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THE TAINTED GRAIL OF BRAZILIAN ETHANOL: ACHIEVING OIL INDEPENDENCE BUT WHO HAS BORNE THE COST AND PAID THE PRICE?

Sandra Dos Santos*

Everyone is entitled to an ecologically balanced environment, an asset for the people's public use and essential to a healthy quality of life, and it is the duty of the Public Authorities and the community to defend it and preserve it for the present and future generations.¹

INTRODUCTION

Sustainable development has been defined as development that "meet[s] the needs of the present without compromising the ability of future generations to meet their own needs."² In a recent declaration by the Forum of Resistance to Agribusiness, a consortium of South American non-governmental organizations (NGOs), the goals of sustainable development and the feverish pitch of fuel ethanol production collided. The Forum stated, "The implementation of the model of production and export of biofuels represents a grave threat to our region, our natural resources, and the sovereignty of our people."³

Within the framework of sustainable development, dialogue and debate concerning energy production and use has been heated. The social and environmental costs of fossil fuel dependence have contributed to the allure of renewable energy. Global dependence on fossil fuels has added to the overall global level of greenhouse gases and created a global threat of climate change,

* J.D. candidate, City University of New York School of Law, 2008. B.A., Georgetown University, 1992. Thank you to my family for instilling in me the value of social justice and the importance of labor rights. Also, a huge thanks to Amanda Allen, Molly Timko, and their editorial staff for their diligence and patience with this piece. Lastly, *amor e carinho* to the Brazilian sugarcane workers and their families who continue to live without hope or opportunity yet manage to still have love in their hearts for the rest of us. *O povo unido já mais será vencido*.

¹ Constituição Federal [C.F.] [Constitution], ch. VI, art. 225 (Braz.). Translated by UNICA, São Paulo Sugarcane Agroindustry Union, available at http://www.unica.com.br/i_pages/sociedade_desenvolv1.asp.

² G.A. Res. 42/187, ¶ 2, U.N. Doc A/RES/42/187 (Dec. 11, 1987).

³ See, e.g., ISABELLA KENFIELD, CTR. FOR INT'L POLICY, BRAZIL'S ETHANOL PLAN BREEDS RURAL POVERTY, ENVIRONMENTAL DEGRADATION (2007), <http://americas.irc-online.org/pdf/papers/0703ethanol.pdf>; see also Kelly Hearn, *Ethanol Production Could Be Eco-Disaster, Brazil's Critics Say*, NAT'L GEOGRAPHIC NEWS, Feb. 8, 2007.

which has negatively impacted and irrevocably harmed identifiable areas of the world.⁴ Communities most vulnerable to such environmental impact are those caught at the intersection of agriculture, forests, and urban sprawl.⁵ These communities have faced numerous issues attributable to development efforts and changing agricultural practices that include changing land management and use,⁶ detrimental labor conditions, political strife, and, tragically, human rights abuses.⁷

Through heavy state intervention, Brazil has become a pio-

⁴ United Nations Statistical Division, http://unstats.un.org/unsd/ENVIRONMENT/air_greenhouse_emissions.htm (last visited Oct. 2, 2007).

[G]reenhouse gases (GHG) refer to carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). These three gases account for around 98% of the environmental pressure leading to climate change. Each of these gases has a potential to trap heat in the atmosphere: i.e. methane is twenty-one times more powerful as a GHG than CO₂, while N₂O is 310 times more powerful

. . . .

The Earth's average surface temperature rose by around 0.6°C during the 20th century and most scientific advisors to the world's governments conclude that evidence is growing that most of the warming over the last fifty years is attributable to human activities, such as burning of fossil fuels and deforestation.

Id.

⁵ Danielle Murray, *Analysis: Ethanol's Potential: Looking Beyond Corn*, ENV'T NEWS SERVICE, July 1, 2005, <http://www.ens-newswire.com/ens/jul2005/2005-07-01-02.asp>.

⁶ *See id.*

⁷ Unfortunately, human rights abuses and concessions by foreign governments to oil companies, including the United States oil sector, are legion. Although numerous examples of such abuses have been exposed by claims brought under the Alien Tort Claims Act, 28 U.S.C. § 1350 (2006), there are two major cases exploring these issues: (1) the military tribunal and hanging of Nigerian activist Ken Saro-Wiwa, the originator of the phrase "ecocide as genocide," and (2) the Unocal litigation related to the atrocities committed in Burma. *Wiwa v. Royal Dutch Petroleum Co.*, 226 F.3d 88 (2d Cir. 2000); *Doe I v. Unocal Corp.*, 395 F.3d 932 (9th Cir. 2002). In *Wiwa*, the Second Circuit reversed the district court's dismissal of claims by the plaintiffs, including Saro-Wiwa's father, that they and their next-of-kin had been imprisoned, tortured and killed by the Nigerian government at the behest of Royal Dutch Petroleum and Shell Oil because of their opposition to the companies' oil exploration activities. *Wiwa*, 226 F.3d at 92. In *Doe*, the Ninth Circuit overturned the district court's determination that the plaintiffs, Burmese farmers, were barred from bringing suit against California-based Unocal for various abuses by Burmese soldiers, including allegations of slave trading, forced labor and rape, committed while the soldiers were guarding a gas pipeline project that Unocal had partnered to construct and operate. *Doe*, 395 F.3d at 936-37. *Doe* was a groundbreaking case; the Ninth Circuit held that since the plaintiffs had produced evidence that Unocal knew of and benefited from the soldiers' abusive acts, the company could potentially be held liable for those acts even though it had not actively participated in them. *Id.* at 941. The Court of Appeals stated in forceful language that human rights abuses and crimes, usually levied by governments, could also be committed by and charged to private, non-state actors. *Id.* at 958-59.

neer in the quest for developing a reliable, cost-effective, and reusable energy alternative to oil consumption. But at what cost has Brazil achieved the energy equivalent of the “holy grail”? And, have those costs been evenly distributed among Brazilian society? Advocates of Brazil’s sugarcane agribusiness and fuel ethanol production have argued that this process is “a practical example of sustainable development by combining the contributions to environmental improvement, the exploration of local economic vocations and the decentralized generation of employment and income.”⁸ However, with respect to the Brazilian production of fuel ethanol, the application of the principles of sustainable development have remained elusive with respect to what is meant by “future generations.”⁹

The development of the Brazilian fuel ethanol industry has sparked both workers’ rights and environmental justice advocates to question its impact on rural communities in terms of natural resource use (e.g., soil erosion, depleting water supply, shifting land use); air quality and public health; and the working conditions of the rural labor force that has long provided the “muscle” to produce Brazilian ethanol. Additionally, there is a more entrenched problem with sugarcane cultivation that has its origins long before Brazil became the leader in fuel ethanol production. Before its independence, the sugarcane agricultural industry was associated with most of the social and economic injustices that had permeated the rural areas of Brazil.¹⁰ Issues of “labor exploitation and land concentration” have long been part of the hidden underbelly of Brazilian sugarcane cultivation and, with the advent of fuel ethanol, clearly remain.¹¹ Some have suggested that the colonial plantation model still remains even if under the guise of a representative democracy.¹²

Although this Comment does not attempt to address all the issues associated with sustainable development,¹³ it does attempt to

⁸ UNICA, Uniao da Agroindustria Canavieira de São Paulo [Union of Sugarcane Agro-Industry], http://www.unica.com.br/i_pages/sociedade_desenvolv1.asp (last visited Nov. 6, 2007). UNICA is a quasi-governmental agency representing the sugarcane, sugar and alcohol business sectors in the São Paulo state, and includes within its membership and oversight over 60% of the Brazilian ethanol production. *Id.*

⁹ José Goldemberg, *Ethanol for a Sustainable Energy Future*, 315 SCIENCE 808, 808 (2007) (“The elusiveness of such a definition has led to unending discussions among social scientists regarding the meaning of ‘future generations.’”).

¹⁰ Kenfield, *supra* note 3, at 2.

¹¹ *Id.*

¹² *Id.*

¹³ Issues related to continued political disenfranchisement, societal poverty, con-

introduce into the dialogue issues that present opportunities for environmental justice and workers' rights advocates to coalesce and effect collaborative change in Brazil. Part I provides a broad overview of the major issues surrounding our global energy supply, the production process involved in creating fuel ethanol, and Brazil's "successful" process to achieve oil independence.¹⁴ Part I also includes future projections for the Brazilian ethanol production industry. Part II describes the identifiable benefits that the development of fuel ethanol has brought including how fuel ethanol has, in large part, provided the residents of Brazil's major centers with lower carbon dioxide emission levels, cleaner air, and presumably healthier lives. Part II also explores some of the deficiencies in the process that have negatively impacted Brazilian society overall, and particularly the local residents, communities and ecosystems where the sugarcane is grown and ethanol is developed. For these communities, ethanol production has brought terrible working conditions, poor health conditions, and harm to the natural ecosystems through changing land and natural resource use; it has also promoted instability among local communities. Part III attempts to articulate and incorporate some of these benefits and deficiencies into a workable cost-benefit analysis to assess the Brazilian ethanol production industry and the impact it has had on its citizens, the country as a whole, and the environment. Part IV attempts to draw some conclusions and assess possible solutions and the role that

centration of wealth in a small percentage of Brazilian society, limited and differential access to education, housing, and social services based on locale, and the implications of foreign investment and trade are not the focus of this Comment. Of course, these are issues relevant to the overall question of whether Brazil has acted in accordance with the principles of sustainable development in its energy policies and ethanol program.

¹⁴ Brazilian Law No. 2.004 sanctioned on October 3, 1953, established the state's monopoly in key sectors of oil production including the refining of both domestically produced and imported oil. Soleis—Legislação Federal, <http://www.soleis.adv.br/> (click on link "LEIS POR ASSUNTO," then click on "P," then click on "Petrobrás—Objeto"), *amended and superceded by* Law No. 9.478, enacted Aug. 6, 1997 and Law No. 11.540, enacted Nov. 12, 2007 (last visited Jan. 31, 2008). On March 12, 1954, Petróleo Brasileiro S.A. (Petrobras), the nationalized company operating this oil production monopoly, was established. About Petrobras, http://www2.petrobras.com.br/Petrobras/ingles/historia/pop/lei/p_lei2004.htm (last visited Jan. 31, 2008). Among its activities, Petrobras has been engaged in off-shore rigging for over twenty years. About Petrobras, http://www2.petrobras.com.br/ingles/ads/ads_Petrobras.html (click on link "self-sufficiency") (last visited Jan. 31, 2008). Within that time at least thirty-five oil workers have been killed at Petrobras facilities, thirty-four others were killed in an oil platform explosion, and approximately five million liters of oil have been spilled. *Race to Stop Oil Rig Disaster*, BBC News, Mar. 17, 2001, <http://news.bbc.co.uk/2/hi/americas/1227193.stm>. Estimates are that, to date, Petrobras has paid close to \$140 million in fines related to these incidents. *Id.*

environmental justice could play in the evolving debate concerning Brazilian ethanol production.

