Why Produce Ethanol from Sugarcane, in the Philippine Context

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The spiraling cost of petroleum and the need for environment-friendly or less green house gas emitting energy due to global warming/ global climate change have jointly made the country's political leaders, industrialists and technologists engage in a frenzied search for alternative and renewable energy, such as biofuels. One recognized biofuel source for locomotive transport is ethanol which can be produced from sugarcane. Of the feedstock source for ethanol, sugarcane has been evaluated to be the best for the country.

This paper is an attempt to put together the rationale behind why the Philippines should produce ethanol from sugarcane. However, the slow pace of ethanol production from sugarcane is threatening to depress further sugar prices due to excess sugar. Learning from the experiences of Brazil, the estimated high price of ethanol produced from sugarcane could be reduced further. As a core strategy, the country must invest in R & D (Research and Development) and put up the technological infrastructure to make ethanol production efficient and to address the challenging environmental concerns regarding the costs (money and energy) of efficient disposal of distillery slop wastes.

Rationale of ethanol production from sugarcane

Most informed analysts agree that "peak oil" is forthcoming. Indeed, an increasing number believe that it is happening now—that petroleum production has peaked in 2005–2006 and will start to diminish around 2010 (Mandil, 2006). Currently, only about 1 barrel of oil is being discovered for every 5 or 6 extracted, and 33 of the 48 significant oil-producing nations worldwide are experiencing production decline (Heinberg, 2006). The consequences, as they begin to accumulate, are likely to be severe as the world is overwhelmingly dependent on oil for transportation, agriculture, plastics, and chemicals. As oil production declines, replacements are unlikely to appear quickly enough and in sufficient quantity to avert unprecedented social, political, and economic impacts (Robert et al., 2005). The ever increasing demand for oil has led to spiraling oil prices.

On the environmental side, burning of fossil fuels is the largest single source of greenhouse gases from human activities, representing *about half of all greenhouse gas emissions causing global warming*. The use of fossil fuels releases carbon dioxide and methane, two greenhouse gases that trap the Earth's heat within the atmosphere, leading to warmer oceans and climates, unstable weather, rising sea levels, flooding, drought, changes in water flow, declining amounts of potable water, forest fires, famine, species extinction, and pressure on species to adapt (IPCC, 2002; Brown, 2001). Thus, there is a need to shift to more environment-friendly or lesser greenhouse gas-emitting and renewable energy source (Dias De Oliveira et al., 2005).

The main advantage of a biofuel like ethanol is that it has the potential to recycle the same carbon molecules and, thus, reduce the emissions of carbon dioxide into the atmosphere (http://www.ec.gc.ca/env priorities/cleanair e.htm, accessed November 10, 2007). Biomass-based transportation cycles reduce carbon dioxide emissions in comparison to a gasoline fuel cycle, i.e., ethanol from corn (−16%), ethanol from biomass (−76%), and methanol from wood (−66%)

(International Energy Agency, 1998; Marland & Turhollow, 1991). Likewise, ethanol-blended fuels can reduce the net quantity of CO_2 emitted into the atmosphere. The carbon dioxide released from ethanol production and use is less than that absorbed by the plants and soil organic matter used to produce ethanol. The carbon dioxide produced during ethanol production and gasoline combustion is extracted from the atmosphere by plants for starch and sugar formation during photosynthesis. It is assimilated by the crop in its roots, stalks and leaves, which usually return to the soil to maintain organic matter, or to the grain, the portion currently used to produce ethanol. Although the soil organic matter breaks down to CO_2 over time, conservation measures, such as reduced tillage, can slow this conversion. Therefore, by increasing organic matter content, the soil becomes a significant sink for carbon dioxide (Direnfeld, 1989; Doidge and Burgess, 1996). Furthermore, ethanol as biofuel is known to be a "green energy" source as it contributes to the reduction not only of green house gases but also pollution emission. As an additive to gasoline, it functions as an oxygenate which reduces carbon monoxide, sulfur dioxide, and particulate matter in cars (Smeets et al., 2006), thus, its use is in compliance with the Philippines' Clean Air Act of 1999. The Clean Air Act requires the addition of oxygenates to reduce carbon monoxide emissions. Compared with conventional unleaded gasoline, ethanol is a particulate-free burning fuel source that combusts cleanly with oxygen to form carbon dioxide and water (http://www.ec.gc.ca/env priorities/cleanair_e.htm, accessed November 10, 2006). Ethanol is currently being used as an oxygenate additive for standard gasoline to replace methyl t-butyl ether (MTBE), a chemical which is difficult to retrieve from groundwater and soil contamination (Hill et al., 2006).

