUIDE FOR ASSESSING THE POTENTIAL OF

# BIOFUELS IN DEVELOPING COUNTRIES

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# EXECUTIVE SUMMARY

The world-wide development of biofuels today is a challenging and complex endeavor that gives rise to a number of questions that originate from the multitude of stakeholders and complex trade-offs that the production, distribution, and utilization of biofuels involves. The current interest in biofuels development stems from a major global reevaluation of traditional energy sources. There is tremendous enthusiasm and potential surrounding the biofuels sector. However, it is essential to understand that biofuels are not a panacea, but an important choice among a myriad of other energy options. Given the many misconceptions surrounding the issue, this guide hopes to clarify some of the most frequently raised questions and provide a basis for policy makers, from which a more thorough and careful study can be conducted. It focuses on ethanol, the most commonly used biofuel to substitute for gasoline, and biodiesel, a substitute for diesel.

One of the major concerns that have been voiced about biofuels production is the implication for food prices. Biofuels production demands significant amounts of land and water, which is being reflected through the prices of the two leading agricultural feedstocks for ethanol: maize and sugar. Goldman Sachs projects that the world demand for corn will rise by 1.9% per year over the next decade.[1] To produce even the current amount of corn required in the United States, for example, farmers are growing less soya and wheat, which pushes up the prices of those crops too. As the grains to feed poultry and livestock become more costly, so do meat, eggs, and dairy. If this leads to a rise in commodity prices, as seen in the case for maize, sugar, rapeseed oil, palm oil, and soybean in 2006 and early 2007, food access could simultaneously be compromised for those already struggling to feed their families.

[1] "Biofuelled." The Economist. 21 June, 2003.

How biofuels will affect energy security also remains one of the top considerations considering the global reliance on fossil fuels. Those countries that are net importers of crude oil, gasoline, or diesel fuel may be able to further their energy security goals by substituting domestically produced biofuels instead. In their current state of production and consumption, however, biofuels cannot be considered a replacement for fossil fuels. Truly enhancing energy security will require promoting biofuel use at a level that may not realistically be met without imposing significant strains on the environment. In fact, even if the entire corn crop in the US were used to make ethanol, that fuel would only replace 12% of current domestic gasoline use.[2]

While biofuels may not be feasible replacements for fossil fuels, their production and consumption is still highly influenced by their prices. The International Energy Agency projected that biofuels would be competitive with petroleum at prices between US$60 and US$100 a barrel.[3] Recent research has indicated that biofuels production has not had any measurable impact on the price of crude oil. Instead, the price of biofuels has risen to that of petrol, and the prices of corn and crude oil have converged.[4] If oil prices remain high, a very likely possibility, the people most vulnerable to the price hikes prompted by the biofuel boom will be those in countries that have chronic food shortages and import petroleum, a situation many developing countries face.

The potential for greenhouse gas (GHG) emissions reductions through the use of biofuels is one that intensifies the excitement surrounding biofuels. A number of studies have found that even when all fossil fuel inputs throughout the production and processing of feedstocks are accounted

[2] Runge, C. Ford and Benjamin Senauer. "How Biofuels Could Starve the Poor." Foreign Affairs. May/June 2007.

[3] Braun and Pachauri 2

[4] "Biofuelled"

for, the use of biofuels results in some reductions in GHG emissions compared to petroleum fuels. However, this result holds only if there is no clearing of forestland or virgin cerrado, or draining of peat lands in order to grow these biofuel feedstocks. Potential emissions reductions vary significantly by feedstock. A study by the Argonne National Laboratory found that the production of 1 BTU of ethanol from corn requires 0.74 BTUs of fossil fuel, including cultivation, harvesting, and processing, yielding an energy balance of +1.35. The production of 1 BTU of ethanol from sugarcane, however, yields an energy balance of +8.3 because only 0.12 BTUs of fossil fuel are required in this process.[5] As other studies have also concluded, ethanol produced from sugarcane and cellulosic materials demonstrates the greatest potential for GHG emissions reductions.[6] In terms of biodiesel, an analysis by the US EPA reported that the use of a diesel mixture containing 20% biodiesel reduced particulate, hydrocarbon, and CO emissions by 10, 21, and 11 percent respectively, but increased the emissions of nitrogen oxides by 2%.[7] While biodiesel offers similar fuel economy to that of regular diesel, E85 contains nearly 28% less energy per liter than gasoline. In the US, blends of up to 10% ethanol may be used without modification to car engines, while 100% biodiesel may be used with minor modifications. Higher concentrations of ethanol require purpose-built vehicles, such as the flex-fuel cars manufactured in Brazil.

In order to make a larger impact on reducing carbon emissions, a greater effort is needed to promote wider consumption. This increased demand may in fact promote environmental degradation through the clearing of forests for increased cultivation and cattle grazing, aggravating soil erosion and the depletion of soil nutrients by crops such as corn. The large scale mono cropping associated with biofuels production also leads to biodiversity loss directly through cleared forests and indirectly as pesticides and other toxins kill invertebrates in the soil,

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[5] A Blueprint 43

[6] A Blueprint 40

[7] Kojima and Johnson 3

interrupting the food chain. Even varied and more sustainable crops grown for energy could negatively impact the environment if they replace wild forests or grasslands. Eutrophication of water bodies, acidification of soils and surface areas, and ozone depletion (all related to nitrogen releases from agriculture) are other potential impacts. Shrinking grasslands could lead to the loss of pastoral lifestyles as well. Thus, unless new policies to protect threatened lands, secure socially acceptable land use, and steer biofuel development in a sustainable direction are swiftly enacted, biofuels run the risk of further aggravating environmental problems.

How and when the government should involve itself in the production and distribution process is one of the most contentious questions in the biofuels debate. Today, the production of biofuels is heavily depended upon government support in various forms, from policies supporting decentralized production or local use to those encouraging the organization of cooperatives. It took the Brazilian government thirty years of continuous support, along with private investment, to steadily improve production efficiency and make ethanol affordable. The use of tax and investment incentives, regulation, and direct public investments from the government can help achieve a critical market size to make such a production economically feasible. Also necessary is an enabling environment complete with biofuel trade and regulatory systems which are in their infancy in many countries. Although government support may be needed to promote a full-scale establishment of this nascent industry, experience has shown that once it has been granted, forms of government promotion are difficult to withdraw.

Brazil's experience offers some valuable policy lessons. Among the most efficacious policies were Brazil's requirement that the auto industry produce cars using blended biofuels, subsidies for biofuels during initial market development, the opening of the electricity market to renewable energy-based independent power producers in competition with traditional utilities, support for private ownership of sugar mills, helping to guarantee efficient operations, and stimulation of rural activities based on biomass energy to increase rural employment. Today Brazil is the only country that has been able to withdraw federal subsidies and allow a self sufficient ethanol market to flourish.

The current structure of agricultural markets in many countries results in the bulk of profits flowing to a very small portion of the population. As with many industrial activities, the existence of economies of scale leads to a favoring of large producers. The transition to liquid biofuels production can be especially harmful to farmers who do not own their own land, and to the rural and urban poor who are net buyers of food as a result of greater pressure on already limited financial resources. Helping farmers add value to their products and increasing their income is the best-case scenario, but at their worst biofuel programs could drive the world's poorest farmers off their land and into deeper poverty.