I. THE BRAZILIAN SUCCESS: PRODUCING ETHANOL FUEL AND ACHIEVING OIL INDEPENDENCE

*Brazil's record shows that it is possible to combat poverty, advance industrial development and develop economically and socially while reducing air pollution and improving air quality. Strong governmental programmes to control vehicle air pollution coupled with extensive use of biofuels have greatly reduced pollution from carbon monoxide, lead and sulfate compounds in our cities. At the same time, our industries have been moving towards more sustainable and cleaner production processes.*¹⁵

*Rural poverty has always been intrinsically related to the economy of sugarcane. Even in the 1970s, when Pernambuco was the largest national producer of sugarcane, the levels of poverty were amongst the highest in the world.*¹⁶

A. The Industrialized World's Ravenous Quest for Energy and the Allure of Ethanol

There is, perhaps more than ever before, a sense of urgency to develop and implement cost-effective and reliable alternatives to reduce reliance on foreign oil and other fossil fuels.¹⁷ Fossil fuels account for approximately 80% of our global energy supply,¹⁸ and our global consumption of crude oil specifically is 42% of the world's total energy consumption.¹⁹ Collectively, "renewable" energy makes up nearly 14% of both the world's supply and consumption.²⁰ Looking beyond the geopolitical concerns regarding

¹⁵ Ronaldo Mota Sardenberg, Ambassador, Federative Republic of Brazil, Statement at the Fifteenth Meeting of the Comm'n on Sustainable Dev., United Nations (May 10, 2007), available at http://www.un.org/esa/sustdev/csd/csd15/statements/brazil_10may.pdf.

¹⁶ KENFIELD, *supra* note 3, at 2 (quoting Marluce Melo of the Pastoral Land Commission (CPT) located in the northern Brazilian city of Recife, Pernambuco).

¹⁷ Murray, *supra* note 5; Peter Baker & Bill Brubaker, *Bush Hails International Ethanol Production*, WASH. POST, Mar. 9, 2007, available at www.washingtonpost.com/wp-dyn/content/article/2007/03/09/AR2007030900767_pf.html (quoting Brazilian President Luiz Inacio Lula da Silva as saying that he was "almost obsessed by biofuel").

¹⁸ Oil, coal, and gas currently make up approximately 34%, 25%, and 21%, respectively, of the global energy supply. INT'L ENERGY AGENCY, KEY WORLD ENERGY STATISTICS 6 (2006), available at <http://www.iea.org/textbase/nppdf/free/2006/key2006.pdf> [hereinafter IEA] (reporting based on 2004 figures that calculated the total world energy supply at 11,059 Mega tonnes oil equivalent (Mtoe)).

¹⁹ *Id.* at 28 (reporting that in 2004, 7,644 Mtoe were consumed globally).

²⁰ *Id.* at 6, 28.

oil-producing countries,²¹ there is the looming reality of the finite nature of fossil fuels that at some point must be taken into account, as well as the environmental and social costs attributable to strict reliance on fossil fuels. Specifically, our dependence on fossil fuels has increased the overall level of carbon dioxide²² and caused global warming that has created climate change.

Fossil fuels are accurately characterized as “exhaustible,” and currently these exhaustible fossil fuels constitute approximately 80% of the global energy supply.²³ Given the finite limitations of fossil fuels, if the production and consumption levels remain constant, our situation will be grave.²⁴ Assuming that the rate of production and consumption remain constant and do not increase, the known reserves of oil are expected to yield for only another forty-one years, natural gas reserves for a slightly longer sixty-four years, and coal reserves for another 155 years.²⁵ Some critics of unabated fossil fuel consumption also point to the increased production costs that are likely to ensue as we near exhaustion of our fossil fuel reserves.²⁶ These would presumably hasten the depletion of our reserves.

²¹ Whether the issue is framed as “the instability existing within the major oil-producing countries” or the “security of supply,” it seems that most countries are looking for alternatives to strict reliance on gasoline because of a growing discomfort with dependence on oil, specifically oil exported from the Middle East. See RENEWABLE FUELS ASS’N, *HOMEGROWN FOR THE HOMELAND: ETHANOL INDUSTRY OUTLOOK 2005* 6 (2005) [hereinafter RFA]. There is an entrenched concern over the political instability of the region, and disruption of the “flow of oil” from terrorist and “sabotage attacks.” *Id.* For many oil importing companies these disruptions and lack of stability have created an additional “risk premium” that has added to the price of oil. *Id.* The current situation is probably even more precarious as populous developing and expanding nations, especially China and India, have been at the forefront of the increased worldwide demand for oil. *Id.* The wake-up call came in 2004, when oil prices hit a then world high of over fifty dollars a barrel. *Id.* In the United States, the demand continues to exceed the domestic supply. *Id.* The result is ever-growing imports to meet this demand, coupled with record prices for a gallon of gasoline. *Id.* See also IEA, *supra* note 18, at 10–11 (reporting that in 2005, the Middle East was the largest producer of crude oil by region with nearly 31% of the world’s production; Saudi Arabia and the Islamic Republic of Iran produced 13.2% and 5.2%, respectively of the world’s crude oil).

²² IEA, *supra* note 18, at 44 (reporting that from 1973 to 2004 total carbon dioxide emissions increased from 15,661 to 26,583 Mega tones (Mt) and the percentage attributable to oil decreased from 51% (7987 Mt) to 40% (10,633 Mt)).

²³ Goldemberg, *supra* note 9, at 808.

²⁴ *Id.*

²⁵ *Id.* (“[F]ossil fuels cannot be considered as the world’s main source of energy for more than one or two generations.”).

²⁶ *Id.* (“[P]roduction costs will increase as reserves approach exhaustion and as more expensive technologies are used to explore and extract less attractive resources.”).

The finite nature of fossil fuels, coupled with the instability of the Middle East,²⁷ and the social and environmental costs of fossil fuel dependence have added to the allure of renewable energy. Ethanol fuel is heavily linked to the societal concern of decreasing overall greenhouse gas emissions as well as the broader issues of “climate control,” including that of global warming.²⁸ Advocates of ethanol-fueled cars opine that the carbon introduced into the atmosphere by ethanol-powered cars is preferable to that of gasoline-powered cars, because in theory there are “no net emissions.”²⁹

Of the three grades of ethanol, fuel grade ethanol is the most widely produced grade.³⁰ In 2004, almost eleven billion gallons of ethanol were produced globally, eight billion of which was fuel ethanol.³¹ UNICA, the São Paulo Sugarcane Agroindustry Union,³² reports lower current numbers of 9.25 billion gallons (thirty-five billion liters) for total ethanol production, and only 5.55 billion gallons (twenty-one billion liters) for fuel ethanol.³³ Ethanol can be produced from various plant-based feed stocks, the most common being those from grain or sugar crops.³⁴ Ethanol powers automotive engines in one of two ways.³⁵ It can either completely replace gasoline in specially designed internal combustion engines, or it is effective as an “octane booster,”³⁶ or fuel extender,³⁷ when mixed with gasoline in blends of 5% to 30%.³⁸ Ethanol-gasoline blends require no modification to automobile engines and

²⁷ *Id.* at 809 (Certainly Brazil, when first launching its Proálcool program in the mid-1970s, was motivated in large part by the desire to reduce oil imports.).

²⁸ *Id.* at 808.

²⁹ Emma Marris, *Drink the Best and Drive the Rest*, 444 NATURE 670, 670 (2006) (reasoning that carbon emissions from gasoline come exclusively from fossil reserves, while the carbon emissions from ethanol were carbon that had previously existed in the atmosphere “just a couple of years ago, before the sugar cane got hold of it and worked its photosynthetic miracle”); Murray, *supra* note 5.

³⁰ RFA, *supra* note 21, at 14. The other two grades of ethanol are beverage and industrial ethanol.

³¹ *Id.* (reporting that of the approximately eleven billion gallons of ethanol produced, 73% was fuel ethanol, with beverage and industrial ethanol only 17% and 10%, respectively).

³² UNICA, *supra* note 8.

³³ UNICA, <http://www.portalunica.com.br/portalunicaenglish/index.php?Secao=social%20aspects&SubSecao=Health%20and%20environment&SubSubSecao=&id=4> (last visited Oct. 30, 2007) (reporting that global production of ethanol is at thirty-five billion liters per year with 60% used as fuel).

³⁴ Murray, *supra* note 5.

³⁵ Christoph Berg, WORLD FUEL ETHANOL ANALYSIS AND OUTLOOK (2004), available at <http://www.distill.com/World-Fuel-Ethanol-A&O-2004.html>.

³⁶ *Id.*

³⁷ Murray, *supra* note 5 (describing use of ethanol in gasoline vehicles).

³⁸ Berg, *supra* note 35 (noting that although ethanol mixes easily with gasoline, it

“achieve the same octane boosting or anti-knock effect as petroleum-derived aromatics like benzene or metallic additives like lead.”³⁹

B. The History of Brazilian Ethanol Production: Subsidies for the Producers and the Consumers

The history of Brazilian ethanol production dates back to 1903, when the sugar industry began producing ethanol as a way of insulating itself from fluctuations in the international sugar market, but did not begin in earnest until 1975.⁴⁰ In 1975, the Brazilian military government responded to increased high oil prices by launching the Proálcool program as a way to replace gasoline with ethanol.⁴¹ The Proálcool program incorporated both incentives to encourage ethanol production and subsidies to lower ethanol prices for consumers.⁴² Some Brazilian officials⁴³ have described the early trajectories as a “learning curve,” as ethanol production increased an average of 6% per year while the costs of production declined.⁴⁴ While production costs were decreasing, the costs “at the pump” for consumers were also heavily subsidized, usually in the form of state-controlled prices and consumer taxes, so as to favor consumption of fuel ethanol instead of gasoline.⁴⁵ The Proálcool program also mandated the type and percentages of ethanol and gasoline that were offered on the consumer fuel market. In 1975, a 22%–25% ethanol-gasoline blend was mandated in the

does not blend easily with diesel and can require emulsifiers if the “diesohol blend” is to obtain more than 3% ethanol).

³⁹ *Id.*; see also Murray, *supra* note 5 (noting that ethanol can be used alone in “flexible-fuel vehicles” that run on any blend of ethanol and gasoline).

⁴⁰ See ENVTL. AND ENERGY STUDY INST. (EESI), ECO: ETHANOL CLIMATE PROT. OIL REDUCTION: A PUBLIC FORUM 2 (2001) [hereinafter EESI].

⁴¹ Berg, *supra* note 35; Murray, *supra* note 5. In 1975, PROALCOOL, Brazil’s National Alcohol Program, was launched to reduce Brazil’s dependence on foreign oil. MARCUS RENATO XAVIER, COMPETITIVE ENTERPRISE INSTITUTE, THE BRAZILIAN SUGARCANE ETHANOL EXPERIENCE 4 (2007), <http://www.cei.org/pdf/5774.pdf>. At that point, 80% of the oil in Brazil was imported, and “the 1973 OPEC oil embargo and production cutback had raised concerns that oil dependency could endanger national security.” *Id.*; see also Goldemberg, *supra* note 9, at 809 (explaining that the Brazilian government was motivated “to reduce oil imports that were consuming one-half of the total amount of hard currency from exports”).

⁴² Berg, *supra* note 35.

⁴³ Professor José Goldemberg is the Secretary of the Environment for Government of the State of São Paulo.

⁴⁴ Goldemberg, *supra* note 9, at 809 (reporting that production increased from 0.9 billion gallons of ethanol in 1980 to three billion gallons in 1990 to 4.2 billion gallons in 2006).