There is a need to create more jobs and employment opportunities, particularly in the rural areas, to lessen migration of rural folks to urban areas. Top international experts suggest that governments should use biofuel as a positive force for rural development. Joseph Schmidhuber, Senior Economist with FAO's Agricultural Development and Economics Division, claimed " *if managed well, bioenergy could promote an agricultural "renaissance" in some developing countries where biofuels can be produced profitably"* (http://RenewableEnergyAccess.com, as cited by Mendoza et al., 2007).

The Philippines' Biofuels Act of 2006 (R.A.9367) provides the legal basis for biofuel production in the country. Specifically for the Philippine sugar industry, ethanol production for fuel will expand the market for sugar. Even the 10% ethanol+ gasoline mix (E10) will already be significant since the 600 million li of ethanol needed by 2011 will entail an equivalent of 1.0 million metric tons sugar. As more car owners use ethanol, it will increase the demand and it will ultimately stabilize or increase sugar prices. The usual "boom and bust" cycle of sugar prices may no longer occur. By year 2010, sugar trading in the ASEAN region will be liberalized. Tariff will go down by 5%. This will translate to about PhP661 to 892/LKg of raw sugar. The world market price of sugar will be at USD 0.10-0.14/lb or about PhP742/LKg. The anticipation is that the Philippines will be flooded with cheap sugar from Thailand or those coming in other countries that produce sugar cheaper than us. Moreover, world production of sugar had increased this crop year and exportable production may reach 51.3 metric tons, an increase of 7.7 metric tons compared to last year 2005/06. Asia is behind the phenomenal rise, with India having 66% of the increase (Amarri, 2007). Philippine sugar production also increased by 4.43 % (94,722 MT) over last year's production.

Producing ethanol from sugarcane or from the low priced sugar coming from Thailand or elsewhere is seen to be the key to the short term/long term world surplus sugar and its ensuing depressing effect on the price of sugar. It is the consensus that ethanol production is the salvation of the sugarcane industry both for the domestic and world sugarcane industry although it should not be a repeat of what is happening now with corn. The combined effects of droughts, flood, and using corn as feedstock for ethanol, particularly in US and China, have caused a sudden spike in the price of corn. It must be part of the planning framework not to sacrifice sugarcane for food in favor of sugarcane for fuel.

Ethanol production as a long term venture: Why specifically use sugarcane?

Why produce ethanol from sugar cane? There are other sources that can be tapped for ethanol production. Four feedstocks of ethanol—corn, cassava, sweet sorghum, sugarcane—were evaluated (Mendoza and Castillo, 2007). Sugarcane yielded the highest gross ethanol yield at 3,900 li/ha and 7,000 li/ha per year for average and high yields, respectively. Sweet sorghum, ranked second at 2,200 - 5,780 li/ha (for the stem and the grains), third is corn at 2,160 - 4, 920 li/ha (2 crops) and cassava, the lowest at 1,100 - 4,500 li/ha only. In terms of net ethanol yields, sugarcane at 2,507 li/ha to 4,711 li/ha is 7 to 11 times more productive than corn at 216 to 679 li/ha, 4 to 9 times more productive than cassava at 267 to 1093 li/ha, and 18 to 28 times more productive than sweet sorghum at 114 to 260 li/ha. Both estimates considered 2 crops per year for corn and sweet sorghum.