Ultimately, large scale biofuel programs for transport are not very likely to help the poorest rural families; those in remote places with low density, widely distributed populations. Unfortunately, much of the developing world's agriculture is located in such regions. Small scale, decentralized biofuel programs for non transport purposes may offer a more promising alternative.[8]

The guide considers these and other questions in depth to allow the reader an insight into the complex world of biofuels in developing countries. It also provides descriptions of biofuels-related activities that USAID has supported. For more information, please refer to the Further Reading section and contact the USAID Energy Team.

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[8] Kojima and Johnson 100

# INTRODUCTION

The world-wide development of biofuels today is a challenging and complex endeavor, and when considered in the context of a developing country, gives rise to a number of further questions that originate from the multitude of stakeholders and complex trade-offs that the production, distribution, and utilization of biofuels involves. So dependent are these issues on local climatic, economic, social, and agronomic circumstances that sweeping generalizations about specific approaches to biofuels development are hardly valid. However, recent history has demonstrated that some key patterns do exist in areas of biofuels production, and these patterns deserve attention and study before any extensive attempt to promote production elsewhere begins.

The current interest in biofuels development originates from a major global reevaluation of traditional energy sources. Sky rocketing oil prices and increasingly dire warnings about climate change have transformed the previously marginal clean energy industry into a booming business, in which biofuels are an important element. A growing number of governments around the world are offering large subsidies to spur production of or require the blending of fossil fuels with ethanol and biodiesel, the two primary biofuels consumed in the transport sector.[9]

Ethanol is an alcohol-based, clean-burning, high-octane fuel produced from renewable feedstocks. It is produced from starch, which can be derived from a variety of feedstocks including sugarcane, corn, wheat and other grains, sugar beets, potatoes, and switch grass. It is the most commonly used biofuel to substitute for gasoline. Biodiesel is a clean-burning, high octane renewable fuel

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[9] A Blueprint for Green Energy in the Americas. Prepared for the Inter-American Development Bank by Garten Rothkopf. 1

derived from long chain fatty acids found in plant oils and animal fats. Potential feedstocks include rapeseed, canola, jatropha, and palm oil. Biodiesel is used to substitute for diesel.

There is tremendous enthusiasm and potential surrounding the biofuels sector. However, it is essential to understand that biofuels are not a panacea, but an important choice among a myriad of other energy options. The opportunity to use biofuels to reduce greenhouse gas emissions from transportation (20% of global gas emissions in 2001[10] ) and stimulate local economies, establish centers of innovation and production, and attract private sector investment is enticing, but must be considered against the many environmental and economic problems that have also been associated with their production and distribution. There is no one universal strategy, and the decision to develop biofuels will require careful evaluation of government and public priorities and capabilities.

Because of its complexity, the biofuels market is often surrounded by hype or by myth. In many instances biofuels are prematurely deemed either a perfect solution or a false promise, neither of which is an accurate assessment. Given that developing countries will require a larger share of world energy resources to meet the demand of growing populations, biofuels represent a clean alternative with many possible benefits. They will not, however, rid the world of fossil fuels anytime soon. Given the misconceptions surrounding the issue, this guide hopes to clarify some of the most frequently raised questions and provide a basis for policy makers, from which a more thorough and careful study can be conducted. Any decision will require the input and expertise of policy makers, economists, scientists, entrepreneurs, and the local farmers and populations which will affect and be affected by any change in policy or community activities.

[10] A Blueprint 4

# Q: What are the implications of biofuels development for food prices and security?

The effects of biofuels on food prices and food security are not only hypothetical, but have been increasingly observed across countries with established biofuel programs, such as the United States. Liquid biofuel production growth is occurring at a time when demand for both food and forest products is also rising rapidly. Filling the 25-gallon tank of an SUV with pure ethanol requires over 450 pounds of corn, enough to meet the caloric requirement to feed one person for one year![11] These considerable demands on the world's land and water resources are beginning to reveal themselves through the prices of the world's two leading agricultural feedstock: maize and sugar.

According to calculations done by Goldman Sachs, demand for grain grew by 1.2% a year during the 1990s when oil was cheap. In recent years it has increased by 1.4%, and Goldman projects it will rise by 1.9% annually over the next decade.[12] To produce even the current amount of corn required in the United States, for example, farmers are growing less soya and wheat, which pushes up the prices of those crops too. As the grains to feed poultry and livestock become more costly, so do meat, eggs, and dairy. To cope with today's boom, farmers will need to increase their yields much faster or bring more land into production, both of which require significant inputs of time, energy, research, and negotiation.

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[11] Runge, C. Ford and Benjamin Senauer. "How Biofuels Could Starve the Poor." Foreign Affairs. May/June 2007.

[12] "Biofuelled." The Economist. 21 June, 2003.

The basis for the rise in prices comes from the competition for land between crops grown for bioenergy and those grown for food. Thus, the availability of adequate food supplies could be threatened to the extent that land, water, and other resources are diverted from food to biofuel production. If this leads to a rise in commodity prices, as seen in the case for maize, sugar, rapeseed oil, palm oil, and soybean in 2006 and early 2007, food access could simultaneously be compromised for those already struggling to feed their families. Studies done by the World Bank and elsewhere indicate that caloric consumption declines in the world's poorest regions by about half of one percent whenever the average price of all major food staples increase by one percent.[13] Cereal and subsistence crop growing may also be shifted to marginalized lands, decreasing yields. Another potential strain is the rise in meat and dairy demand that occurs as countries develop and incomes rise.

To some extent, food security risks mirror the opportunities associated with biofuels. Agricultural commodity prices have long been influenced by energy prices through fertilizers, machinery, and the like. Rising commodity prices benefit producers but hurt low income consumers. Expanding agricultural commodity use for biofuel production will serve to strengthen this price relation and could increase food price volatility, with negative consequences for food security.[14] Also, if traditionally grain exporting countries begin to use their surpluses to produce biofuels instead, importing countries in need may experience more severe food shortages.

Of course, if increased production of biofuels can raise the incomes of small farmers and rural laborers in developing countries, it may in fact improve food security. In addition, with further research it may be feasible to grow energy crops on marginal lands and food crops on more favorable lands, although marginal land yields are still under debate. Farmers can also rotate

[13] Runge and Senauer

[14] Sustainable Bioenergy 32

food and energy crops, yet again farmers' willingness to grow one or the other is highly dependent on relative prices fetched on the market. Thus, under the current situation, food production and biofuel production remain substitutes. In the future, a well designed modern biofuel system may abet local food production. For example, if leguminous nitrogen fixing crops for biofuels are rotated with cereals, the overall productivity of the system could be enhanced. These results depend on the advance of second generation biofuel technologies. Since both agricultural and energy markets are highly distorted through taxes, tariffs, and subsidies, however, it is hard to predict the net effects of reforms or advances in either sector.

# Q: How can biofuels affect oil prices and energy security?

Those countries that are net importers of crude oil, gasoline, or diesel fuel may be able to further their energy security goals by substituting domestically produced biofuels instead. Especially for countries that meet over half their energy requirement through oil imports from potentially unstable regions of the world, the argument for supply diversification remains a strong one. The extent of energy diversification, however, is limited by the demand for renewable transport fuels and the infrastructure in place to ensure supplies to meet this demand. This potential must be considered in the context of the numerous warnings that biofuels, in their current state of production and consumption, cannot be considered a replacement for fossil fuels. Truly enhancing energy security will require promoting biofuel use at a level that may not realistically be met without imposing significant strains on the environment. In fact, even if the entire corn crop in the US were used to make ethanol, that fuel would only replace 12% of current domestic gasoline use.[15] Biofuels may, however, enhance supply reliability for rural regions if they produce at affordable prices for local consumption purposes.