⁴⁵ *Id.* (stating that the real cost to a consumer for ethanol fuel in 1980 was roughly three times that of gasoline, but the price differences were subsidized).

Brazilian market, and then in 1979 a pure ethanol was introduced into the automotive fuel market.⁴⁶ The Brazilian government also put into place incentives to encourage automobile manufacturers to produce engines that could run on 100% “pure hydrated ethanol.”⁴⁷

It has been estimated that these various consumer and producer subsidies totaled approximately \$30 billion over twenty years,⁴⁸ with \$12.3 billion spent in the years between 1975 and 1989, primarily in agricultural and industrial sector investments.⁴⁹ Supporters of the Proálcool program argue that this cost was more than offset by the \$50 billion decrease in oil imports as of the end of 2006.⁵⁰ Although the government at the time amounted to a “military regime,” these mandatory regulations are now viewed as having been key to both the “success” of the ethanol production program,⁵¹ and to enabling the implementation of democratic processes.

C. The Current Brazilian Sugarcane and Ethanol Agribusiness

Today, approximately 40% of the fuel sold in Brazil includes ethanol.⁵² Estimates are that a quarter of the fuel used in Brazilian ground transportation is sugarcane-derived ethanol.⁵³ Current production estimates are that Brazil produces 10.4 billion liters/year, of which approximately 62% are produced in the state of São Paulo.⁵⁴ Much of the “success” of the ethanol production program in Brazil is at least partially dependent on the strength of the “flex-fuel cars”⁵⁵ that predominate the Brazilian automobile consumer market.⁵⁶ Since Ford and Volkswagen first launched flex-fuel pro-

⁴⁶ EESI, *supra* note 40, at 2; Goldemberg, *supra* note 9, at 809.

⁴⁷ Goldemberg, *supra* note 9, at 809.

⁴⁸ *Id.* All dollar amounts are measured in United States currency.

⁴⁹ XAVIER, *supra* note 41, at 6.

⁵⁰ Goldemberg, *supra* note 9, at 809.

⁵¹ *Id.* (stating that these ethanol-gasoline blend mandates constituted a “Renewable Portfolio Standard for fuel” that is now being considered as a model in several states of the United States, Japan, and the European Union).

⁵² Murray, *supra* note 5; XAVIER, *supra* note 41, at 3; EESI, *supra* note 40, at 2.

⁵³ Chris Somerville, Editorial, *The Billion-Ton Biofuels Vision*, 312 *SCIENCE* 1277, 1277 (June 2, 2006).

⁵⁴ UNICA, A Clean and Renewable Fuel, http://www.unica.com.br/i_pages/alcool_alcoolcombustivel.asp (last visited Jan. 31, 2008).

⁵⁵ XAVIER, *supra* note 41, at 6 (noting how flex-fuel cars can run on both gasoline, ethanol, or a mixture of the two); *see also* EESI, *supra* note 40, at 2. Henry Ford’s design for the Model T allowed it to be powered by either ethanol or gasoline since ethanol constituted a major portion of the fuel transportation market until the 1930s when the low oil prices allowed gasoline to dominate the market. *Id.*

⁵⁶ *See* UNICA, A Clean and Renewable Fuel, http://www.unica.com.br/i_pages/

totypes in 2002, the percentage of new automobiles bought in Brazil has been steadily increasing to current estimates of 73% to 80%.⁵⁷ As of 2007, there are approximately 23 million automobiles in Brazil for the 49.1 million households, an average of 0.47 vehicles per household.⁵⁸ It is estimated that as many as three million automobiles in Brazil run on one form of ethanol, hydrated alcohol, and that the other form, anhydrous alcohol, is added to yield the 22% blended gasoline sold in Brazil.⁵⁹

Brazilian cars have much smaller motors than their American counterparts.⁶⁰ Ethanol yields fewer miles (or kilometers) per gallon (or liter) than regular or regularly blended gasoline.⁶¹ The consumer appeal of a flex-fuel car is that an owner can constantly choose between “neat ethanol,” and the “regular” (i.e., gasoline-ethanol blended) gasohol based on the current prices and any applicable local tax rates.⁶² While some pundits have lauded the freedom of switching back and forth as one drives through Brazil,⁶³ some critics have noted that, without any price subsidy, ethanol is only price-competitive for Brazilian drivers “when it costs no more than 70 percent of the price of gasoline.”⁶⁴ The farther away from

alcohol_alcoolcombustivel.asp (last visited Jan. 31, 2008) (estimating that within the last twenty-two years, \$1.8 billion per year was saved by replacing gasoline with fuel ethanol, the “equivalent to 200 thousand barrels of gasoline/day”).

⁵⁷ XAVIER, *supra* note 41, at 6 (noting that in March 2004, 16% of all new automobiles sold in Brazil were flex-fuel cars, and that by February 2006 that figure had increased to 73%); União da Agroindústria Canavieira de São Paulo (UNICA), ETHANOL FROM SUGAR CANE IN BRAZIL: EVOLUTION, PRESENT SITUATION AND FUTURE POSSIBILITIES (2006) [hereinafter ETHANOL FROM SUGAR CANE IN BRAZIL] (reporting that as of May 2005, 80% of all new cars sold in Brazil were flex-fuel cars); *Brazil Ethanol Workers “Badly Treated,”* MAIL & GUARDIAN ONLINE, Mar. 22, 2007, http://www.mg.co.za/articlepage.aspx?area=/breaking_news/breaking_news__business/&articleid=302675 (“More than four out of five new cars in Brazil can run on ethanol, either mixed with gasoline or pure.”); Stan Lehman, *Brazil Police Battle Bush Protesters*, WASH. POST, Mar. 9, 2007 (stating that President George W. Bush approved of Brazil’s ethanol program, which he noted “powers eight out of every 10 new Brazilian cars.”).

⁵⁸ XAVIER, *supra* note 41, at 3. In stark contrast, the average automobile to household ratio in the United States is 1.9 vehicles per household; in addition, there are 204 million vehicles for 107 million households. *Id.*

⁵⁹ UNICA, A Clean and Renewable Fuel, http://www.unica.com.br/i_pages/alcohol_alcoolcombustivel.asp (last visited Sept. 18, 2007).

⁶⁰ XAVIER, *supra* note 41, at 3.

⁶¹ *Id.* at 8; Marris, *supra* note 29, at 670 (reporting a lower distance yield of approximately 20% to 30% fewer kilometres to the litre); Robert F. Service, *Cellulosic Ethanol: Biofuel Researchers Prepare to Reap a New Harvest*, 315 SCIENCE 1488, 1488 (2007) (noting that in the United States, ethanol gave way to “cheap and plentiful gasoline” which yields “30% more energy per gallon than ethanol does”).

⁶² Marris, *supra* note 29, at 670.

⁶³ *Id.*

⁶⁴ XAVIER, *supra* note 41, at 9.

production areas, the less price-competitive ethanol becomes.⁶⁵ A city like Rio de Janeiro, or other areas in the North and Northeast of Brazil, is economically precluded from selecting ethanol because of the high transportation costs and lack of economic viability of ethanol.⁶⁶ Others have noted possible manufacturer reluctance to produce ethanol-only vehicles and diminishing sales of ethanol fuel as signs of a possible decline in the Brazilian domestic ethanol market.⁶⁷ Despite this, the future plans for Brazil include the extension of the flex-fuel technology to encompass and include all light vehicles.⁶⁸

Increasingly, the Brazilian government has rolled back the state-sponsored subsidies and incentives that have impacted both the ethanol production and consumption markets. The price subsidies on ethanol have been “progressively removed” since the 1990s, and as of 2004, ethanol and gasoline have been “fully competitive” with one another on the “international market” without the benefit of government assistance.⁶⁹ Due to both economies of scale and modern advances in process and equipment technology, production subsidies “are a thing of the past in Brazil.”⁷⁰ It should be interesting to note whether the Brazilian “freedom of choice” between ethanol and gasoline by the consumer at the pump will continue when faced with more market-driven prices.

D. Brazil: The “Success” Lies in the Process

No other country in the world has an ethanol production scheme rivaling that of Brazil.⁷¹ Even the United States, with its established ethanol production process relying exclusively on corn,

⁶⁵ See generally *id.*

⁶⁶ *Id.*

⁶⁷ EESI, *supra* note 40, at 2.

⁶⁸ XAVIER, *supra* note 41, at 6; see also ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57 (stating that the current fleet of Brazilian light vehicles is estimated at twenty-two million; current estimates are that ethanol is used in roughly 41% of the fuel used to run the light vehicle fleet).

⁶⁹ Goldemberg, *supra* note 9, at 809.

⁷⁰ *Id.* The technological advances in terms of equipment include “the use of high-pressure boilers that allow cogeneration of electricity,” which result in energy “surpluses sold to the electric power grid” affording ethanol production plants revenue from not only the ethanol itself but from the surplus energy generated through the burning of the bagasse. *Id.*

⁷¹ Murray, *supra* note 5 (reporting that Brazil led world ethanol production in 2004, with the United States, China, India and France close behind, respectively). China produced nearly one billion gallons of ethanol primarily from its wheat and corn rich provinces; India produced 500 million gallons of ethanol made from sugar-cane; and France, “the front-runner” within the European Union, produced over 200 million gallons from sugar beets and wheat. *Id.*

yields no more than 3.5 billion gallons⁷² and at a much higher cost per yield of energy.⁷³ Brazil is the clear leader in the global market for the production of sugarcane (33.9%), sugar (18.5%) and ethanol (36.4%).⁷⁴ Of the total sugarcane available for crushing in Brazil, 45% is used for sugar production, while 55% is used for ethanol production.⁷⁵ Reported figures state that between 1990 and 1997, Brazil produced between 11.5 to 12.5 billion liters of ethanol.⁷⁶ From 1996 to 1998, the production of ethanol peaked from over fourteen billion to nearly 15.5 billion liters.⁷⁷ Reported figures from 1998 to 2002 indicate a decrease from nearly fourteen billion to just over 11.5 billion liters.⁷⁸ Still, by 2004, Brazil was already the world's leader in the distillation of ethanol at four billion gallons (fifteen billion liters) per day.⁷⁹ Two years later, this figure increased to 4.2 billion gallons.⁸⁰ It is speculated that in 2007, Brazil will have produced 4.4 billion gallons (16.5 billion liters).⁸¹ Currently, Brazil is also the largest exporter of both sugar and ethanol.⁸²

Despite criticisms of the ethanol program in terms of its harm to rural communities, issues of changing land-management,

⁷² Murray, *supra* note 5; see also RFA, *supra* note 21, at 2 (reporting that more than 30% of the gasoline sold in the United States contains ethanol).

⁷³ Murray, *supra* note 5 (noting that the amount of energy needed to make ethanol from corn nearly matches the energy contained in the ethanol itself).

⁷⁴ ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57; see also *Brazil Ethanol Workers "Badly Treated," supra* note 57 (explaining that in 2006, Brazil produced approximately 17.7 billion liters of sugarcane-based ethanol constituting roughly 35% of the global supply).

⁷⁵ UNICA, <http://www.portalunica.com.br/portalunicaenglish/?Secao=sugarcane> (last visited Apr. 15, 2008).