In terms of resources use—i.e., labor, capital and production inputs like fertilizer—sugarcane proved to be the most efficient. Considering net ethanol yields, sugarcane produced 5 to7 li of ethanol per kg fertilizer, cassava at 0.89 to 1.68 li ethanol, corn at 0.72 to 1.36 li ethanol and 0.48 to 0.52 li ethanol for sweet sorghum. Sugarcane yielded 4 to 5 times more ethanol than cassava, 5 to 6 times more ethanol than corn, and 10-14 times more ethanol than sweet sorghum. Sugarcane produced 20.90 to 32.94 li of ethanol per man day, cassava 3.66 to 11.27 li, corn 4.5 to 7.72 li, and only 1.3 to 1.65 for sweet sorghum for average and high yields, respectively. As per labor use efficiency, sugarcane produced 16 to 20 times more ethanol than sweet sorghum per 1 day of man labor, 3 to 5.7 times more for cassava and 4.6 times more than corn. Sugarcane yielded 12 to 15 times more ethanol per peso spent for sweet sorghum as feedstock source, 4.83 to 9.63 times more for corn and 3.83 to 6.9 x more for cassava.

As feedstock source for ethanol production under Philippine conditions (even without imputing the added cost of saccharification), sugarcane is still the cheapest. The feedstock cost is PhP21 to 23/li for average and high purchase price of cane per tonne, respectively. At PhP4 to 6/kg of cassava roots, cassava is the most expensive feedstock for ethanol production at PhP 3.3 to 36.3/li. Corn and sweet sorghum are between the sugarcane and cassava in terms of feedstock costs. As feedstock costs only, ethanol costs PhP33 to 34.14/li for corn while it is PhP29 to 34.4/li for sweet sorghum (average for grain and stems).

Furthermore, sugarcane is also the easiest agronomic crop to manage as feedstock for ethanol due to the following reasons: 1) there is only one planting every 4 years; 2) it does not succumb to moisture extremes as in corn and sweet sorghum; 3) in the advent of strong typhoons, the stems simply lodge and they recline when weather becomes favorable; 4) sugarcane tolerates some delays in harvesting (12-14 months). It is not as exacting in harvesting time as in cassava roots. In addition to its being resource use efficient, the combustion of bagasse adequately provides the huge energy requirements during juice extraction, clarification and distillation of fermented juice. On the other hand, corn, cassava and sorghum grains do not have similar by-products that can supply the energy (fuel) needed by the factory. This explains sugarcane's highest energy efficiency or less fraction of energy which is used to produce ethanol.

Brazil as world leader of ethanol production from sugarcane and its implications

Let us examine the current situation of ethanol production. Brazil is the indisputable world leader in ethanol production from sugarcane. The US produces a slightly higher amount of ethanol but it is mostly produced from corn (Table 1) (Peskett et al., 2007). Earlier, it was emphasized that sugarcane is the best feedstock for ethanol (Mendoza & Castillo, 2005). Brazil produces ethanol from sugarcane at USD0.20/li (Oliviero, 2005) while the estimated ethanol cost/li at Eastern Batangas, Philippines is about USD0.65/li (Mendoza et al., 2007) or 2.6 times higher than Brazil's. The landed cost of imported ethanol from Brazil is only PhP22.0/li (USD 0.47/li) which is way below our production costs.

TABLE 1. Top world producers of ethanol

USA	39%
BRAZIL	33%
CHINA	8%
INDIA	4%
FRANCE	2%
Rest of the world	14%
TOTAL	100%

Source: based on figures from RFA 2007

When Brazil started producing ethanol in 1975, it used *batch fermentation* technology. By 1985, it switched to *continuous fermentation* technology which is more efficient than batch fermentation. Altogether, when Brazil started in 1975, it was obtaining only 60 li/TC (Oliverio, 2005). By 2005, it was producing 80 li/TC. When the country started in 1975, due to the technology's low efficiency, it was producing ethanol at USD0.80/li (PhP36.80). By 2005, the cost of production was reduced by 75% at USD0.20/li (PhP29.20/li) (Table 2).