While biofuels may not be feasible replacements for fossil fuels, their production and consumption is still highly influenced by their prices. Sustained higher oil prices create a favorable market for biofuels and make it possible for the industry to survive without sustained government support. The International Energy Agency projected that biofuels would be competitive with petroleum at prices between US$60 and US$100 a barrel.[16] Theoretically, greater

[15] Runge and Senauer

[16] Braun and Pachauri 2

biofuels use could help bring the oil market into balance and significantly reduce prices. Reality, however, reveals that biofuel consumption remains a tiny proportion of world energy consumption compared to the world oil market. Recent research has indicated that biofuels production has not had any measurable impact on the price of crude oil. Instead, the price of biofuels has risen to that of petrol, and the prices of corn and crude oil have converged.[17] If oil prices remain high, a very likely possibility, the people most vulnerable to the price hikes prompted by the biofuel boom will be those in countries that have chronic food shortages and import petroleum. This risk is applicable to a large portion of the developing world: according to the UN Food and Agriculture Organization, in 2005 most of the 82 low income countries with food deficits were also net petroleum importers. [18]

The extent and benefits of energy diversification, however, can be significantly enhanced if biofuel trade is liberalized. Such trade is currently limited because of the protection of domestic producers and unwillingness on the part of home governments to subsidize imported biofuels. The United States currently offers a federal tax refund of 51-cents-per-gallon of domestically produced ethanol blended with gasoline, but has placed an ad valorem tariff of 2.5 percent as well as an import duty of 54-cents-per-gallon on imported ethanol. Liberalization of the biofuel trade would allow the most efficient producers to expand operations beyond their borders. It would also promote increased efficiency and contribute to lower prices, allowing a greater source diversification worldwide. The cost of ethanol per gallon of fuel from sugarcane in Brazil, at $0.83 per gallon of fuel, is lower than the cost from corn in the United States, at $1.09 per gallon.[19] If

[17] "Biofuelled"

[18] Runge and Senauer

[19] Von Lampe, Martin. Agricultural Market Impacts of Future Growth in the Production of Biofuels. Organisation for Economic Co-operation and Development: Committee for Agriculture. 1 February 2006.

costs are as low as they are in Brazil, biofuels may account for a sizable fraction of total transportation fuels.

# Q: What is the potential for biofuels to reduce greenhouse gas (GHG) and other emissions?

The biofuels field is experiencing an unprecedented wave of research and development, both in the private and public sectors, in part because of the widely accepted notion that biofuels are a "clean" and "green" source of energy, that they are renewable and carbon neutral. The momentum also stems from the necessity to engage the transport sector in any affective response to growing energy demand and intensifying environmental problems. Not only does the transport sector register the fastest greenhouse gas (GHG) emission growth in developed countries, but rapid economic growth in countries like India and China will increase energy consumption for transportation by 55% by 2030.[20] The introduction of cleaner non fossil fuels to this sector has become a priority.

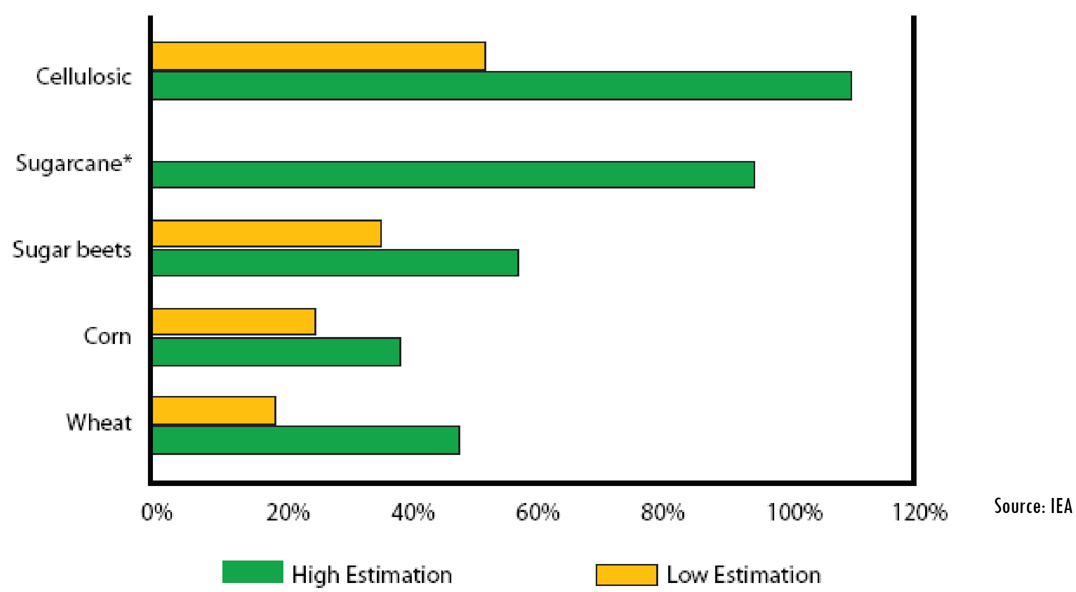
A number of studies have found that even when all fossil fuel inputs throughout the production and processing of feedstocks are accounted for, the use of biofuels results in some reductions in GHG emissions compared to petroleum fuels. However, this result holds only if there is no clearing of forestland or virgin cerrado, or draining of peat lands in order to grow these biofuel feedstocks.  In fact, an article in Science magazine concluded that if the prime objective of biofuels development is the mitigation of carbon dioxide—driven global warming, policy-makers may be better advised in the short term (30 years or so) to focus on increasing the efficiency of fossil fuel use, to conserve the existing forests and savannahs, and to restore natural forest and grassland habitats on cropland that is not needed for food. The article, making no allowance for emissions arising from change in land use to produce fuels crops, found that forestation of an

[20] A Blueprint 4

equivalent area of land would sequester two to nine times more carbon over a 30-year period than the emissions avoided by the use of the biofuel.[21]

Potential emissions reductions also vary significantly by feedstock (see Chart 1). A study by the Argonne National Laboratory found that the production of 1 BTU of ethanol from corn requires 0.74 BTUs of fossil fuel, including cultivation, harvesting, and processing, yielding an energy balance of +1.35. Energy balance can be defined as the ratio of energy output to input which is the ratio of the energy output of the fuel to the energy input in growing the crops, producing the fuel, and transportation and delivery. The production of 1 BTU of ethanol from sugarcane, however, yields an energy balance of +8.3 because only 0.12 BTUs of fossil fuel are required in this process.[22] As other studies have also concluded, ethanol produced from sugarcane and cellulosic materials demonstrates the greatest potential for GHG emissions reductions.[23] Ethanol may also be used instead of MTBE, a carcinogenic groundwater pollutant, to replace lead as an octane enhancer in gasoline.

Figure 1: Ethanol Well-to-Wheel GHG Emissions Reductions Compared to Gasoline




[21] Righelato, Renton and Dominick V. Spracklen. “Carbon Mitigation by Biofuels or by Saving and Restoring Forests?” Science. Vol 317. 17 August 2007

[22] A Blueprint 43

[23] A Blueprint 40

In terms of biodiesel, the major components of acid rain (exhaust emissions of sulfur oxide and sulfates) are virtually eliminated if biodiesel replaces conventional diesel. An analysis by the US EPA reported that the use of a diesel mixture containing 20% biodiesel reduced particulate, hydrocarbon, and CO emissions by 10, 21, and 11 percent respectively, but increased the emissions of nitrogen oxides by 2%.[24]

Despite the apparent benefits of biofuel adoption, the International Energy Association envisions smaller emissions reductions in the transport sector than sectors such as electricity generation because of its conservative estimate of the potential for biofuels to replace fossil fuels in the medium term.[25] Analyses from many countries indicate that biofuels are currently a relatively expensive way to reduce GHG emissions, with the exception of Brazil, where ethanol from sugarcane is competitive with current gasoline prices.[26] Nonetheless, in order to make a larger impact on reducing carbon emissions, a greater effort is needed to promote wider consumption.