⁷⁶ UNICA, http://www.unica.com.br/i_pages/estatisticas/prod/alcooltotal/br.htm (last visited Sept. 11, 2007) (1990–1991, 11,515,151 m³ produced; 1991–1992, 12,716,180 m³ produced; 1992–1993, 11,697,035 m³ produced; 1993–1994, 11,285,590 m³ produced; 1994–1995, 12,696,780 m³ produced; 1995–1996, 12,583,392 m³ produced).

⁷⁷ *Id.* (1996–1997, 14,379,700 m³ produced; 1997–1998, 15,407,514 m³ produced).

⁷⁸ *Id.* (1998–1999, 13,912,207 m³ produced; 1999–2000, 13,002,326 m³ produced; 2000–2001, 10,593,035 m³ produced; 2001–2002, 11,560,652 m³ produced).

⁷⁹ Murray, *supra* note 5; ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57. In 2005, reports were that 310 sugar mills processed 380 Mt sugarcane to yield twenty-six Mt sugar and 4.1 billion gallons of ethanol. *Id.*

⁸⁰ XAVIER, *supra* note 41, at 7.

⁸¹ See Hearn, *supra* note 3; XAVIER, *supra* note 41, at 7 (reporting that the production figures have increased to roughly fifty-five million tons of sugar or ethanol generated by 306 operating mills).

⁸² UNICA, http://www.unica.com.br/i_pages/estatisticas/maiores_exp_acucar_ing.htm (last visited Sept. 25, 2007). In 2001, Brazil exported 11,168,722 metric tons of sugar, which was nearly seven million metric tons more than the second largest exporter of sugar, the European Union. *Id.*

human rights abuses, and worker mistreatment, it has the potential to create a locally-produced, renewable fuel source that enables countries to lower their dependence on oil imports, to improve trade imbalances with other nations that are also seeking to wean themselves from oil, and to diversify their own energy portfolios—a potential that Brazil has embraced.⁸³

The “success” of the Brazilian ethanol production can in many ways be explained by looking at Brazil’s relative success in meeting “three key success factors”: the abundance and inexpensive cost of the sugarcane; the closed loop process and technology involved; and a supportive state and political framework.⁸⁴ With a thirty-year history of production, the Brazilian ethanol production has achieved the status of a “global energy commodity that is fully competitive with motor gasoline and appropriate for replication in many countries.”⁸⁵ The questions for both environmental justice and labor rights advocates are whether this replication is in fact appropriate and, if not, how replication of this model would impact those regions and communities.

Few countries are as uniquely situated as Brazil is to take advantage of the accurately characterized “simplicity” of the sugarcane-based ethanol production process.⁸⁶ Sugarcane is crushed to extract a sucrose solution that is then fermented along with yeast into alcohol.⁸⁷ This alcohol is then distilled to the “desired concentration.”⁸⁸ In Brazil, this production process is powered by burning the “bagasse,” the fibrous pulp left over when the sugar is squeezed from the cane.⁸⁹ Current figures indicate that bagasse and straw produce approximately 100 million tons of usable waste.⁹⁰ This “waste” is considered to be one of the significant advantages of sugarcane-based ethanol since it too can be used as

⁸³ Murray, *supra* note 5.

⁸⁴ Berg, *supra* note 35.

⁸⁵ Goldemberg, *supra* note 9, at 808.

⁸⁶ See generally Marris, *supra* note 29, at 670 (“Brazil’s tropical sun makes it a great place for growing sugar cane: it is the largest cane producer in the world, producing more than twice as much as the number two, India.”).

⁸⁷ *Id.*; see also Service, *supra* note 61, at 1489 (explaining that starch is “a straightforward polymer of glucose that is easily broken down by enzymes”).

⁸⁸ Marris, *supra* note 29, at 670.

⁸⁹ *Id.*; see also José E. D. Cançado et al., *The Impact of Sugar Cane-Burning Emissions on the Respiratory System of Children and the Elderly*, 114 ENVTL. HEALTH PERSP. 725, 728 (2006) (citing the Brazilian Agriculture Ministry’s 2005 report that approximately 80% of the sugarcane crops are burned annually as part of the harvesting process).

⁹⁰ XAVIER, *supra* note 41, at 7 (explaining that the waste can be used as fuel for heat and power generation).

fuel—the fuel that drives the process.⁹¹ This use of sugarcane, as both the raw material for fuel ethanol and the fuel that powers the process, is the reason the Brazilian ethanol production process is so often referred to as a “closed one.”⁹² This burning of the bagasse, however, has its own price. The issue of environmental and health problems for the rural communities where production occurs, and for the sugarcane cutters and workers who labor in the process, is certainly not lauded or even discussed among ethanol advocates.⁹³

E. Plans for the Future: Increased Production and Exportation

The consensus among Brazilian political and economic leaders is that as more countries and states begin to address the issues surrounding foreign-oil, greenhouse gases, air pollution, and declining public health, the demand for Brazilian fuel ethanol will increasingly be thought of as a solution to these problems.⁹⁴ Reports from the Brazilian Ministry of Agriculture indicate that Brazil is projected to increase production of fuel ethanol to 442,000 barrels a day by 2010.⁹⁵ In June of 2006, UNICA reported that forty-one new mills were being built and another fifty more were in an evaluation phase.⁹⁶ The projected increase in ethanol production from these ninety-one new operations could be as high as 50%.⁹⁷

⁹¹ See *id.*

⁹² See generally Marris, *supra* note 29, at 670 (“Put the alcohol into your gas tank and you are effectively driving it on sunlight.”); XAVIER, *supra* note 41, at 7. Brazilian distilleries and mills are nearly self-sufficient in terms of the energy required to fuel operations. *Id.* The energy generated from the bagasse affords an opportunity to sell surplus electricity. *Id.*

⁹³ Tom Phillips, *Brazil's Ethanol Slaves: 200,000 Migrant Sugar Cutters Who Prop Up Renewable Energy Boom*, THE GUARDIAN (London), Mar. 9, 2007, available at <http://www.guardian.co.uk/brazil/story/0,,2029962,00.html>. Phillips reports on the “much bleaker picture” of ethanol production, where “thick green plantations of sugar cane stretch out as far as the eye can see” on one side of the road, and on the other:

lopsided red-brick shacks crowd together, home to hundreds of impoverished workers . . . working 12-hour shifts in scorching heat and earning just over 50p [pence] per tonne of sugar cane cut, before returning to squalid, overcrowded “guest houses” rented to them at extortionate prices by unscrupulous landlords, often ex-sugar cutters themselves.

Id.; see also 1,000 Laborers at Plantation Rescued, L.A. TIMES, July 4, 2007, at A8.

⁹⁴ EESI, *supra* note 40, at 2–3 (noting that in Mexico, Canada, European Union, France, Netherlands, Sweden and Spain there is a growing interest and support among political leaders for the use of ethanol as a gasoline alternative).

⁹⁵ Marris, *supra* note 29 (noting that in 2005, Brazil produced 282,000 barrels (forty-five million liters) a day).

⁹⁶ ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57.

⁹⁷ *Id.*

Petrobras, the Brazilian state-controlled oil giant, is at the forefront of this push to expand the current levels of ethanol production.

In a recently revealed project, developed cooperatively by the University of Campinas in São Paulo and the Ministry of Science and Technology, Brazil is striving for an ethanol production increase with the goal of replacing 10% of the world's demand for gasoline within the next twenty years.⁹⁸ This would mean increasing the roughly three billion liters (660,000 gallons) currently exported to 200 billion liters (forty-four billion gallons) over the course of twenty years,⁹⁹ an increase of nearly 670%.¹⁰⁰ The estimated cost to do this would be \$10 billion per year for the first four to five years, and then diminishing costs until the last seven to eight years when the return on investment would begin to cover the costs.¹⁰¹ In other reports, Petrobras stated that Brazilian ethanol production can be increased "15 times over five years," and, to ease the concern of environmental groups, this could be done "without further destruction of the Amazon or harming food production."¹⁰²

In addition, there are calls from Brazilian interests and others to invest and implement new technologies within the biofuels industry to increase ethanol production by improving the process, potentially chilling criticisms by environmental advocates over certain aspects of ethanol production and its impact on rural communities and land use in Brazil. The Brazilian ethanol industry envisions that over the next two decades, the implementation of "bio-refineries" to fully utilize the potential of the baggasse, waste, and currently unused sucrose will enable much of these increased target goals.¹⁰³ According to these groups, there already exists a global interest in developing the technology by which energy and fuel can be derived from the hydrolysis or gasification of biomass.¹⁰⁴ Advocates of these technologies note that once these technologies are implemented and working in Brazil, they can and should be implemented in other countries that are similarly situated in terms of climate and ability to cultivate sugarcane in these

⁹⁸ Agency France-Presse, *If Increased Brazilian Ethanol Production Could Replace 10% of Global Gasoline*, INDUSTRY WEEK, Feb. 15, 2007, available at <http://www.industryweek.com/ReadArticle.aspx?ArticleID=13610&SectionID=2> [hereinafter INDUSTRY WEEK].

⁹⁹ *Id.*

¹⁰⁰ KENFIELD, *supra* note 3, at 1.

¹⁰¹ INDUSTRY WEEK, *supra* note 98.

¹⁰² *Brazil Ethanol Workers "Badly Treated," supra* note 57.

¹⁰³ ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57.

¹⁰⁴ *Id.*

quantities.¹⁰⁵ Often the rhetoric of sustainable development is used as the justification.¹⁰⁶

The Brazilian government also has plans for increased export of ethanol production.¹⁰⁷ Current estimates show that although 80% of Brazil's ethanol production is for domestic use, production for exports will continue to increase.¹⁰⁸ Production intended for both domestic use and export abroad has increased in the last decade.¹⁰⁹ In 2006, Brazil exported roughly 19% of the sixteen billion liters produced, thereby supplying the world with 70% of its ethanol supply.¹¹⁰ It is estimated that by 2010, Brazilian companies will have invested roughly \$10 billion to create dozens of new sugar mills to ramp up ethanol production with a goal of doubling the current export levels.¹¹¹ Despite arguments to the contrary, this targeted increase would require an increase in current land used to grow sugarcane. Estimates are that the current level of six million hectares will need to be increased to thirty million hectares.¹¹²

¹⁰⁵ See Goldemberg, *supra* note 9, at 809 ("Production of ethanol from sugarcane can be replicated in other countries without serious damage to natural ecosystems.").

¹⁰⁶ UNICA, *Energy and Sustainability: Sugar Cane Ethanol—Commodity of the 21st Century* (Sept. 19, 2005), http://www.unica.com.br/i_pages/files/energy_sugar.pdf.

The time has come for renewable energy: humanity realizes that there is an obligation to recognize the properties of fuels recovered from newly reaped vegetable material. . . . Such orientation is clear in the provisions of the Kyoto Protocol, which is already in force. There, the matters pertaining to climate changes, income generation in developing countries, efficient use of non-renewable energy sources

. . . .

We want to be important participants in the greatest operation ever designed by humans to make our planet habitable for future generations: to make the dream reflected in the Kyoto Protocol goals come true by multiplying the use of ethanol.

Id.

¹⁰⁷ KENFIELD, *supra* note 3, at 1.

¹⁰⁸ XAVIER, *supra* note 41, at 7.