Brazil has more than 30 years experience of producing ethanol from sugarcane. The Brazilians have passed through the so-called learning curve as explained by van den Wall Bake et al. (2006). The Brazilians have optimized the ethanol production by improving the various stages of production over three decades. On cane production, they were able to develop improved sugarcane varieties for ethanol (high % TSAI, total sugar as invert), bred and selected cane cultivars that are nitrogen fixing, developed and promoted the adoption of green cane harvesting–cum-trash farming and together with optimum cultural practices and good ratooning varieties, they ratoon their canes 4 to 5 times. This minimizes the cost of new cane establishment (land preparation, cane point preparation and planting). They are into mechanized harvesting and bulk hauling or transport of their canes to the mill. Besides, their factories are centrally located their sugarcane farms.

TABLE 2. Ethanol Yields per ton cane and costs/li in Brazil

	Ethanol Yield/TC	Cost/Li
	Li/TC	(USD)
1975	60	0.80
2005	80	0.20

5 million ha cane -> 26 Million ton sugar, 16 Million m3/yr ethanol

Source: Oliverio, 2005

Canes grown and harvested in Brazil are much sweeter (average of 13% sugar content) while the Philippine canes are averaging only 10% sugar content. Why is there a big difference? It is due to the interaction of cultural practices, input application, varieties, and climate. Sugarcane planters in Brazil apply low amount of nitrogen (30-50 kg/ha) because of nitrogen-fixation in the decomposing trash and the nitrogen-fixation occurring in their canes. High nitrogen-application (150–300 kg nitrogen per ha) depresses nitrogen-fixation and growth is promoted rather than sugar storage. Likewise, Brazil is climatically endowed due to its geographic location. It is less visited by typhoons (or none at all!) and it has cooler climate at harvest time—climatic elements that are so conducive to sugar storage or ripening of canes stalks. Furthermore, efficient harvesting and hauling, as well as large mill capacity allow Brazil to synchronize harvesting and milling such that no harvested canes are crushed more than 48 hours after cutting (except for their accidentally burnt canes). This minimizes sugar inversion losses. Prolonged crushing provides ample time for *leoconostoc* bacteria to act on inverted sucrose and make the juice sour.

Furthermore, Brazil's climate and ethanol production technology allow it to produce cheap ethanol not only monetarily but also energetically.

The energy balance (Ee) of Brazilian ethanol production ranges from 8-12 (Macedo et al., 2004; Smeets et al., 2006). This means that 8-12 units of energy (gasoline, diesel oil) are produced for every 1 unit of energy used. The high energy efficiency is attributed to Brazil's very sweet canes (high fermentable sugars), efficient processing, and low energy used in growing canes (low chemical fertilizer application and longer ratooning cycles). The high energy efficiency is important as it means that only a small amount of energy is used to produce ethanol. This elevates the competitiveness of ethanol production from sugarcane over other ethanol feedstock sources like corn, cassava or sweet sorghum which have almost 1 energy balance (Mendoza, 2007). For instance, corn has an average energy balance (Ee) of 1.12 (average Ee from Pimentel, 1997 - Ee=0.75, Shappouri et al.,1995 - Ee=1.28; Lorenz & Morris, 1995 - Ee= 1.38) which means that the energy gain is only 12%.

Brazil has the technological and physical infrastructure, climatic and land resource endowment optimized through the years, for ethanol production. If Brazilians are so cost efficient (monetary) energy and very productive (ethanol wise), it is simply because they perceived "the handwriting on the wall" earlier since they realized that "peak oil" was coming and did the shift without turning back. They moved ahead in optimizing ethanol production from cane production to processing. Overall, Brazil is a huge country consisting of about 874.4 million hectares. It has the Amazon (the largest forest area in the world although deforestation has occurred) that provides them ample hydrologic water for cane production and processing. This is not to mention the Atlantic Coast Forest that protects their canes from strong winds coming from the Atlantic Ocean. With these vast land areas, Brazil can produce all the cane feeds stocks for ethanol production. In 2005, sugarcane was planted in 5 million ha producing 26 million tons of sugar and 16 million m^3/yr of ethanol (Oliverio, 2005). Anticipating the world demand for ethanol and realizing their comparative advantage (natural and technological endowment as explained earlier) in producing ethanol from sugarcane, Brazil is now planning to expand cane production in 30 million ha (3.4 % of 874 million ha). Over the next 15 years, an extra 100 million ha could be planted with cane primarily on pasturelands (Blackburn, 2006). To cost-effectively move ethanol from the site of production, Petrobras, the state oil company, is constructing an 800-mile pipeline from the interior refinery in Paulina and then onward to the Port of Sao Sebastiao (Grain, 2007).