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[24] Kojima and Johnson 3

[25] A Blueprint 33

[26] Sustainable Bioenergy 49

# Q: What are the environmental considerations of biofuels development?

An effort to promote wider consumption of biofuels will, in turn, require more production. This increased demand may in fact promote environmental degradation through the clearing of forests for increased cultivation and cattle grazing, aggravating soil erosion and the depletion of soil nutrients by crops such as corn. In the face of growing land constraints, farmers may choose to use less than optimal land, which will require additional water and fertilizer, increasing both costs and the danger of soil contamination and erosion. Such land constraints also limit the extent to which biofuels can be produced to meet domestic consumption needs and replace fossil fuels. Importing biofuels may be difficult given certain agronomic policies and energy security goals in place in some countries, but failing to do so could serve as a detriment to the environment.

Looking for new areas to crop, the temptation for farmers to cut down wild forests is strong. Because of the rapid rate of deterioration of these lands, however, farmers can be observed moving to new deforested areas every four to five years. Along with deforestation and soil erosion, large scale mono cropping leads to biodiversity loss directly through cleared forests and indirectly as pesticides and other toxins kill invertebrates in the soil, interrupting the food chain. Soybeans and corn are row crops that also contribute to water pollution, require fertilizer and fuel to grow, harvest, and dry, and are the major cause of nitrogen runoff during the rain. The nitrogen runoff problem is further aggravated as corn displaces soybeans as a main source of ethanol. Even varied and more sustainable crops grown for energy could negatively impact the environment if they replace wild forests or grasslands. Eutrophication of water bodies, acidification of soils and surface areas, and ozone depletion (all related to nitrogen releases from agriculture) are other potential impacts. Shrinking grasslands could lead to the loss of pastoral lifestyles, loss of food for domesticated and wild herbivores depending on these lands, and related negative social impacts.[27] Potential water shortages or conflicts could arise due to the large water requirements for many of these crops. This gives a marked advantage to regions with adequate rainfall, such as Brazil, compared to growers in regions relying on irrigation, such as Australia and India.

Alternatively, certain feedstocks can in fact add nutrients back to the soil and help curtail soil erosion. For example, corn and soybeans are often grown in rotation on the same land because soybeans add back nitrogen that the corn crops deplete from the soil. Plants such as jatropha can be grown in drier, rougher climates that minimize the need for irrigation, reducing the risk of soil erosion.[28] Good farming methods can also achieve increases in productivity with neutral or even positive impacts on the environment. Such practices include the use of bio-char (black carbon), intercropping, crop rotation, double cropping, and conservation tillage and can reduce soil erosion and water consumption, improve soil quality, and reduce the need for chemical fertilizers and pesticides. Because of the multiple stages of growing and processing them, however, biofuels still run the risk of further aggravating environmental problems unless new policies to protect threatened lands, secure socially acceptable land use, and steer biofuel development in a sustainable direction are swiftly enacted.

To that end, governments involved in biofuel production have implemented regulations to control the extent of environmental damage. For example, the Brazilian state of Sao Paulo requires that sugar cane producers set aside 20 percent of their total planted area as natural reserves. In India, a multi-species biodiesel program may help to ensure genetic diversity in plants as India

[27] Sustainable Bioenergy 44

[28] Sustainable Bioenergy 43

seeks to protect its 300 species of oil bearing trees.[29] And at least some palm oil industries in Southeast Asia have promoted animal sanctuaries and green corridors to enhance biodiversity. Yet reports of large scale land clearing and increasingly threatened species only gain in number as biofuels become more popular on an international scale, putting into question the effectiveness and regulation of such legislation. For example, although Brazilian officials claim that scientifically, it is impossible to grow sugar cane in the rainforest, USAID officials traveling through the country as recently as February 2007 observed a large expanse of sugar cane and a recently installed ethanol plant near the Brazilian town of Capixaba, a landscape predominated by pastureland on what was formerly lush rainforest. There is every indication that sugar cane cultivation has joined cattle ranching and soybean cultivation as a profitable enterprise in the Brazilian rainforest, putting even more pressure on the unique ecosystem.

As stated before, farmers often choose to relocate to lands of lesser quality that are not suitable for food production to grow energy crops. The practice and capability of growing energy crops on marginal lands has become an important area of research, especially as concerns about food security and biodiversity mount. Jatropha curcas, for example, is an oil bearing crop that produces a seed that can be converted into biodiesel. Capable of growing in infertile soil, even in droughts, and inedible by grazing animals, the crop is now a poster child of sorts for biofuels projects in the developing world.[30] Indonesia is planting Jatropha on non-forerstry and non-agricultural land. Mozambique is preparing to plant C4 (carbon fixing plants adapted to high daytime temperatures and intense sunlight) arid-resistant plants on unused lands. Mali is beginning to experiment with Jatropha on abandoned lands, and India has a thriving biodiesel sector based on Jatropha and Pongamia cultivation. With so many hopes pinned to this type of

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[29] Sustainable Bioenergy 46

[30] UN Trade and Development 20

cultivation, forgotten are some of the basic reasons why marginal lands are, after everything is said and done, still marginal.

Lacking adequate nutrients or moisture or both, marginal lands may seem to support Jatropha cultivation adequately. Yet without added nutrients, moisture, and improved germplasm, only marginal yields can be expected to come from those lands, threatening the economic viability of such an undertaking in the first place.[31] Poor lands may be cheaper and more available, but they are often plagued with infertile and stony soils, low rainfall, steep slopes, or bush cover that must be cleared. Greater technical expertise and careful management is needed to sustain crops on such lands. And although there may be an ample supply of marginal land available in developing countries, most often these lands are for communal use to graze livestock. Jatropha is toxic to livestock, weedy, and generally not a good plant to use in agroforestry systems save as living fences to shield food crops from livestock. If planted densely, Jatropha would push out grasses and shrubs on which livestock depend. Families that depend on these animals for food or income are put in greater danger of food insecurity. Also, farmers in developing countries generally only have access to a very small plot of land to grow food crops. Without some form of tenure recognized by the community, it is almost impossible for individual farmers to benefit from their labor. Financially acceptable crop yields from marginal lands can thus demand high costs and involved production inputs. Before automatically assuming energy crops can grow on degraded lands, it is essential to consider the difficult trade-offs between yield, output prices, site quality, and quality dependent production costs.[32]

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[32] World Bank Roles 8

# Q: What crops are best suited for biofuels?

The two most widely used crops for ethanol production are sugarcane and maize, and most biodiesel today is made from rapeseed and soybeans. Yet there are many more crops that may meet the biological requirements for use as biofuel feedstock, and as such there is a tremendous amount of research being conducted to determine which crops and crop species are most suitable for different biofuel applications, soil types, farming systems, and cultivation scenarios. Economic viability, suitability for different biofuel applications, yield per hectare, input requirements, potential for yield increase, versatility, drought and pest resistance, competing uses, price volatility, and opportunity costs are just some of the key considerations to selecting feedstock.[33]

Certain feedstocks are also more appropriate for large scale production while others are better suited for small scale applications. For example, areas with chronic unemployment problems may consider cultivating the inedible oilseed jatropha, for it is a labor intensive crop that must be harvested by hand. As a general rule, crops that demand high fossil energy inputs and scarce or valuable land with relatively low energy yield per hectare should be avoided. For the developing country context especially, crops that can grow on marginal land with little input and rainfall needs should be considered. However, it should be noted that transportation costs limit how far potential feedstock can be transported, and so crops growing on marginal land with little input do not automatically translate into low feedstock costs.