¹⁰⁹ RFA, *supra* note 21, at 15. In 2004, Brazil exported 634 million gallons of ethanol. *Id.* India and the U.S. are the leading buyers importing 125 and 112 million gallons of ethanol, respectively. *Id.* South Korea and Japan imported sixty-three and fifty-five million gallons, respectively, and Sweden and the Netherlands imported fifty-two and forty-one million gallons, respectively. *Id.*

¹¹⁰ KENFIELD, *supra* note 3, at 1.

¹¹¹ XAVIER, *supra* note 41, at 7.

¹¹² KENFIELD, *supra* note 3, at 1; *see also* Goldemberg, *supra* note 9, at 809.

A simple calculation shows that expanding the Brazilian ethanol program by a factor of 10 (i.e., an additional 30 million hectares of sugarcane in Brazil and in other countries) would supply enough ethanol to replace 10% of the gasoline used in the world. This land area is a small fraction of the more than 1 billion hectares of primary crops already harvested on the planet.

Id.

This projected increase is one of the most contentious areas of the ethanol debate as this may require some encroachment upon and use of Brazilian natural forests for the growing of food crops.¹¹³

Certainly, foreign investors have given the Brazilian ethanol production process and agribusiness heavy consideration,¹¹⁴ much to the dismay and fear of environmental justice and worker advocates.¹¹⁵ Some critics who have pointed to a waning domestic market have suggested that Brazil could be using its market position as the undisputed ethanol leader as economic leverage to not only increase exports, but also to market its ethanol “expertise” abroad.¹¹⁶ The United States is the largest importer of ethanol from Brazil.¹¹⁷ In 2006, Brazil exported 1.74 billion liters to the United States; this represented 58% of the total Brazilian export figure of three billion liters.¹¹⁸ Research suggests that President Bush’s targeted reduction of gasoline consumption in the United States will require approximately 135 billion liters of increased ethanol per year.¹¹⁹ This could be a boon to Brazil’s ethanol production market and expansion plans. Perhaps most importantly, the Brazilian government in 2006 could arguably have claimed to have achieved its ultimate goal of “oil self-sufficiency,”¹²⁰ but the question remains: at what price and who among Brazilian society has paid that price?

¹¹³ See Murray, *supra* note 5 (discussing how an increase in land area for ethanol production may negatively impact already diminishing rainforests).

¹¹⁴ See FINANCE, PRIVATE SECTOR AND INFRASTRUCTURE MGMT. UNIT OF THE WORLD BANK, HOW TO REVITALIZE INFRASTRUCTURE INVESTMENTS IN BRAZIL: PUBLIC POLICIES FOR BETTER PRIVATE PARTICIPATION 5 (Report No. 36634-BR) (Jan. 10, 2007) (stating that improvements to Brazil’s infrastructure will necessitate a strengthening of private sector confidence that will require a reduction of costs of capital and curbing of regulatory risks).

¹¹⁵ Kenfield, *supra* note 3, at 3.

¹¹⁶ EESI, *supra* note 40, at 2 (reporting that Brazil and Thailand entered into an agreement in 2001 by which Brazil will provide technical expertise and assistance to help Thailand meet its domestic production goal of two million liters (520,000 gallons) per day by the end of 2002); *id.* at 2–3 (reporting that Ford Motor Company and Thailand’s National Science and Technology Development Administration joined forces in 2001 to promote ethanol production in Thailand “as a means of curbing the nation’s reliance on foreign oil, while boosting domestic crop prices . . . [and to] examine which technologies are most cost-effective and environmentally sound for ethanol production in Thailand.”).

¹¹⁷ KENFIELD, *supra* note 3, at 1.

¹¹⁸ *Id.*

¹¹⁹ *Id.*

¹²⁰ See Associated Press, *Brazil Oil Agency Chief Says Offshore Field Could Nearly Triple Nation’s Reserves*, INT’L HERALD TRIB., Apr. 14, 2008, available at <http://www.ihf.com/articles/ap/2008/04/14/business/LA-FIN-Brazil-Oil.php>.

II. THE ETHANOL TRAP: IMPROVING AIR QUALITY IN URBAN CENTERS WHILE INCREASING AIR POLLUTION AND PUBLIC HEALTH CONCERNS IN RURAL COMMUNITIES

*In Brazil, our experience over the last thirty years with biofuels as an energy source, which began with the Ethanol Program and continues today with the Brazilian Biodiesel program, illustrates the potential that I am referring to. . . . [T]hese policies have resulted in the decrease in the importation of oil and oil derivatives, reduced dependency on fuels from other countries, significant job creation, income generation in semi-arid regions, and the introduction of new crop combinations to these areas. It is important to emphasize that these policies are highly replicable in other countries.*¹²¹

*Most of the expansion required will affect the Cerrado ecosystem and the Amazon, which are already being destroyed because of cattle ranching and soybean farming This displacement effect is not hypothetical São Paulo used to be one of the most important cattle regions in Brazil. Now sugarcane has replaced it and pushed cattle to other places in the Cerrado and Amazon.*¹²²

The development of the Brazilian ethanol production and sugarcane agribusiness has yielded many benefits for Brazil, its citizens, and possibly for future generations that will partake in a cleaner environment.¹²³ There is the decreased dependence on oil imports¹²⁴ and the policy implications and advantages that might be derived from that decreased dependence.¹²⁵ There is “a positive net energy balance,” which means that the energy contained in a given quantity of ethanol is greater than the energy required to produce that amount.¹²⁶ The possibly less harmful impact on the local environment, resulting from ethanol consumption, may also improve overall public health levels.¹²⁷ Arguments have also been made that ethanol production will benefit traditionally disadvan-

¹²¹ Claudio Langone, Exec. Sec’y, Braz. Ministry of the Env’t, Statement at the U.N. Commission on Sustainable Development, 14th Session, New York (May 10–12, 2006), available at www.un.org/esa/sustdev/csd/csd14/statements/brazil_12may.pdf.

¹²² Hearn, *supra* note 3 (quoting Leonardo Lacerda, advocate with the Brazilian chapter of the World Wildlife Fund (WWF)).

¹²³ See Berg, *supra* note 35; Goldemberg, *supra* note 9, at 808.

¹²⁴ See generally Berg, *supra* note 35 (noting that reducing dependence on oil imports is one of several reasons for the success of fuel ethanol).

¹²⁵ Guto Harri, *Brazil’s Sugar Crop Fuels Nation’s Cars*, BBC NEWS, Feb. 15, 2006, <http://news.bbc.co.uk/2/hi/business/4715332.stm> (reporting that the Brazilian sugar industry was able to cut \$400 billion in oil imports and questioning where those saved monies could be spent).

¹²⁶ Berg, *supra* note 35 (noting that the energy contained in one tonne of ethanol is greater than the energy required to produce one tonne).

¹²⁷ See Berg, *supra* note 35.

taged rural areas by creating more jobs¹²⁸ and paving the way for sustained development.¹²⁹ Lastly, advocates of biotechnology generally argue that the research and investment in ethanol production will not only result in improved ethanol fuel and infrastructure, but also in improvements in the overall biomass technology and sector.¹³⁰

A. *Where Brazilians Drive Their Cars: Ethanol Fuel Limits Greenhouse Gas Emissions and Helps Combat Global Warming and Climate Change*

Use of ethanol fuel instead of regular gasoline will absolutely curb the level of carbon dioxide emissions in a given area.¹³¹ This will, in turn, reduce the overall level of greenhouse gases,¹³² and improve the general public health and well-being of the given community or area. Some ethanol advocates also argue that use of biofuel energy forecloses additional greenhouse gases into the atmosphere,¹³³ and reduces overall air pollution since no new greenhouse gases are added to the atmosphere and emission of fine particulates, sulfur, and lead, commonly in the atmosphere from fossil fuel burning emissions, will be reduced.¹³⁴ Addition-

¹²⁸ *Id.*

¹²⁹ Goldemberg, *supra* note 9, at 808 ("Renewable energy is one of the most efficient ways to achieve sustainable development.").

¹³⁰ See Berg, *supra* note 35; U.S. DEP'T OF ENERGY, DOE/sc-0095, BREAKING THE BIOLOGICAL BARRIERS TO CELLULOSIC ETHANOL: A JOINT RESEARCH AGENDA (2006), available at <http://genomicsgtl.energy.gov/biofuels/2005workshop/b2blowres63006.pdf>; COMM'N OF THE EUROPEAN COMMUNITIES, RENEWABLE ENERGY ROAD MAP, RENEWABLE ENERGIES IN THE 21ST CENTURY: BUILDING A MORE SUSTAINABLE FUTURE (2007), available at http://ec.europa.eu/energy/energy_policy/doc/03_renewable_energy_road_map_en.pdf; BIOFUELS RESEARCH ADVISORY COUNCIL, EUROPEAN COMM'N, BIOFUELS IN THE EUROPEAN UNION: A VISION FOR 2030 AND BEYOND (2006), available at <http://cordis.europa.eu/documents/documentlibrary/2720EN.pdf>.

¹³¹ See Hearn, *supra* note 3 ("Biofuel is widely considered a way to reduce greenhouse gases from fossil fuel use and thereby reduce human-caused global warming.").

¹³² ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57 (reporting that current projections suggest that ethanol production, with its 8:1 energy yield to energy used to produce, can reduce overall greenhouse emissions by as much as 13%).

¹³³ See Murray, *supra* note 5 (noting that as sugarcane, or another biofuel crop grows, it absorbs carbon dioxide from the atmosphere which will be offset by the future greenhouse emissions when the fuel is burned but with no net addition); see generally Marris, *supra* note 29, at 670.

¹³⁴ See Murray, *supra* note 5; Goldemberg, *supra* note 9, at 809 ("Renewables are less polluting, both in terms of local emissions (such as particulates, sulfur, and lead) and greenhouse gases (carbon dioxide and methane) that cause global warming."); see also RFA, *supra* note 21, at 12.

Some reports have suggested that even a low 10% ethanol blended fuel could have the following positive impacts: a reduction in the tailpipe fine particulate matter (PM) emissions by 50%; a reduction in second-

ally, as the link between global warming and climate change has been firmly established,¹³⁵ one can argue that when a major urban center, such as the city of São Paulo, transitions from regular gasoline to fuel ethanol, there will be a positive effect on the city and possibly the global environment as well.

It is an indisputable fact that the urban air quality in Brazilian cities has improved within the last thirty years, especially in cities like São Paulo where ethanol fuel has been consumed in large quantities by a vast majority of consumers.¹³⁶ There, the replacement of lead additives in gasoline with ethanol has contributed to improved air quality.¹³⁷ The use of ethanol fuel has also contributed to the general phasing out of lead and MTBE (methyl tertiary butyl ether).¹³⁸ This experience is mirrored in many of the other large Brazilian urban centers.¹³⁹

B. Where Brazilians Produce the Ethanol to Fuel Their Cars: Ethanol Fuel Production Results in Problems With Natural Resource Use, Air Pollution, Declining Public Health, and Inhumane Worker Conditions

Despite these successes, critics of the Brazilian ethanol program have identified a number of environmental problems attributable to the ethanol production industry. Notably, greenhouse gas emissions, worsened air quality, soil erosion, and other environmental problems crop up at the locales where sugarcane is grown and ethanol produced, facts that undermine the otherwise rosy pic-

dary PM formation by diluting aromatic content in gasoline; a reduction in carbon monoxide (CO) emissions by up to 30%—even in new cars; a reduction in toxics content by 13% (mass); and a reduction in toxic contents by 21% (potency).

