Feasibility Study for an Integrated Anhydrous Alcohol Production Plant using Sweet Sorghum as Feedstock

FINAL REPORT

Department of Agriculture
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International Society for Southeast Asian Agricultural Sciences

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International Society for Southeast Asian Agricultural Sciences (ISSAAS), Inc.
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International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

Department of Agriculture- Bureau of Agricultural Research (DA-BAR)

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ROBERTO F. RAÑOLA, JR.
Study Team Leader

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LIST OF ACRONYMS

API	American Petroleum Institute
ARC	Agrarian Reform Communities
ASTM	American Society for Testing and Materials
BOD	Biological Oxygen Demand
BOI	Board of Investments
BP	Bronzeoak Philippines, Inc.
BTU	British Thermal Units
CDM	Clean Development Mechanism
COD	Chemical Oxygen Demand
DA	Department of Agriculture
DA-BAR	Department of Agriculture-Bureau of Agricultural Research
DAP	Days After Planting
DBP	Development Bank of the Philippines
DENR	Department of Environment and Natural Resources
DOE	Department of Energy
DOF	Department of Finance
DOLE	Department of Labor and Employment
DOST	Department of Science and Technology
DTI	Department of Trade and Industry
EMB	Environmental Management Bureau
ENA	Extra Neutral Alcohol
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GM	Genetically Modified
HP	Horse Power
ICRISAT	International Crop Research Institute for Semi-Arid Tropics
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal Rate Of Return
ITH	Income Tax Holiday

JECFA	Joint Expert Committee on Food Additives
klpd	Kilo-liters per day
kVA	Kilo Volt Ampere
LCA	Life Cycle Analysis
LDAs	Less Developed Areas
MACRS	Modified Accelerated Cost Recovery System
MD	Man Day
MMSU	Mariano Marcos State University
MOA	Memorandum of Agreement
MTBE	Methyl Tertiary Butyl Ether
MT	Metric Tons
NDC	National Development Company
NOx	Nitrogen Oxides
NPV	Net Present Value
OPEC	Organization of Petroleum Exporting Countries
OPV	Open Pollinated Variety
PBB	Philippine Biofuel Board of the Philippines
PCF	Prototype Carbon Fund
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PCIERD	Philippine Council for Industry and Energy Research and Development
PNS	Philippine National Standards
POT	Package of Technologies
RA	Republic Act
SB	Senate Bill
SCBI	San Carlos Bioenergy Inc.
UAC	Up flow Anaerobic Contact
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UPLB	University of the Philippines Los Baños
USDA	United States Department of Agriculture

EXECUTIVE SUMMARY

Using biofuel as a substitute to fuel oil has become a major global strategy by fuel oil importing countries and will remain so for addressing the rising cost of fuel oil for transport and industrial uses, increasing energy risk due to undependable supply of energy, economic growth and environmental risks from carbon dioxide and other GHGs emitted by fuel oil fired vehicles and industrial facilities. What makes biofuels such as bioethanol and diesohol attractive as substitute lies in the fact that it reduces dependence on fuel oil, is renewable, has practically no emission of GHGs and other pollutants, improves rural income and employment, and reduces foreign exchange outflows. For this purpose, the Philippines recently enacted the Biofuel Law (RA9367) primarily to address the abovementioned concerns. It mandates decreasing dependence from fuel oil for transport by 22% in year 2010.

Sweet sorghum is one of the most promising sources of biofuel feedstock for the Philippines. There are several advantages to growing the crop for biofuel. First, it is hardy and thrives in arid conditions such as that in India and Africa where precipitation is low and access to irrigation water is limited. At the same time, it is able to withstand storms and flooding and thus reduces the risk of crop failure This is especially important considering that lately, the Philippines has been experiencing extreme weather disturbances such as extended dry seasons in some areas and increasingly strong typhoons in others. These have caused serious disruptions in the country's agricultural supply chain given the inability of farmers to plant crops for lack of irrigation during extended dry seasons in some areas while other areas suffer from crop failures due to storm occurrence.

Second, yield of bioethanol from sweet sorghum is comparable to that of sugar cane and better than cassava. It is a short duration crop which can be grown for two cycles a year and can serve as a secondary crop for rice in rainfed rice growing areas. And also the input requirement such as fertilizers and irrigation water is low. It provides also substantial returns to farmers given the fact that they are able to sell both grains and stalks. Tests in the Mariano Marcos State University have shown that sweet sorghum can produce 43-65MT of stalks and 3.28-4.4MT of grain per hectare. Both grain and stalks can be used as feedstock for bioethanol production and sold at reasonable prices. The grain however can be used as substitute feed material for corn as long as it is priced 15-20% lower than that of corn. On the other hand, the stalks can be used as raw material in the production of can syrup, vinegar, basi, jaggery and electricity from co-generation. In the Ilocos region particularly, the infrastructure already exists which allow farmers to produce these value-added products.