As stated before, sugarcane is the most efficient feedstock today for ethanol production, in part because of its high yield per hectare and the ability of producers to use the bagasse and stalks of

[33] Sustainable Bioenergy 25

the cane to help power a processing plant. It is considered the leading feedstock candidate for first generation ethanol production.[34] The following table gives a brief summary of different crops and their growth requirements.

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## Figure 2: Biofuel Feedstock Requirements

| CROP TYPE | SOIL | WATER | NUTRIENTS | CLIMATE |
|---|---|---|---|---|
| **Cereal** | less disruption of soil; very constant yield; humus balance is negatively influenced by annual removal of straw | – | medium | moderate |
| **Hemp** | deep soil with good water supply, pH balance between 6 and 7 | some moisture the entire season | moderate, no pesticide needed | varied environmental conditions, preferably warmer climates |
| **Jatropha** | undemanding, does not require tillage | can be cultivated under both irrigated and rain-fed conditions | adapted to low fertility sites and alkaline soils, but better yield can be achieved if fertilisers are used | Tropical and subtropical but also arid and semiarid. |
| **Maize** | soil should be well-aerated and well-drained | efficient user of water | require high fertility and should be maintained continuously | temperate to tropic conditions |
| **Miscanthus** | good water supply, brown soils with high humus percentage, optimum pH between 5.5 and 7.5 | crucial during the main growing seasons | low | adapted to warmer climates but fairly cold-tolerant |
| **Oil Palm** | good drainage; pH between 4 and 7; soil flat, rich, and deep | even distribution of rainfall between 1,800 and 5,000 throughout the year | low | tropical and subtropical climate with temperature requirement of 25–32°C |
| **Poplar** | deep, moist soil, medium texture, and high flood tolerance | high; irrigation may be needed | high | arctic to temperate |
| **Potato** | deep, well-drained, friable, well-aerated, porous, pH between 5 and 6 | high; irrigation required | high fertiliser demand | optimum temperature of 18–20°C |
| **Rapeseed** | mild, deep loamy, medium texture, well-drained | 600 mm minimum yearly precipitation. | similar to wheat | sensitive to high temperatures, grow best between 15 and 20°C |
| **Rice** | needs permeable layer and good drainage | very high, grown in flooded fields | relatively high input of fertilisers, very intensive systems | constant temperatures in tropical areas, optimum around 30°C |
| **Sorghum** | light-to-medium textured soils, well-aerated, well-drained, and relatively tolerant to short periods of water logging | shows a high degree of flexibility towards depth and frequency of water supply because of drought resistance characteristics | very high nitrogen feeding crop | optimum temperatures for high producing varieties are over 25°C |
| **Soybean** | moist alluvial soils with good organic content, high water capacity, good structure, loose soil | high | optimum soil pH of 6 to 6.5 | tropical, subtropical, and temperate climates |
| **Sugarbeet** | medium-to-slightly heavy texture, well-drained, tolerant to salinity | moderate, in the range of 550 to 750 mm/growing period | adequate nitrogen is required to ensure early maximum vegetative growth, high fertiliser demand | variety of temperate climates |
| **Sugarcane** | does not require a special soil type, but preferably well-aerated with a total available water content of 15 percent or more | high and evenly distributed through the growing season. | high nitrogen and potassium needs but at maturity, the nitrogen content of the soil must be as low as possible for a good sugar recovery | tropical or subtropical climate |
| **Sunflower** | grown under rain-fed conditions on a wide range of soils | varies from 600 to 1,000 mm, depending on climate and length of total growing period | moderate | climates ranging from arid under irrigation to temperate under rain-fed conditions |
| **Switchgrass** | ranging from prairies to arid or marsh | drought-resistant and very-efficient water use | low | warm-season plant |
| **Wheat** | medium textures | high | high | temperate climates, in the sub-tropics with winter rainfall, in the tropics near the equator, in the highlands with altitudes of more than 1,500 m, and in the tropics away from the Equator where the rainy season is long and where the crop is grown as a winter crop. |
| **Willow** | sandy, clay, and silt loams | substantial quantities of water | significant nutrient uptake | can tolerate very low temperatures in winter, but frost in late spring or early autumn will damage the top shoots. |

Source: Daimler Chrysler, WWF, Ministry of Agriculture of Baden Wuerttemberg, and UNEP

# Q: What is the government's role in biofuels projects?

The production of biofuels is heavily depended upon government support in various forms, from policies supporting decentralized production or local use to those encouraging the organization of cooperatives. It took the Brazilian government thirty years of continuous support, along with private investment, to steadily improve the efficiency of its production processes and make ethanol affordable for consumers. Because most of the environmental and social benefits of bioenergy are externalities not considered in the priced market, leaving its development solely to the private sector will lead to economically efficient outcomes that may not, however, match their environmental and social potential. Additional support may also be necessary to ensure the continued participation of small scale farmers in medium or large scale biofuel production. Because of the extent of government involvement in the biofuel industry, it is essential to carry out a proper analysis to weigh the upfront and long term economic, social, and environmental costs and benefits of a biofuel program. When, where, and how the government is to be involved in an important step in this decision making process.

The government can help overcome the high initial costs of producing and using biofuels. Any biofuel project requires massive and coordinated investments by farmers, processors, car manufacturers, consumers, and fuel distributors among many others. The use of tax and investment incentives, regulation, and direct public investments from the government can help achieve a critical market size to make such a production economically feasible. Also necessary is an enabling environment complete with biofuel trade and regulatory systems which are in their infancy in many countries. The public sector also has a role to play in overcoming vested interests in existing technologies, such as within the car and oil industries, which hamper biofuel expansion.

Although government support may be needed to promote a full-scale establishment of this nascent industry, experience has shown that once it has been granted, forms of government promotion are difficult to withdraw. A classic example of this dilemma is America's corn subsidies (about $10 billion a year) that continue to be debated within political and economic circles. In fact, every country with a biofuel program has provided subsidies to the industry, and not one except Brazil has removed them yet. Tax considerations have also been essential in creating a biofuel market. Excise duty reduction or elimination has been a common method for fiscal assistance, along with low interest loans, tax holidays, lower corporate taxes, and tax reductions on hybrid vehicles. Other forms of support to biofuel manufacturers include administered pricing and restrictive trade polices.

Protectionist trade policies have facilitated certain countries with no comparative advantage in the production of a biofuel feedstock to enter and expand the market. Such support for domestic farmers may boost production above market equilibrium and contribute to increased volatility of world prices, not to mention the negative impacts on efficiency and scientific advancement that stem from restrictions on import competition.

Brazil's experience offers some valuable policy lessons. Among the most efficacious policies were Brazil's requirement that the auto industry produce cars using blended biofuels, subsidies for biofuels during initial market development, the opening of the electricity market to renewable energy-based independent power producers in competition with traditional utilities, support for private ownership of sugar mills, helping to guarantee efficient operations, and stimulation of rural activities based on biomass energy to increase rural employment.