Id. (noting the composition and character of ethanol—roughly 35% oxygen, “water soluble, non-toxic, and biodegradable”—contributes to reduced particle and greenhouse emissions).

¹³⁵ Elisabeth Rosenthal & Andrew C. Revkin, *Science Panel Says Global Warming Is ‘Unequivocal,’* N.Y. TIMES, Feb. 3, 2007, at A1 (“Global warming is ‘unequivocal’ and that human activity is ‘very likely’ causing most of rise in temperatures since 1950.”).

¹³⁶ XAVIER, *supra* note 41, at 8; ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57; UNICA, Social Aspects: Health and Environment, http://www.unica.com.br/i_pages/sociedade_desenvolv2c.asp (last visited May 17, 2008) (stating that in São Paulo there has been a 57% and 64% reduction in carbon monoxide and hydrocarbon, respectively, “two of the most aggressive pollutants,” despite increased automobile density).

¹³⁷ XAVIER, *supra* note 41, at 8.

¹³⁸ Goldemberg, *supra* note 9, at 809; ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57; UNICA, Social Aspects: Health and Environment, http://www.unica.com.br/i_pages/sociedade_desenvolv2c.asp (stating that lead levels were reduced by 70% to 80% between 1979 and 1983).

¹³⁹ XAVIER, *supra* note 41, at 8.

ture presented by advocates of fuel ethanol. The continued abuse and ill treatment of sugarcane workers, and the rural violence and shifting land-abuse also present problems that are not commonly addressed when evaluating the success of the Brazilian ethanol industry.

i. The Increasing Air Pollution and Decreasing Public Health Standard in the Rural Communities Producing Ethanol

Although consumers, such as drivers of automobiles and urban dwellers, reap the benefits of fuel ethanol's "no new" greenhouse emissions, rural communities and sugarcane laborers cannot make the same claim. In fact, their communities and public health have in many ways worsened from an already bad beginning, as the Brazilian agribusiness has soared. Environmental justice advocates and even ethanol advocates agree that the ethanol program has created greenhouse gas emissions that pollute the air quality in rural areas.¹⁴⁰ Certainly, this issue is at the heart of increasing dialogue concerning the emissions that stem from the burning of sugarcane and bagasse,¹⁴¹ and from fossil fuel powered equipment used in the cultivation and transportation process.¹⁴²

¹⁴⁰ See Marris, *supra* note 29 (stating sugarcane cultivation contributes to the emission of nitrous oxide, a greenhouse gas); see also Isais de Carvalho Macedo et al., *Assessment of Greenhouse Gases* 13–14 (Apr. 2004) (identifying four different models by which GHG emissions can be categorized, in which only Group One could be assumed to have a net contribution of zero).

¹⁴¹ As more countries have begun implementation and innovation with biomass burning, there is raised awareness that emissions from biomass burning are also "an important global source of particles and gases to the atmosphere, especially in the tropics where biomass burning is widespread." Cançado et al., *supra* note 89, at 725. Estimates are that each year "7,500–8,600 Tg (teragrams) of dry material is emitted to the atmosphere around the world through the process of burning." *Id.* Approximately 23% of this total is derived from the burning of agricultural waste. *Id.* In the tropical regions, where biomass burning is more commonplace, it is estimated that 2,000–4,500 Tg of carbon and 36–154 Tg of particulate matter (PM) are annually emitted into the atmosphere. *Id.* Estimates are that 43% of the dry material is derived from savannah burning, 18% from rainforest burning, and 16% from wood burning for fuel. *Id.*

¹⁴² See Macedo, *supra* note 140, at 13–14. Macedo categorizes the remaining three models along similar lines:

Group 2: Carbon flows associated with the use of fossil fuels in the production of all chemicals and inputs used in the agricultural and industrial sectors for the production of sugar cane and ethanol, as well as in the manufacture of equipment, construction of buildings and their maintenance. . . . Group 3: The GHG flows not associated with the use of fossil fuels are mainly N₂O and methane; consideration was given to: Release of other GHG (non CO₂) in the process of cane field burning; Release of N₂O from the soil, due to fertilizer decomposition; Release of

The decreasing air quality and rising public health concerns among rural communities where ethanol is produced is a major, unaddressed problem that is often cited by critics of the Brazilian ethanol program when evaluating or gauging the success of the Brazilian ethanol program. The major factual issue in play is the burning of sugarcane fields twice a year before each manual harvesting.¹⁴³ The same process that makes the Brazilian program such a success—specifically burning bagasse to generate the biomass fuel to power the ethanol production process—seems to be causing the greatest harm to rural communities. The pollution and smoke created by this sugarcane burning is well-documented.¹⁴⁴ The Brazilian government has identified new and tougher legal restrictions on the burning of sugarcane as a way to combat this problem in the future.¹⁴⁵ Additionally, ethanol advocates in both the industry and public sector have argued that the flaw lies in the current technology and process, but that the theory is a sound one and future science will eradicate even this flaw in the system.¹⁴⁶

In 2002, a law was passed by the state of São Paulo mandating that 30% of the so-called “mechanizable areas”—those sugarcane fields with slopes lower than 12%—would not be burned.¹⁴⁷ Despite this law, sugarcane farmers have either failed or been reluctant to comply.¹⁴⁸ The main reason for this lack of compliance is the reluctance to replace inexpensive manual labor with mechanized harvesting, a more expensive proposition.¹⁴⁹ An argument

other GHG (non CO₂) in the combustion of bagasse in steam boilers; Release of other GHG (non CO₂) in the combustion of ethanol in engines. . . . Group 4: This group includes what can be called “virtual” flows of GHG emissions; they would take place if, in the absence of ethanol, the fuel demand was met by gasoline and if in the absence of surplus bagasses, fuel oil was used. These emissions can be categorized as GHG avoided emission by substituting ethanol for gasoline . . . [and] by substituting bagasse for fuel oil in other industrial sectors.

Id.

¹⁴³ Luiz Antonio Martinelli & Solange Filoso, *Polluting Effects of Brazil's Sugar-Ethanol Industry*, 445 NATURE 364, 364 (2007).

¹⁴⁴ See, e.g., Cançado et al., *supra* note 89, at 276.

¹⁴⁵ ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57 (“Legal restrictions on cane burning are providing adequate protection in rural areas.”).

¹⁴⁶ See Murray, *supra* note 5 (suggesting that the problem of noxious burning as well as shifting land use might be resolved by creating technology to take advantage of the “more abundant and land efficient cellulosic feedstocks, such as agricultural and forest residues, grasses, and fast-growing trees”).

¹⁴⁷ Martinelli & Filoso, *supra* note 143, at 364.

¹⁴⁸ See *id.*

¹⁴⁹ *Id.*

can be made that substitution of cheap labor with mechanized farming would undermine the success of the Brazilian ethanol program. Compliance with this law has been pushed back several times, usually at the insistence of the sugarcane cultivation industry¹⁵⁰ which commands enormous political pressure in Brazil. Un-enforceable or non-workable rules such as these have not reduced the smoke pollution arising from ethanol production.¹⁵¹

In rural areas in Brazil where sugarcane is cultivated, the main source of aerosol particles is biomass burning.¹⁵² The pollution from this burning of sugarcane has been linked to an increasing number of respiratory diseases and ailments in the rural areas where sugar is cultivated.¹⁵³ As a general matter, aerosols damage human health, but the consensus is that small particles, especially those of less than 2.5 micrometers (μm) in aerodynamic diameter (PM_{2.5}), are potentially the most damaging because of their ability to penetrate deep into the human lung and impact the lower respiratory organs.¹⁵⁴ This burning of bagasse and the resulting emissions of aerosol and trace gases has also impacted the composition and acidity of rainwater in those areas.¹⁵⁵ Both phenomena have occurred in the state of São Paulo, where twenty tons per hectare are burned annually for harvesting.¹⁵⁶

A limited number of studies address the effects of small aerosol particle emissions on the health of these rural communities. But one recent study attempts to show a causal link by looking at hospital admissions data related to respiratory conditions for the children and elderly populations of the Piracicaba region of São Paulo state.¹⁵⁷ Estimates are that, in the Piracicaba region, the burning of sugarcane contributes to 60% of this “finemode aerosol mass.”¹⁵⁸ The study reported that for both children and elderly populations there were significant percentage increases in hospital emissions related to respiratory conditions during the “burning pe-

¹⁵⁰ *Id.*

¹⁵¹ *Id.*

¹⁵² Cançado et al., *supra* note 89, at 727 (contrasting this with major cities such as New York and Santiago where the major source of airborne particles are fossil fuel emissions).

¹⁵³ Martinelli & Filoso, *supra* note 143, at 364.

¹⁵⁴ Cançado et al., *supra* note 89, at 725 (citing a 1996 study published by the American Thoracic Society).

¹⁵⁵ *Id.*

¹⁵⁶ *Id.*

¹⁵⁷ *Id.*

¹⁵⁸ *Id.* at 727 (noting that the “resuspended soil dust” contributed to 14%, and industry and oil combustion, which each contributed 12% of the aerosol concentration).

riod" as opposed to the "non-burning period."¹⁵⁹ Among children, the percentage increase related to PM10 was approximately 40%, and PM2.5 and BC were approximately 20% each. Additionally, the study reported that the following approximate percentage increases from PM2.5 elements: 30% for potassium; 40% for silicon; and 50% for aluminum.¹⁶⁰ Overall, the study showed that respiratory-related hospital admissions for children were two to three times higher during the burning season.¹⁶¹ The authors of the study posited that these already significant increases could be exacerbated by the lower humidity and temperatures that accompany the periods in which the burning occurs.¹⁶² These lower temperatures and humidity could be impairing the dispersion of the particles and heightening the health and respiratory effects.¹⁶³ The study showed similar results for elderly populations, specifically higher incidents of respiratory admissions among the elderly during the less humid and colder periods when the burning occurred, but found that industrial emissions also contributed to this population's respiratory problems.¹⁶⁴

There is a general consensus among medical science that a population's exposure to high levels of toxins and pollutants can increase "the risk of acute respiratory infections, chronic obstructive pulmonary disease and lung cancer."¹⁶⁵ Children are believed to be the most susceptible sub-population and the most at risk for these illnesses.¹⁶⁶ Studies in São Paulo city have shown that particle matter has an adverse effect on the respiratory health of children and causes inflammatory and infectious diseases in both the upper and lower respiratory systems.¹⁶⁷ Children under the age of five are even more at risk, as acute lower respiratory infections are the single largest contributor of death among children in that age bracket.¹⁶⁸ Environmental justice advocates report that although children under the age of five make up 12% of the global population, they bear 43% of the health risks such as these that are attrib-

¹⁵⁹ *Id.* at 727–28.

¹⁶⁰ *Id.* at 727, figure 3 (comparing the burning and non-burning periods for potassium, silicon, and aluminum).

¹⁶¹ *Id.* at 728.

¹⁶² *Id.* at 727.

¹⁶³ *Id.*

¹⁶⁴ *See id.*

¹⁶⁵ *Id.* at 728.