At 80 li/TC and 80 TC/ha, the average ethanol yield/ha is 6,400 li/ha. Theoretically, Brazil can produce 192 million m^3/yr ethanol. Its plan is to increase their ethanol production in year 2005 by 12 times. With this planned production, Brazil can supply the projected global ethanol demand of 120 million m^3 by year 2020 (IEA, 2004). Implied in its huge and magnificent plan is a logical geopolitical consequence, that is "*transferring mid-east oil cartel to Brazilians ethanol cartel.*" Brazil has all the lands and technological superiority now to produce "cheap ethanol" which is two times cheaper than gasoline considering its landed price at PhP22.0/li (pump rice of gasoline at PhP 44/li) under Philippine conditions.

Why still produce ethanol from sugarcane in the Philippines?

Brazil has all the edge to produce "cheap ethanol" but is it economically and politically strategic or correct to just allow it to produce ethanol from sugarcane for the Philippines? To answer the question, two time frames should be considered. In the very near term (2-3 years), the country has no choice except to take advantage of the cheaply imported ethanol from Brazil. To start with, our production systems are not yet in place. Many investors' plans are still on the feasibility study (FS) stages. Since our country is small and we have a high population density, it is difficult to locate and consolidate land areas to financially justify the construction of an economic-size ethanol factory. The low and uncertain purchase price of canes will make sugarcane planters hesitant to commit their canes (i.e., 5 years contract) to prospective investors of ethanol factories. Definitely, the low priced Brazilian ethanol is influencing the complex decision-making process of the planters and the investors.

In the medium to long term (3 years up), the situation will be different. Many car companies had moved to Brazil to manufacture flexi cars and cars that can run on pure ethanol. Last year, more than 1 million units of flexi cars were sold. Brazilians want to take advantage of the cheaper-than-oil ethanol to be "*just-in-time*" again with the rapidly depleting fossil fuel oil (Ho, 2005) and natural gas (Darley, 2004). The demand for ethanol is still assured as countries replace *MTBE* with ethanol as oxygenate for gasoline (at least 10% blend). As fossil fuel-gasoline supply declines and the demand continues to increase, plus the Middle East's proneness to conflict, these will push up even more gasoline prices. The world will soon scramble for Brazilian ethanol and the market signals will simply suggest that "*the era of cheap oil is gone and so are the days of cheap Brazilian ethanol.*"

These are scenarios based on scientifically analyzed possibilities. On top of these possibilities, there are other parallel developments. The increase in oil price is now triggering an increase in the manufacture of more energy efficient *hybrid cars* that reduce oil consumption by 25-30%, and electric cars, solar powered cars and hydrogen cars that are all non-oil consuming. As of 2005, the world has 800 million cars (Brown, 2005). But many car owners are not rich enough to buy energy efficient cars because they are still very expensive! Furthermore, the factories for the mass manufacture-assembly of these cars are not yet in place so the supply is still small relative to the demand, hence they are expensive. In the next 2 to 3 decades or more, oil-dependent cars will still dominate the roads. Assuming car-lovers would have the money to buy energy efficient or non-oil powered cars and the manufacture-assembly line will be in place (also assuming that the best technology-mix will be available), it will still take 2-3 decades to replace half (500 million units) of the cars which are estimated to reach 1 billion by year 2030. (The manufacture-assembly of efficient cars would be 20-25 million cars per year. Is this even achievable?). It will take the whole century to move away completely from oil-powered cars—the same whole century that made us fully dependent on oil-powered cars.