Developing countries should be aware of international experiences in the field before embarking on a brand new project. In terms of subsidies, one pattern observed across countries has been the disproportional benefit to agribusiness firms, rather than small farmers or landless workers. Such trends can further ingrain the tendency of public resources benefiting large producers at the expense of smaller ones. The potential for permanent price competitiveness of biofuels is an essential one for developing countries to consider, otherwise governments run the risk of locking themselves into persistent support mechanisms.

Thus, government involvement in the sector runs the risk of reaching excessive proportions, leading to deteriorating agricultural performance and discouraging free, competitive trade and reducing the incentives for private investment in agriculture and agribusiness. Adverse public sector interference may also result in insufficient adoption of appropriate technology as well, leading to low irrigation, low use of purchased inputs and machines, low yields, and low labor productivity because it is not profitable to adopt productivity enhancing technology any longer. A commodity that requires direct government intervention may aggravate, rather than alleviate, already existing agricultural problems in several developing countries.

The challenge facing all interested governments is to create a policy and market environment that supports the design and implementation of biofuel activities that contribute to sustainable development, without risking the possibility of perpetually financing an inefficient industry. The most likely national biofuel program to achieve this goal is one that coordinates among several tasks within areas such as rural development initiatives, energy policy and infrastructure development, fiscal and trade policy, agriculture/forestry policy, capacity building, and technology development.[35] Such a program is best managed through a central coordinating institution responsible for biofuel development that can help formulate the needed policy and

[35] World Bank Roles 25

regulatory framework. This institution should serve as an authorizing agency, one with the legal authority to design a coherent legal framework clarifying rules and roles of all potential participants. This sort of an institution signals to the private sector and other investors a serious commitment to biofuels.

It is essential that the central coordination institution create a framework within which development NGOs, community based organizations, and most importantly the private sector, can work. Along with promulgating socioeconomic and environmental guidelines, the institution should provide clear and transparent rules and steps that private sector partners can follow. It should serve as an information clearinghouse for things such as regional biofuel assessments, descriptions, contacts for activities, reviews, evaluations, technical data, management practices, investors, legal regulators, etc. The roles of various players should be clearly delineated, with the proper rights and responsibilities bestowed on the parties. The private sector has an integral role to play in creating a long term vision for biofuel development, and the government must recognize and foster that involvement.

Governments can play diverse roles in facilitating the creation of private sector participation in biofuels development. The key to providing effective support to entrepreneurs is to highlight market creation activities that the entrepreneurs themselves cannot or will not undertake themselves. For example, since the private sector tends to under-invest in research and development because of universal rather than private benefits, the government should allocate funding in this area to compensate. Similarly, building consumer awareness is an activity that may fall on the government's shoulders. Some areas in rural regions of developing countries simply do not have a population of entrepreneurs who can take up the job of marketing a novel product. The government can, in this case, help provide some basic training to equip people with the necessary skills and information to take up entrepreneurial tasks. Again, one of the major barriers to entrepreneurial activity across countries has been complicated and lengthy processes of registration, permits, licensing, etc. Thus, the process for maintaining compliance with legal requirements should be streamlined. Simple steps such as making guidelines and applications available on the Internet have been greatly appreciated by private sector partners.

A key element in the development of a sustainable market for biofuels is the establishment of a commodity status for biofuels. This feat has yet to be accomplished even in Brazil, despite the fact that the ethanol program has been running for the last 30 years. Ethanol is being produced and regulated based on the sugar market. The Government of Brazil is still providing high level subsidies to ethanol producers in order to maintain their commitment to produce. The private sector continues its investment in ethanol plants mainly because of the sugar market's backing, or in other words, if the sugar price is higher than the ethanol price, they still have the flexibility to produce sugar instead. The main result is that ethanol distributors do not find any producer willing to close long term ethanol supply contracts. Deals are closed just for the next crop. Flex fuel cars have contributed to the status quo: car owners just check the ethanol price versus the gasoline price, if ethanol price is 30% below gasoline's price, they fill the tank with ethanol, otherwise, they use gasoline. A commodity status for biofuels would help create a long-term role for and interest from the private sector.

# How will biofuels affect local economies?

Countries around the world today are implementing aggressive blend mandates for their domestic fuel markets, increasing the share of biofuels in transport energy consumption to a projected 5% by 2020. Even under a conservative projection, meeting this demand would require a nearly five fold increase in biofuels production worldwide, and an investment of over $200 billion in the next 14 years just for expanding capacity. Worldwide investment equaled $38 billion in 2005.[36] Given the momentum behind this push for biofuels, there is tremendous scope for developing countries to position themselves for entry into this rapidly growing market.

Biofuels hold the promise of contributing to rural development through agricultural growth in feedstock production, biofuel manufacture, and in the transport and distribution of feedstock and related products. Feedstock accounts for over half the cost of biofuels production.[37] Job creation is one avenue of growth that has received particular attention. Successful biofuel industries bring with them significant potential for job creation with positions that range from high skill science, engineering, and businesses focused jobs to low skill industrial plant jobs and unskilled agricultural labor. In particular, rural communities with persistent underemployment could benefit from the majority of jobs that are created in farming, transportation, and processing. Where such job creation is a high priority, the focus may include the encouragement of labor intensive biofuel feedstock, biodiesel versus ethanol production, and/or creating applications for that biofuel directly of use to the local community. Oilseed crops tend to be the most amenable to job creation of all biofuel feedstock in developing countries, especially when harvested manually.

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[36] A Blueprint 1

[26] Kojima, Masami and Todd Johnson. Potential for Biofuels for Transport in Developing Countries. Washington, DC: Energy Sector Management Assistance Programme, October 2005. 7

In general, bioenergy projects based on agriculture tend to generate more employment and earnings than their non-agricultural counterparts. [38]

There are, however, equally as important threats to local economies that stem from biofuel production and manufacture. Although there is potential under certain conditions for job creation, in the case of large-scale mechanized farming there may be larger numbers of displaced workers in poorer labor conditions. Small scale and labor intensive production may seem less attractive if there are significant trade offs with production efficiency and economic competitiveness. In addition to weighing job creation potential against the costs of creating and maintaining the jobs, decision makers must assess the quality of those jobs. Sugarcane harvesting, for example, creates many jobs but they are seasonal and offer comparatively low wages. Since labor intensive jobs are usually the first to disappear in the process of economic development, the long term prospect of creating a large number of permanent jobs within this skill level is not necessarily favorable. Net job creation can only occur where growing crops for biofuels is adding to, not displacing other, agricultural activities or where growing these crops displaces agricultural activities requiring less labor.[39]

The current structure of agricultural markets in many countries results in the bulk of profits flowing to a very small portion of the population. Without more equitable ownership, this divide could become as severe for energy commodities as it is for food commodities today. As with many industrial activities, the existence of economies of scale leads to a favoring of large producers. The transition to liquid biofuels production can be especially harmful to farmers who do not own their own land, and to the rural and urban poor who are net buyers of food as a result

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[27] Sustainable Bioenergy: A Framework for Decision Makers. UN-Energy, 2007. 17

[28] Kojima and Johnson 101

of greater pressure on already limited financial resources. Helping farmers add value to their products and increasing their income is the best-case scenario, but at their worst biofuel programs could drive the world's poorest farmers off their land and into deeper poverty. The global market forces that are affected by the merging of the energy and agricultural industries could lead to new and stable streams of income, but could also increase marginalization of indigenous peoples and the poor, destroy traditional livelihoods, and drive small farmers without clear land titles from their land.