With these various options available to the farmers, they can sell the stalks for at least PhP 550/MT and the grain for PhP 8/kg. and get a return of PhP 61-72T/hectare/year for just two cycles of the crop which is higher than their traditional crops such as corn and tobacco. By-products such as cane syrup, ethanol for wine making, feed for livestock, vinegar, etc. provide additional income to farmers.

The propagation of such a productive and flexible crop as sweet sorghum holds a sweet promise for farmers.

Third, the feedstock cost for the distillery from sweet sorghum is low and ranges from PhP 12.55-14.07/liter of bioethanol using the data for Open Pollinated Varieties generated at MMSU. This is lower than the feedstock costs of sugar cane, cassava, corn and molasses per liter of bioethanol. With hybridization, the crop productivity is expected to improve and the feedstock costs will surely go down. Hence, while the distillery investors can earn reasonable rates of return using the sweet sorghum OPV's as feedstock, they can look forward to improved incomes as new varieties are developed.

Financial measures indicate the profitability of bioethanol production from sweet sorghum in the Philippines. For plant capacity of 40kld the NPV and IRR is PhP 66.6 M and 21% respectively. The payback period is 9 years.

Fourthly, sweet sorghum is a cheaper and more reliable source of feedstock and bioethanol fuel for consumers. Being a short-cycle crop, it allows distilleries and farmers to quickly respond to the demands of the market. Also, blending ethanol into gasoline has been shown to improve mileage, as well as lower toxic emissions. Furthermore, ethanol blended gasoline can be sold at retail at a lower price compared to unleaded gasoline. With the greater predictability of production and supply of sweet sorghum, the refineries, and hence the consumers, can be assured of a steady supply of cheap, gasoline- improving bioethanol. In addition, it can sequester carbon dioxide better than other crops and can be traded in the market.

Lastly, the market for bioethanol is a huge captive market in the Philippines, a factor that will attract investors to enter the business of bioethanol processing. It will require 20 bioethanol plants to meet the requirement of an E10 blend by 2010 as mandated by the biofuel law. The substitution of fuel oil by ethanol can go as high as 20% if the supply of fuel oil worsens in the future. In Brazil, fuel flex vehicles provide flexibility in using different blends of bioethanol-gasoline or 100% bioethanol to car users. In addition, demand from markets such as Japan is huge. Investment from this country in addition to available commercial technologies may trickle in joint venture operations. However, as in other countries such as Brazil, subsidy from government is expected to support the industry during its infancy.

Overall, it may be concluded that the country stands to benefit from additional jobs created, foreign exchange savings and a cleaner environment with the promotion of ethanol as fuel. The success of a biofuel program however is dependent on the country's access to a cheap and reliable feedstock. Sweet sorghum promises to provide a cheap and reliable source of bioethanol and should be promoted aggressively by the government if it wants its biofuels program to succeed.

CHAPTER I. INTRODUCTION

A. INTRODUCTION

1.0. Background of the Study

Energy security and reducing greenhouse gas emissions are perhaps, more than ever now, the most important priorities of most if not all countries in the world. Energy security is a growing concern because of uncertainties in supply coupled with sharp increases in prices because of geopolitical tensions and weather disturbances in oil producing countries. In addition, maintaining a clean and healthy environment has also gained worldwide attention, even as the Intergovernmental Panel on Climate Change recently confirmed that human activities are to blame for global warming. To address these, many oil importing countries have embarked on programs to develop alternative cost-effective but locally available, non-conventional renewable energy sources which would reduce their dependence on oil, especially for transport, as well as minimize adverse impacts on the environment. Advances in technology have opened new opportunities for achieving these objectives.

The need for clean locally available fuel for transport has drawn attention to biofuels especially during the past few years. Global fuel ethanol production more than tripled between 1980 and 2000. World production of bioethanol increased to 46 billion liters in 2005 and may reach 75 billion liters by 2015. Some countries such as Brazil and US started their biofuel programs much earlier than other countries while others are playing catch-up and are now looking seriously at investing in biofuel production. Some countries in fact have passed laws to attract investments. The Philippines is one of these countries, having recently enacted the Biofuel Law of 2007 (RA9367).

Biofuel is considered as the most promising source of alternative fuel in the Philippines. Renewable fuels such as bioethanol and biodiesel, which comes from biological feedstock, have been confirmed to be an effective substitute for oil (Tewari, 2003, as cited in Amparo et.al, 2006). In addition, bioethanol has been proven to provide more benefits than reformulated gasoline alone. Bioethanol can be produced from locally available renewable resources that reduce the foreign exchange burden of countries. Furthermore, bioethanol burns cleaner as a result of its molecular structure. Although it has a lower energy content, it has better combustion, is cleaner for fuel injection/engines, improves fuel economy, and reduces risk of ozone damage and global warming due to the reduction in benzene, butadiene, and formaldehyde emissions. It can stimulate the economy through greater fuel diversity and job creation.