There is another point to consider. Of the Philippines' total energy demand, oil, natural gas and coal add up to 56%. Oil for locomotive transport is 66% of the total oil consumption, or about 28.38% of the oil demand (Marasigan, 2005). Oil for electricity and industrial use still consumes the largest chunk of fossil fuel. As peak oil and the ensuing decline in supply hit us, the price of oil will still increase. The oil + ethanol price nexus will still surge up. The decision to be made, whether to go-or-not-to-go *full blast* for ethanol as renewable energy should consider all the cited possibilities. The Brazilians are putting their resources (and many foreign investors are with them) on the exponential ethanol production plan. In 2006 alone, over USD9 billion was invested in the Brazilian ethanol industry (Rothkopf, undated). In March 2007, as part of an USD8 billion partnership between Japan and Brazil, Petrobras, Mitsui and Itochu agreed to set up a Brazilian joint venture that would supply ethanol to Japan for at least 15 years (http://tinyurl.com/2kldwq, accessed November 10, 2007).

Going back to the earlier statement that ethanol production from sugarcane for fuel will expand the market for sugar and that it is the cure for the "boom and burst" cycle of sugar prices, the answer is a definite *yes*. But to realize these benefits, it requires significant preparations and adjustments. There are many things that need to be done as gleaned from the Brazilian experience, which is summarized below:

- Production technology
  - Improved variety, longer ratoon cycles
  - Increase mill capacity and extraction rates
  - Improved continuous fermentation process
  - Improved distillation techniques
- Policies for ethanol
  - Low interest loans
  - Guaranteed purchase of ethanol by PETROBAS
  - Regulated pricing and production quotas
  - 5% lower tax for gasohol cars

- Insights from the economics of biofuel production
    - Economies of scale are important in biofuel production (though relatively less important in the production of feedstock than in processing);
    - Feedstock is the largest cost of production;
    - Biofuels can be complementary to other types of agricultural production and create linkages and multipliers;
    - Biofuels production requires significant labor force.
- Main lessons learnt from the Brazilian alcohol programme
    - Production costs need to be reduced further, more mechanized harvesting;
    - Full use of all the energy stored in the sugarcane and its residues is essential to exploit its market, but the economics of electricity production need careful examination;
    - Size of the subsidy currently being paid by Brazilian car users remains high;
    - Carbon emissions substitution potential of the programme could be developed further in the context of the UNFCCC, Joint Implementation and the Clean Development Mechanism under the Kyoto Protocol;
    - Development of the use of bio-ethanol as a feedstock for ETBE (ethyl tertiary butyl ether), which can be used in mixtures with gasoline to reduce air pollutants and net CO2 emissions from transport, can be based on the Brazilian experience of bio-ethanol production (Finguerut, 2005).

Producing ethanol presents not only technological, political but also environmental challenge!

With all the push in producing ethanol from sugarcane, it is equally important to point out that producing ethanol is accompanied by a huge liquid waste effluent called distillery slop or vinasse ranging from 12-18 li per li of ethanol (Madrid et al., 1982; Barril et al., 1983; Alaban and Gibe, 1986). Slop wastes contain considerable amount of potash and many other nutrients, but it is highly acidic, high in biological oxygen demand (BOD) and chemical oxygen demand (COD), and has obnoxious smell (Singian et al., 1992; Barril et al., 1983). It is highly toxic if not properly treated and disposed of (Madrid et al., 1982; Manalili et al., 2006). As early as the planning stage, slop waste disposal should be conceptualized. It will be a potential source of conflict in the community once the obnoxious odor dissipates in the air and the black color of the slop waste seeps through the ground water being pumped for domestic use/drinking water in the community.