The agricultural policy in effect in the area will thus also determine the scale and distribution of economic benefits. Policy considerations include the availability of rural infrastructure, credit, and land tenure. Without some form of tenure recognized by the community, it is almost impossible for individual farmers to plant, protect, and manage crops on these lands and benefit from their labor. The more involved farmers are in the production, processing, and use of biofuels, the greater is their chance of deriving some of the benefits as well. Having a stake in such stages buffers producers from the possibility of a decrease in crop prices since those low prices can benefit the bottom lines of biofuel production facilities and increase incomes of those who take part in ownership. Farmer ownership of processing facilities also reduces feedstock supply risk, and the economic multiplier effect in rural communities is dramatically enhanced when farmers receive a greater share of the profits from value-added activities.[40] Although smaller farmers are less likely to shift their production to biofuels because of higher personal risks, substantial supplies and associated public revenues can still be attained on a small scale by incubating the pool of resources, facilitating collective ownership, and enforcing fair pricing laws.[41] Examples can be seen in Brazil, France, Germany, Mauritius, and the United States where small and locally

[40] Sustainable Bioenergy 27

[30] Ibid

owned biofuel production facilities, such as farmer cooperatives, have brought about higher local revenues and lower social spending. Brazil's rural areas especially were helped by proper infrastructure policies, giving needed incentives for the development of a new industry. Smaller scale production, however, will probably necessitate higher government subsidies than larger scale production because of the efficiency trade-off.

Ultimately, large scale biofuel programs for transport are not very likely to help the poorest rural families; those in remote places with low density, widely distributed populations. Unfortunately, much of the developing world's agriculture is located in such regions. Small scale, decentralized biofuel programs for non transport purposes may offer a more promising alternative.[42]

[42] Kojima and Johnson 100

# Q: What are the non-transport uses of biofuels?

Much of the literature on biofuels and its coverage in the media centers on transport uses of biofuels. When concentrating on the applications in developing countries, however, it is essential to consider biofuels for direct electricity production as well. The local use of endogenous biofuels in developing countries may be more attractive than transport or export oriented production, as direct use can replace expensive imports of oil or natural gas, create regional value chains, reduce indoor air pollution from biomass such as wood and charcoal, and accommodate more sustainable growing practices.

The processing of oils from plants such as Jatropha into biodiesel can directly fuel non transport uses such as cooking stoves and lamps, or can be used to power generators for different applications. The need for processing infrastructure, of course, differs according to the purpose and scale of production. The amount of oil actually produced from the seeds and kernels of the plants is highly contingent upon the method of extraction, with hand presses being much more inefficient but inexpensive when compared to more sophisticated machines. The oil may also not be of use in standard equipment. When used for cooking and lighting, oil derived from Jatropha cannot be used directly in conventional kerosene stoves or lamps. Kerosene is still required to start the stove and to clean it just before it is turned off.[43] Unrefined Jatropha oil may also only be used in certain types of diesel engines, such as Lister-type engines. The Lister type engine is commonly used in developing countries to run electric generators to power small scale flour mills. Jatropha oil can be used in any diesel engine, however, if the oil has gone through a process called trans-esterification. The glycerin by-product of this process can be used to make a high

[43] Benge 6

quality soap to be sold locally as well. The ability of this process to be carried out in a small, rural setting, however, is highly debatable.

Many remote communities across the developing world are already utilizing locally produced biofuels for dynamic uses. Some places in West Africa are using biodiesel to produce electricity for artisan activities (e.g. blacksmiths, mechanics, carpentry, etc.), to power tools such as cereal mills, alternators, and carpentry equipment, as well as using the electricity to distribute water. The market in India for biodiesel is quite mature, and The Energy and Resources Institute of India announced in January 2006 a 10-year project in conjunction with BP to cultivate 8,000 hectares of wasteland with Jatropha and install the equipment necessary to produce 9 million liters of biodiesel a year.[44] The successful development of this sector in India is often used to justify the processing of oils for such purposes in other countries. What should be understood is that India's sector combines both transport and non transport uses, and is based on processing an adequate year-round supply of a variety of nuts that allow entrepreneurs to amortize expensive machinery over a period of time and make a decent profit. Projects based on a single source of oil, such as Jatropha, which produces a variable amount of nuts only once o twice a year may prove to be unsustainable and inefficient.

This brings us to the larger question of the economics of Jatropha as a substitute for diesel in non transport applications. While the jury is still out on this question, it is true that a sustainable program could add to the energy independence of rural villages. What remains to be seen is the ability of such programs to survive on their own when project subsidies are removed. It is important when doing realistic planning to incorporate the fact that optimal seed yield of Jatropha won't be obtainable for several years.[45]

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[44] Braun and Pachauri 6

[45] Benge 10

# Q: What are the infrastructure requirements of biofuel development?

There are two stages at which infrastructure must be considered: the first stage includes the requirements for the production and distribution of biofuels, and the second includes the requirements for the actual consumption of biofuels in vehicles. For the first stage, adequate road and communications infrastructure is important so that fertile land with good rainfall can be accessible in order to minimize the costs of moving feedstock to processing plants and ethanol or biodiesel to consumption centers. Since there are economies of scale for biofuel production, infrastructure for transport and distribution is important to ensure the long term success and growth of biofuel projects. Corn based ethanol plants can be larger because of its ability to be stored for long period of time, whereas sugar cane must be processed within 48 hours to avoid deterioration. Communication ability is also important to stay informed about weather and market conditions. Infrastructure and other services tend to be limited and of poor quality in marginal areas, which can raise expenses incurred in getting the fuel to market and thus limit the economic scale of production.[46] In many instances, the relatively low energy density and bulkiness of crops limits the distance that cost effective transportation of unprocessed feedstock can be arranged.

At the retail and end-use level, both ethanol and biodiesel can be mixed directly with fossil gasoline and diesel respectively. Consequently, there is no significant additional infrastructure needed for storing or producing these mixed products, save perhaps a splash blending facility for ethanol. Blends of fossil fuels and biofuels up to certain percentages may also be used in

[46] Kojima and Johnson 56

commercial vehicles without modification, but purpose built vehicles such as the flex fuel cars produced in Brazil may need to be purchased to encourage the use of higher concentrations. In the United States, unmodified gas vehicles can run on E10 (10% ethanol blended with gasoline) without difficulty, but flex fuel vehicles can run on blends up to E85. Ethanol, however, does not offer advantages in fuel economy when compared to gasoline. E85 contains nearly 28% less energy per liter than gasoline (actual performance varies by vehicle).[47] The final delivery of ethanol is difficult as well because it is easily contaminated with water and is highly corrosive. It cannot be used in the country's traditional gasoline pipeline infrastructure and thus poses an obstacle to its widespread sale and use.

The addition of biodiesel to diesel fuel, even in modest quantities, can significantly improve the performance of conventional diesel. It has been shown to reduce friction and wear-and tear between moving vehicle parts, and biodiesel offers similar fuel economy as conventional diesel. Only minor modification is required for the consumption of B100 (100% biodiesel) in engines.

The infrastructure requirements differ depending upon the feedstock used, but in every case there are significant costs involved from production to consumption of biofuels. For example, to optimize oil extraction from Jatropha seeds and to produce a quality of biodiesel that will maximize profits requires equipment, some quite expensive; chemicals such as caustic soda which may be very flammable, toxic, dangerous, and difficult to use; and timely placed infrastructure and trained personnel. Proper financing for infrastructure should be obtained before beginning any project to ensure the long term success of a biofuels project.