¹⁶⁶ *Id.*

¹⁶⁷ *Id.*

¹⁶⁸ *Id.*

utable to environmentally-related problems.¹⁶⁹ For children of areas such as Piracicaba, the risk becomes even greater when considering what the effects from this long-term and chronic exposure are or might be. These communities have now been exposed to the effects of the burning of sugarcane for approximately six months every year for the last thirty to forty years.¹⁷⁰ Beyond the acute effects, the injury from such chronic exposure might be more useful in answering the ultimate question of who has paid the highest price for the success of Brazilian ethanol.¹⁷¹

ii. Soil Erosion and Water Depletion

With respect to soil erosion, there are conflicting reports as to whether it is a "potentially damaging side effect" of sugarcane cultivation or whether the "environmental degradation from soil erosion in sugarcane fields is widespread."¹⁷² To grow and harvest sugarcane requires nitrogen fertilizers that could create severe soil erosion.¹⁷³ Estimates suggest that up to thirty tons of soil per hectare per year erode within the São Paulo state.¹⁷⁴

One of the most controversial issues related to ethanol production has been its effect on water use, and the possible environmental problems related to irrigation. The government and the industry have stated that Brazilian ethanol production requires no irrigation, and that the industry's water consumption has reduced as the production process has grown and evolved, especially in the last decade.¹⁷⁵ Environmentalists are fearful that increased ethanol production and cultivation of sugarcane will deplete the nation's water supply.¹⁷⁶ The central concern involves the spillover of wastewater from sugarcane mills and distillation facilities.¹⁷⁷ Many environmental advocates warn that this is polluting local water supplies, and in turn harming rural communities while causing erosion that is harming the interior's natural water supply.¹⁷⁸ Some have suggested that despite legal restrictions intended to

¹⁶⁹ *Id.*

¹⁷⁰ *Id.*

¹⁷¹ *Id.*

¹⁷² Martinelli & Filoso, *supra* note 143, at 364.

¹⁷³ See Marris, *supra* note 29, at 670.

¹⁷⁴ Martinelli & Filoso, *supra* note 143, at 364.

¹⁷⁵ ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57.

¹⁷⁶ See Lehman, *supra* note 57. Lehman reported that Brazilians protesting during a visit of President George W. Bush to Brazil carried placards through the streets of São Paulo that read, "For every liter of ethanol produced, 4 liters of fresh water are consumed." *Id.*

¹⁷⁷ See Hearn, *supra* note 3.

¹⁷⁸ *Id.*

protect the riparian buffers that prevent soil erosion to rivers and streams, only 30% of these riparian zones have been protected.¹⁷⁹ The official state response is that although legal restrictions have been put in place, tougher enforcement may be needed.¹⁸⁰

iii. Fuel Crops Instead of Food Crops: Shifting Land Use in Brazil Could Mean Encroachment and Development in the Amazon and Destruction of Biodiversity

Environmentalists and critics of the Brazilian ethanol program have zeroed in on the increased call for ethanol production, with its inherent need for more land, and the impact that this increased land use will have in terms of encroachment on certain regions, notably the Amazon rain forest and the Cerrado savanna region.¹⁸¹ Additionally, these groups have attempted to bring into the general discourse concerning ethanol, the possibility that the allure of ethanol production will derail the agricultural production mix and cause a shift from growing crops for food to growing crops solely for fuel.¹⁸²

Brazil has two million acres (850 million hectares) of land.¹⁸³ Native forests in Brazil account for 1,400 acres (550 hectares).¹⁸⁴ Two-thirds of these native forests are located in the Amazon.¹⁸⁵ Currently, the sixteen billion liters (or 4.2 billion gallons) of ethanol produced from Brazilian sugarcane requires approximately three million hectares of land.¹⁸⁶ Advocates of ethanol production maintain that the “competition for land use between food and fuel has not been substantial” since sugarcane cultivation requires 10% of total cultivated land and between 0.7% and 1% of total land available for agriculture in the country.¹⁸⁷ According to these esti-

¹⁷⁹ Martinelli & Filoso, *supra* note 143, at 364.

¹⁸⁰ Hearn, *supra* note 3 (“Our laws say that mills can never put water in the river that is worse than what the river has.” (quoting Antonio Luiz Lima de Queiroz, a specialist with São Paulo state’s environmental agency)).

¹⁸¹ *Id.*

¹⁸² *See id.* (“[T]here is concern that higher-priced crops like sugarcane will displace soy and cattle farming in the Cerrado—driving those operations into the forests, which would have to be flattened to make way for farms.”).

¹⁸³ Hearn, *supra* note 3; ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57 (as of 2006, 55% of the land in Brazil contained natural forests, 7% of land was used for agricultural purposes, and 35% was “pasture land” in which growth was occurring).

¹⁸⁴ Hearn, *supra* note 3.

¹⁸⁵ *Id.*

¹⁸⁶ Goldemberg, *supra* note 9, at 808.

¹⁸⁷ *Id.*; ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57 (noting that half of the land cultivated for sugarcane is used for ethanol, and the other half is intended for sugar, itself).

mates, only 5.6 million hectares of Brazilian land are used to cultivate sugarcane for use in both sugar and ethanol production.¹⁸⁸

Environmentalists point to the “unregulated biofuels boon” and suggest that these natural ecosystems bear the brunt for the expansion of the ethanol program.¹⁸⁹ For the Cerrado and the Amazon, critics have identified the possible worsening “loss of species diversity, water-quality problems, and habitat fragmentation in some of the world’s most biologically diverse regions.”¹⁹⁰ Sugarcane is not a crop that can be easily cultivated in rain forest climates.¹⁹¹ Precisely because of this unsuitability, the Brazilian government has up until this point deliberately chosen to not expand sugarcane cultivation into these climates.¹⁹² Since the conversion from natural forest to agricultural lands would require biomass burning to clear the land and remove dry vegetation, environmentalists are also concerned that the hazardous pollution and health effects associated with sugarcane burning will also be felt in these areas.¹⁹³

However, the concern that environmentalists raise most is that non-Amazon or non-Cerrado land will be used as a new staging ground for sugarcane agribusiness, and that lower-priced food crops like soy will be pushed aside to make way for more sugarcane farms.¹⁹⁴ The fear that environmentalists have is that native forests, especially in the Amazon, will be paved, flattened, and spoiled to make way for agriculture and even livestock.¹⁹⁵ Additionally, environmentalists raise concerns that the Brazilian government’s embrace of biofuels could lead them to cultivate palm trees in the Amazon so as to harvest palm oil—another source of biofuel.¹⁹⁶ The fear is that the desire for this additional biological energy source will cause devastation to the Amazon in the same way that

¹⁸⁸ Goldemberg, *supra* note 9, at 808.

¹⁸⁹ Hearn, *supra* note 3.

¹⁹⁰ *Id.*

¹⁹¹ *Id.*

¹⁹² *Id.*

¹⁹³ Cançado et al., *supra* note 89, at 725 (estimating that 18% of the dry material burned is related to rainforest burning).

¹⁹⁴ *Brazilians Clash over Bush Visit*, SYDNEY MORNING HERALD, Mar. 9, 2007, available at <http://www.smh.com.au/news/World/Brazilians-clash-over-Bush-visit/2007/03/09/1173166942570.html> (“[Ethanol production] can create more problems than solutions. . . . The cane cutters will be affected, we’re going to have more jungle burning, which could harm the environment, and even producers of other crops will suffer.” (quoting Rebeca Lerer, coordinator of climate and energy for Greenpeace Brazil)). See generally Murray, *supra* note 5.

¹⁹⁵ Hearn, *supra* note 3.

¹⁹⁶ *Id.*

palm plantations heave lead to problems and deforestation in the Borneo and Sumatra rainforests of Southeast Asia.¹⁹⁷

However, advocates of the sugarcane agribusiness in Brazil continue to argue that the abundance of available land and increasing technological efficiency make these claims by environmental justice advocates “overblown.”¹⁹⁸ Other advocates argue that the current market conditions would not allow for any serious change in the overall agricultural production.¹⁹⁹

iv. Inexpensive Labor: The Lack of Labor Rights & Inhumane Worker Treatment

Rural communities in sugarcane producing tropical countries are uniquely situated to take advantage of the interest in sugarcane-derived ethanol: they can take “advantage of year-round growing seasons, large labor supplies, and low production costs.”²⁰⁰ Without question, Brazil’s successful implementation of an ethanol program has rested in large part on its having the lowest cost of production in the world.²⁰¹ Notably, critics contend that sugarcane agribusiness remains to this day un-divorced from the Brazilian sugarcane plantations of its colonial past.²⁰² Local Greenpeace activists have highlighted the “social unrest” caused by having the economic benefits concentrated among the “wealthy families [and] corporations . . . while the poor are left to cut the cane with machetes.”²⁰³ Many workers’ rights advocates in Brazil also conflate any rise in ethanol production with an increasing alliance be-

¹⁹⁷ *Id.*

¹⁹⁸ Hearn, *supra* note 3 (“You don’t need more than 5 percent of that land to reach production levels imagined for ten years from now.” (quoting Carvalho Macedo of Brazil’s National Sugarcane Agro-Industry Union); “A simple calculation shows that expanding the Brazilian ethanol program by a factor of ten . . . would supply enough ethanol to replace 10 percent of the gasoline used in the world. This land area is a small fraction of the more than 1 billion hectares [2.5 billion acres] of primary crops already harvested on the planet.” (quoting São Paulo state environment secretary José Goldemberg)).

¹⁹⁹ Marris, *supra* note 29, at 672 (“Sugar cane is only [Brazil’s] fourth biggest commodity, in terms of revenue, with cattle, chicken and soya all bringing in more money. The limiting factor in expansion is capital rather than land.”).

²⁰⁰ Murray, *supra* note 5.

²⁰¹ KENFIELD, *supra* note 3, at 2.

²⁰² *Id.* (“The problems with [sugarcane’s] production today are very similar to the problems it generated hundreds of years ago” (quoting Maisa Mendonça, director of the São Paulo-based non-governmental organization Rede Social)).

²⁰³ Lehman, *supra* note 57; KENFIELD, *supra* note 3, at 1 (noting assertions made by the Forum of Resistance to Agribusinesses that the ethanol industry is “simply a repeat of the same model of economic growth via agro-export that has been practiced since Portuguese colonization”).

tween Brazil and the United States.²⁰⁴

Approximately 85% of the production of ethanol is concentrated in the "Center South" region of the country with over 50% in the state of São Paulo.²⁰⁵ This area accounts for nearly 80% of the domestic production with the northeast accounting for the remaining 20%.²⁰⁶ Although mechanization has been introduced into the sugarcane agribusiness model, manual labor is a key component of ethanol production.²⁰⁷ For many of these rural communities, the rise in ethanol production provided new jobs and raised the incomes of these working farms.²⁰⁸ Some have argued that this has created an overall improvement for these rural economies.²⁰⁹

Even with the increased use of mechanization within the last several years, conflicting estimates report that the sugarcane industry has directly provided between 800,000 and over one million jobs.²¹⁰ This is not insignificant for a country whose rate of unemployment is roughly 10%.²¹¹ However, while there has been creation of new jobs, there is strong criticism of the working conditions, especially those of manual harvesters.²¹²

According to worker and environmental justice advocates, the reason Brazil has the lowest cost of ethanol production in the world is in huge part through "labor exploitation," specifically a massive quantity of quasi-slave labor and government refusal to implement and comply with environmental regulations.²¹³ The differential between the average cost of production in São Paulo (\$165 per ton) and that in Europe (\$700 per ton), coupled with the median monthly salary for a sugarcane plantation laborer (between \$167 and \$195)²¹⁴ strongly suggests at least a correlation be-

²⁰⁴ Lehman, *supra* note 57 ("We know that Bush and the United States are known for exploiting weaker countries into deals that will only benefit themselves without worrying about the environment." (quoting Mariana Schwarz, a twenty-five year-old publicist and Greenpeace activist)).