The distillery slop waste or vinasse contains considerable amount of potash and many other nutrients, hence it could be used as fertigation (combination of irrigation and fertilizer application). The 50 m^3/ha distillery slop waste application (Batangas distillery slop waste application protocol approved in February 2005) almost corresponds to the amount of distillery slop produced from 1 hectare of sugarcane grown for ethanol. Theoretically, a 1:1 production and application connotes that there is no distillery slop waste application problem even with the huge volume produced per li of ethanol. In reality, however, vinasse will still accumulate due to the following cases: 1) Disposal or field application will be expensive for sugarcane fields which are far from the factory; 2) Field application is limited to the dry season and during the growing stage (up to 6 months which ever comes first, rainy days or 6 months growth stage); 3) Field application will also be dependent on the availability of tankers. Hauling trucks are used for carrying canes to the mills. When hauling is done, often the rainy season has started and it is not favorable anymore to apply vinasse. There must be trucks that must be purchased by the factory to deliver and apply vinasse in farmer's fields; 4) Also, disposing slops properly will involve the use of energy and labor. Hauling the slop and applying it in the field translates to considerable energy costs estimated at 2.12 LDOE/ TC or 3.4 li of ethanol equivalence and about P200/cu.m or PhP3.0/l (Mendoza et al., 2007).

In Brazil, the majority of the vinasse waste is disposed of by spraying it onto the cane fields. As a result of this practice, the following were observed: (1) Sugar cane productivity has decreased substantially due to the resulting damage to the soil; (2) Some sugar cane planters no longer allow the disposal of the waste in their fields; (3) The leaching of the vinasse from the soil into the waterways both underground and above ground has affected water quality and destroyed the habitats associated with waterways; (4) Cities located near the cane fields suffer from the stench; (5) Environmental regulations are now being enforced and the resulting fines are hurting the sugar/alcohol producers (Smeets et al 2006).

Given all the prospects of producing ethanol as relates to its influence on price stabilization and together with the challenge in finding the acceptable arrangements between the sugar cane planters and millers/ distillery factory owners, it will be compounded by the challenge on how to cost-effectively dispose distillery slop waste. On the assumption that 50% of the vinasse is applied in sugarcane fields, disposing the 50% unused distillery slops will present difficulties. Should the farmers accept the delivery and application of 50 m3/ha slops in their farms, it is important to come up with a workable plan on how to dispose half of the slop which could not be applied in the field. Technology is not yet in place in the country for recycling or processing slop into useful products except for biogas. Biogas production, however, will not reduce the volume of slop wastes. Moreover, it will enhance further the black color of the slop. The study of Manalili et. al. (2005) on the economic and environmental impacts of using treated distillery slops for irrigation of sugarcane fields is instructive. The study estimated the cost of river-clean up (color and BOD due to run-off) and ground water contamination due to leaching, and it ranged from PhP51,000 to PhP106,000 or PhP129 to 3.21 per cu.m. of slop.

On the brighter or optimistic side, we can always deduce, *if there is a problem, there is a solution! Problems are coupled with opportunities. If there is no pain, there is no glory.*

Conclusion

Brazil has all the lands, climate, resource endowment and technological superiority to produce "cheap ethanol" which is 2 times cheaper than gasoline considering its landed price at PhP 22.0/li (pump price of gasoline at PhP 44/li) under Philippine conditions, and 3 times cheaper considering our current costs of production. While this is true, it is still economically and politically correct to produce ethanol from sugarcane for the Philippines. Drawing from the Brazil experience, we can improve our production systems as we gain experience and improve our technology with time. As the world moves quickly to gobble up cheap ethanol from Brazil in the foreseeable future, the market will simply signal "*the era of cheap oil is gone and so are the days of cheap Brazilian ethanol.*" When that time comes, it might be too late!

The sugarcane industry leaders must unite and put their act together to propel the development of the sugarcane ethanol industry for fuel. Everybody wants a successful ethanol industry. The government should fully support the ethanol industry in terms of R&D to improve the technology from cane production to ethanol processing including waste disposal, issue more definitive and supportive policies (tariff protection for locally produced ethanol against cheap ethanol from Brazil and elsewhere). Brazil is the role model. Much could be learned from its experience, technologies and supportive policies for a successful domestic ethanol industry.

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