[47] A Blueprint 44

## Q: What international agreements on biofuels is the United States Government a signatory to?

US Secretary of State Condoleezza Rice and Brazilian Foreign Minister Celso Amorim signed an MOU on March 9, 2007 in Sao Paulo, Brazil, to advance cooperation on biofuels. The agreement highlights the importance of biofuels as a transformative force in the region to diversify energy supplies, bolster economic prosperity, advance sustainable development, and protect the environment. As the world's two largest producers of ethanol, the United States and Brazil intend to advance the research and development of new technologies to promote biofuels use. The United States and Brazil already are working through existing mechanisms such as the U.S.-Brazil Commercial Dialogue launched in 2006, the U.S.-Brazil Consultative Committee on Agriculture established in 2003, the 1999 U.S.-Brazil Memorandum of Understanding on Energy, the U.S.-Brazil Common Agenda for the Environment established in 1995, and our 1984 Framework Agreement on Science and Technology.

Regionally, the two nations intend to help third countries, beginning in Central America and the Caribbean, to stimulate private investment for local production and consumption of biofuels. The United States and Brazil expect to support feasibility studies and technical assistance in partnership with the Inter-American Development Bank, the United Nations Foundation, and the Organization of the American States. Multilaterally, the United States and Brazil intend to work through the International Biofuels Forum to examine development of common biofuels standards and codes to facilitate commoditization of biofuels. This initiative does not include discussion of United States trade, tariffs or quotas.

# Q: What type of activities might USAID support?

USAID Missions, Regional Bureaus, and the Energy Team in USAID's Economic Growth, Agriculture and Trade (EGAT) Bureau have played an important role over the years in laying the foundation for energy sector reform, increased access to modern energy services, and ensuring the sustainability of energy sector improvements around the world. Currently, USAID Missions around the world spend approximately $100 million per year on clean energy development programs. Over the years USAID has supported a wide range of bio-energy projects, but support for biofuels programs has been limited. USAID does not have an all-encompassing viewpoint or policy on biofuels. Rather, USAID considers the various economic, social, and environmental advantages and disadvantages of each unique biofuels project. USAID works with governments to establish policy, legal and regulatory regimes that are attractive to private sector investment while safeguarding citizens' interests.

The nature of USAID support for biofuels development will be highly dependent on the specific needs of a given country. However, it is likely that USAID programs might focus on four areas: (1) providing assistance to governments to ensure that sound regulations and policies are in place to attract private sector investment in biofuels; (2) helping ensure access to financing through a Development Credit Authority loan guarantee program (3) promoting public-private biofuel partnerships through the development of Global Development Alliances (GDAs) with the private sector; (4) working with governments and the private sector to ensure that growth in the biofuels sector is sustainable and does not have a negative impact on the human and natural environment. Below is a summary of existing and planned USAID biofuels activities by region:

### *Caribbean*

**Haiti –** USAID recently conducted an environmental assessment in Haiti and recommended expanding the use of bio-energy crops including wood and oil-seed bearing plants. The report noted that production of oil bearing crops in drier agricultural zones may be used to reduce soil erosion and improve watershed management but that these crops at the present time were not well established. The report recommends that the USAID Mission closely monitor liquid biofuel opportunities and work with local stakeholders to define an action plan for pilot efforts in this sector.

**Dominican Republic –** The government of the Dominican Republic has expressed interest in working on biofuels. To date, the USAID mission has not had the financial resources to respond to government requests for assistance with ethanol conversion projects. Nevertheless, energy remains a priority for the DR mission. With the potential for an increase in energy funding in Fiscal Years 2007 and 2008, the USAID mission in the Dominican Republic hopes to be better positioned to assist with biofuel policy development and promotion of biofuel pilot projects. One possible area of support might be developing GDAs with the private sector.

### *Central America*

**Guatemala –** USAID/Guatemala is presently considering a GDA project concept submitted to assist small producers of biodiesel from a native plant species in Guatemala. The mission is in the process of asking for a full proposal.

**Honduras –** USAID/Honduras is currently exploring options for working with the Palm Oil plantations on the north coast that are producing biofuels to ensure that they do not have a negative impact on the region's rich biodiversity. In addition, the Mission is exploring options to work with the national government to develop a fiscal incentives policy to stimulate the development of biofuels.

**Regional Program DCA –** USAID's regional programs and Development Credit Authority (DCA) currently have a $10 million loan portfolio guarantee program with five local Central American banks (Banco Cuscatlán, El Salvador; Bancentro, Nicaragua; Panabank, Panama; LAFISE, Costa Rica; and Bamer, Honduras) to support cleaner production and clean energy loans. USAID also provides technical support to the private sector to prepare investment plans and to bank representatives to educate them on the benefits of clean production. Under the terms of the DCA, biofuel projects qualify for the guarantee program.

***Latin America***

**Brazil –** Biofuels is one of the components of the USAID/Brazil Energy Program. Recently one of the Mission's implementing partners (ICFI) prepared a draft U.S. Brazil Biofuels Roadmap with suggestions of possible joint activities on biofuels between Brazil and the U.S., and information on the Brazilian biofuels market focus on specific projects and partnerships with the private sector. The USAID/Brazil environment program is also working to encourage responsible sourcing of agricultural commodities – including biofuel commodities. The Mission currently has a GDA with The Nature Conservancy to engage soybean producers and traders on the Amazon fringe on responsible sourcing of soybeans.

***Asia***

**India –** For three years, USAID has been supporting the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) to work in Adilabad District, Andhra Pradesh, India to promote a biofuel based groundwater irrigation project. The project supports communities to cultivate Pongamia and Jatropha tree and shrub species and extract biofuel from the oilseeds to run water pumps to provide irrigation services to farmers. USAID also supports a host of other community development activities associated with the biofuel production and utilization scheme. These include women's self-help group formation and empowerment; small-scale income generation from sale of tree seedlings, vermi-compost, oil, oilcake fertilizers, non-timber forest products (bamboo, honey, tendu leaves) and the innovative sale of verified carbon emissions reduction through fuel substitution; and watershed and wasteland management.

USAID's Office of Infrastructure and Engineering/Energy Team is available to provide technical assistance to Mission's considering biofuels development programs. For more information please contact:

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# Q: What are some key questions to consider when embarking on a biofuels project?

There are a number of questions to consider before a country embarks on a biofuels program. Some of the most important to ask are:

- What is the geography of the land? This includes
  - Climate
  - Rainfall patterns
  - Soil health
- What agricultural products are currently produced in the region, and what is their possible energy use and expansion potential?
- What other major economic activities occur in the region, and how may they be affected by a biofuels program? One important example is feedstock cultivation and the impacts of reduced land availability.
- What modern technologies are available for bioenergy conversion and use?
- What are the current agricultural policies that affect this area? How does the government plan to get involved?
- Who are the other key stakeholders in this project?
- What are the costs across the supply chain: raw material production or gathering, processing, transport, and infrastructure modifications?
- Opportunity costs of land, labor, and water used?
- What are the possible risks to food security?
- What are impacts on jobs and present and future prices, markets, and subsidies?
- How can biofuels be integrated into the community itself?
- How will small scale farmers be involved and protected?
- How will the project be financed in the long run?

A good document to consider for specific developing country contexts is A Blueprint for Green Energy in the Americas, prepared for the Inter-American Development Bank by Garten Rothkopf.

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