²⁰⁵ XAVIER, *supra* note 41, at 7; *see also* Brazil Ethanol Workers "Badly Treated," *supra* note 57 (noting that 60% of the ethanol production facilities are located in São Paulo).

²⁰⁶ XAVIER, *supra* note 41, at 7.

²⁰⁷ Goldemberg, *supra* note 9, at 808 (noting that ethanol production requires "more workforce per unit of energy than conventional fossil fuels").

²⁰⁸ Murray, *supra* note 5.

²⁰⁹ *See id.*

²¹⁰ ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57; Marris, *supra* note 29, at 670.

²¹¹ Marris, *supra* note 29, at 670.

²¹² *See* Martinelli & Filoso, *supra* note 143, at 364.

²¹³ KENFIELD, *supra* note 3, at 2.

²¹⁴ *Id.*

tween cheap labor and cheap fuel ethanol.

There are conflicting reports with respect to the wage rates of sugarcane harvest workers. Some reports state that these jobs offer the highest wages within agriculture with the exception of soybeans.²¹⁵ Other reports state that workers at ethanol production facilities earn less than \$200 per month while working an average of twelve hours per day.²¹⁶ Added to this cheap labor supply are the estimated 40,000 seasonal migrant laborers from the Minas Gerais and the Northeast, traditionally the two poorest regions in Brazil, who travel to the state of São Paulo each year for sugarcane harvesting.²¹⁷ Sugarcane cutters, who make up the vast majority of field labor, are traditionally paid by the weight of their cuttings.²¹⁸ Studies from the State University of São Paulo have suggested that “the required rate of productivity for cane cutters is increasing.”²¹⁹ During the 1980s, the average rate of productivity required of an individual sugarcane cutter was “between five and eight tons of sugarcane cut per day; today it is between 12 and 15 tons.”²²⁰

The mortality rate among sugarcane cutters is a watershed issue within the current social and political dialogue in Brazil. The reports on mortality rates are varied and show a great discrepancy. From 2004 to 2006, the locally-based Pastoral of Migrants registered seventeen deaths in São Paulo due to “excessive labor.”²²¹ The São Paulo State Regional Delegation of Labor, meanwhile, recorded that 416 ethanol production workers died in 2005 alone.²²² In addition to the deaths of ethanol workers and the general unrest and violence that plague production areas, Brazilian labor inspectors and regulators are also at risk of serious injury and death.²²³

In March 2007, reports surfaced worldwide that São Paulo state prosecutors denounced what they called “degrading working conditions” at five ethanol production plants in the Marilla region.²²⁴ These reports were both a wake-up call to society about

²¹⁵ ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57.

²¹⁶ *Brazil Ethanol Workers “Badly Treated,” supra* note 57.

²¹⁷ KENFIELD, *supra* note 3, at 2.

²¹⁸ *Id.* (noting that pay is based on the weight of their cuttings).

²¹⁹ *Id.*

²²⁰ *Id.*

²²¹ *Id.*

²²² *Id.*

²²³ Laurie Kazan-Allen, *Open Season on Brazil’s Labor Inspections*, 10 INT’L J. OCCUPATIONAL HEALTH 240, 240 (2004) (discussing the deaths of three labor inspectors and the challenges faced by the business sector, public officials, and the courts).

²²⁴ *Brazil Ethanol Workers “Badly Treated,” supra* note 57.

the inhumane working conditions of sugarcane and ethanol laborers, and insightful in terms of how quickly state officials denounced the conditions so as to not tarnish the image of fuel ethanol.²²⁵ The state labor prosecutors found that approximately 40% of the sugarcane cutters were victims of “bad treatment.”²²⁶ Reported working conditions included allegations that 400 of the 1,000 sugarcane cutters worked in direct sunlight, without water, during the hottest hours of the day, and without the benefit of any kind of safety equipment.²²⁷ There were also reports of no eating or bathing facilities at the employment sites.²²⁸ When asked whether these alleged conditions were in fact degrading or inhumane, one labor prosecutor, Edmundo Jose de Oliveira Neto, stated that “[o]f course everything depends on what is deemed degrading, but for us, yes, these are degrading working conditions for the employees.”²²⁹

The United States and Brazil accord, which many believe is “meant to help turn ethanol into an internationally traded commodity,”²³⁰ has galvanized Brazilian activism. For some, the timeline has an almost sinister ring to it. On January 22, 2007, the Brazilian administration announced an increase in federal funds for the ethanol agribusiness of nearly \$6 billion through 2011.²³¹ On January 23, 2007, President George W. Bush declared in the State of the Union address that the United States was to reduce its use of gasoline by 20% by 2017.²³² By March of 2007, Brazil and the United States formalized “a strategic alliance to promote biofuels.”²³³ The political spin for this alliance is that this is an important step for both the environment and “global security.”²³⁴ The political capital that many feel is the driver for this alliance is the standardization of ethanol on the global economic market in the same manner that oil and other fossil fuels are defined.²³⁵ This may be the final step in the process of transforming fuel ethanol into the commodity Brazil has hoped for, and local advocates have feared.

²²⁵ *Id.*

²²⁶ *Id.*

²²⁷ *Id.*

²²⁸ *Id.*

²²⁹ *Id.*

²³⁰ Lehman, *supra* note 57.

²³¹ KENFIELD, *supra* note 3, at 1.

²³² *Id.*

²³³ *Brazil Ethanol Workers “Badly Treated,” supra* note 57.

²³⁴ *See id.*

²³⁵ *See id.*

III. COST-BENEFIT ANALYSIS FOR BRAZILIAN ETHANOL PRODUCTION: FLAWED MODEL OR FRAMEWORK THAT NEEDS MINOR ADJUSTMENTS?

*The cane producers who were seen 10 years ago as agribusiness bandits are becoming national and world heroes because everybody is paying attention to ethanol.*²³⁶

*The cane producers represent a monoculture sector that doesn't create jobs and doesn't spread wealth, it concentrates it in the hands of a few . . . and the few jobs they create offer precarious conditions, they are promoting slave labor.*²³⁷

The Brazilian ethanol production market is arguably the first renewable fuel to be cost-effective. Certainly, among other ethanol production processes, it has been the most cost-effective; even the United States, the second largest biofuel market in the world, comes a distant second.²³⁸ According to UNICA, the Brazilian industry association, the average production cost of ethanol is approximately \$0.75 per gallon.²³⁹ This would make the production costs for ethanol in Brazil the lowest in the world.²⁴⁰ The factors that contribute to this cost-effectiveness include the "superiority of sugarcane to corn as an ethanol feedstock,"²⁴¹ the favorable Brazilian climate, the inexpensive-but-ready labor force,²⁴² and "a mature infrastructure built over at least three decades."²⁴³ The Brazilian ethanol program also has other built-in advantages that might not be as obvious or capable of replication as these factors.²⁴⁴

²³⁶ *Leftist Brazilian President Silva Slammed for Calling Ethanol Producers 'Heroes,'* INT'L HERALD TRIB., Mar. 21, 2007, <http://www.iht.com/articles/ap/2007/03/21/america/LA-GEN-Brazil-Ethanol-Controversy.php> (reporting a statement made by President Luiz Inacio Lula da Silva to a group of farmers in the central state of Goias for which he later reached much censure from Brazilian environmental justice and workers rights groups).

²³⁷ *Id.* (quoting a response to President Silva's remarks from Vanderlei Martini, the head of a state chapter of the Landless Rural Workers Movement).

²³⁸ XAVIER, *supra* note 41, at 1 (factors supporting Brazil's ethanol production as more economical than the United States).

²³⁹ *Id.* at 8.

²⁴⁰ *Id.*; ETHANOL FROM SUGAR CANE IN BRAZIL, *supra* note 57 (finding that between 1975 and 2002, productivity, gauged as gallon of ethanol per acre, doubled while the costs of producing ethanol decreased three times over).

²⁴¹ XAVIER, *supra* note 41, at 1.

²⁴² Murray, *supra* note 5 (emphasizing that rural communities in sugarcane-producing tropical countries are uniquely situated to take "[a]dvantage of year-round growing seasons, large labor supplies, and low production costs").

²⁴³ XAVIER, *supra* note 41, at 1.

²⁴⁴ *Id.* at 10 (summarizing Brazil's advantages as: "Favorable climate, abundance of fertile land, and plentiful rainfall in the Center-South region[,] [p]roduction areas

The importance of sugarcane as the raw material used in this process cannot be overestimated. Sugarcane has a “highly favorable energetic balance,”²⁴⁵ yielding eight times the amount of energy that was used to produce it. Within the Brazilian model, sugarcane accounts for approximately 60% of the cost of production.²⁴⁶ Economists note that this 60% is the threshold that needs to be met for Brazilian ethanol to remain viable and retain its competitive advantage.²⁴⁷

Additionally, one cannot overlook the role that the Brazilian government played at every juncture to ensure the continued interest and viability of ethanol production among the key stakeholder groups, industry, and even the consumer.²⁴⁸ In the 1990s when petroleum prices fell, the ethanol program became uneconomical and Brazil’s Congress “resorted to drastic measures by passing a law forcing oil companies to add small quantities of ethanol to their gasoline (in Brazil, gas sold at the pumps is 25% ethanol).”²⁴⁹ Brazilian consumers face a danger of losing money with this E20 blend, depending on the “volatile ethanol prices,” and sugar growers also may prefer to “make even more money by selling their product as sugar on the world market rather than fermenting it into alcohol.”²⁵⁰

As biofuel enters maturity, environmental and social justice advocates are pointing out some of the problems and issues surrounding the advent of these energy sources, and highlighting the pitfalls and obstacles that may lurk within the seemingly successful targets and goals. Within the context of a cost-benefit analysis, the current model needs to be broadened out to encompass a more holistic view of the entire process.²⁵¹

near major consumption areas of bagasse for plant energy use and surplus electricity sales[,] [h]ybrid sugar mill/distillery complexes[,] [s]tate-of-the-art computerized planting, harvesting, and plant operations.”).

²⁴⁵ *Id.* at 8.

²⁴⁶ *Id.*

²⁴⁷ *Id.*

²⁴⁸ *See id.* at 1 (“Ethanol’s infrastructure model did not arise from free market competition: It required huge taxpayer subsidies over decades before it could become viable.”).

²⁴⁹ *Id.*

²⁵⁰ *Id.*

²⁵¹ *See* Tommy Dalgaard, Uffe Jorgensen, Jorgen E. Olesen, Erik Steen Jensen, & Erik Steen Kristensen, Letter to the Editor, *Looking at Biofuels and Bioenergy*, 312 SCIENCE 1743 (June 23, 2006).