RA 9367 or the “Biofuel Law of 2007” was enacted to also address the growing concern over the increasing cost of fuel. It mandates the blending of locally-sourced biofuels on all liquid fuels and engines sold in the country. It requires that all gasoline sold in the country should contain at least five percent ethanol. The objective is to reduce the Philippine dependence on imported fuel by providing a local supply of alternative and renewable energy (RA 9367) given the erratic price fluctuations. Government agencies in cooperation with State Colleges and Universities embarked on several biofuel production development programs. A study was conducted in Mariano Marcos State University (MMSU) to determine the viability of growing sweet sorghum as a source of bioethanol. While the field trials show that it is technically feasible to grow sweet sorghum given the high yields produced, the question remains as to whether the growing of the crop and processing it into bioethanol is commercially viable. These are very important to establish if prospective investors will be invited to make the big investments required for producing bioethanol.

2.0 Objectives of the Study

The objective of the study is to determine the feasibility of producing sweet sorghum and processing into bioethanol.

Specifically, the study aims to:

1. Determine the financial viability of producing sweet sorghum especially among smallhold farms in the Philippines;
2. Determine the feasibility of using sweet sorghum as source of feedstock for the production of Bioethanol;
3. Recommend specific courses of action based on the findings of the study.

B. BIOETHANOL INDUSTRY DEVELOPMENT, POLICIES AND DIRECTIONS

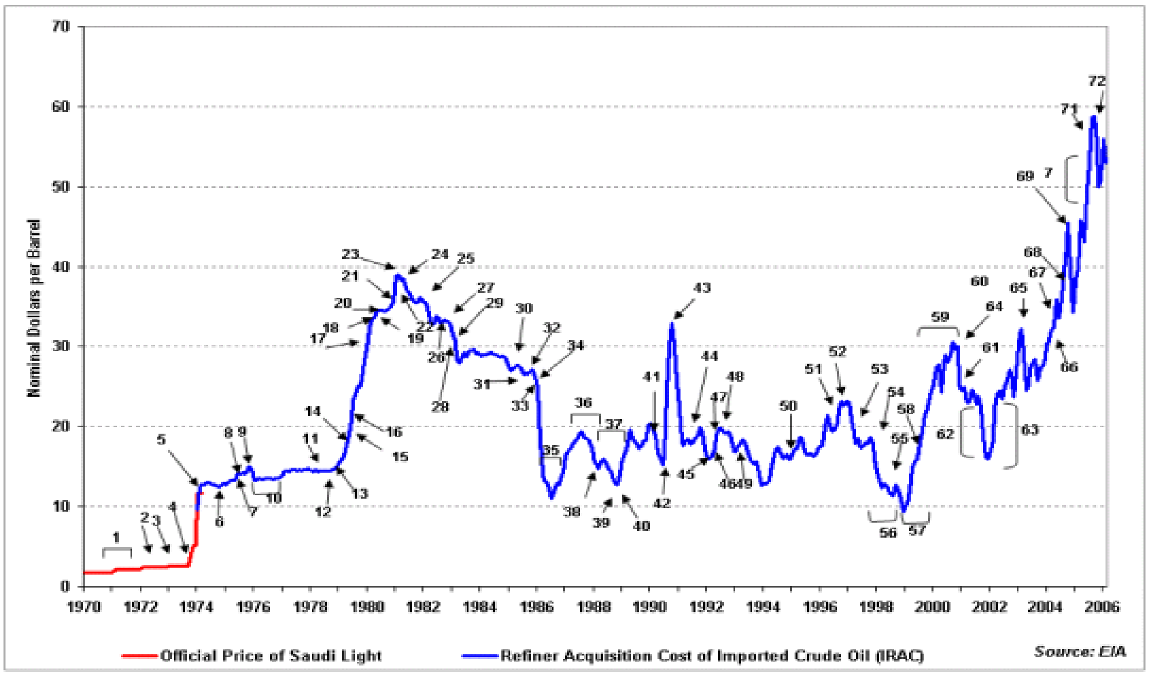
1.0 Oil Prices Trends

Oil prices have been very volatile because of geopolitical tensions, weather disturbances, and the monopolistic behavior of the Organization of Petroleum Exporting Countries (OPEC), the surge in use by emerging economies like China and India, and declining reserves. This has caused great concern in both developing and developed countries. Most vulnerable are the Asian economies that have experienced higher inflation rates due to these oil price increases. Between 1970 and 2005 for example, the nominal prices of oil increased from just US$2.00/barrel to US$59.00/barrel. In 2006, prices went beyond the US$60.00/barrel barrier.

Figure 1 shows the major events triggering the supply shocks and increases of oil prices. The first significant increase in oil prices started in October 19 – 23, 1973, when OPEC initiated an oil embargo that drastically reduced the flow of oil to importing countries. Prices increased sharply from just US$3/barrel to US12/barrel. In 1979, the revolution in Iran that deposed the Shah triggered another round of fuel price increases. OPEC then raised its price by 14%. The price of oil reached US$39/barrel in 1981 as war erupted between Kuwait and Iraq. Political tensions in other oil producing countries such as Nigeria with workers going on strike in 1995 and continuing up until 2005 and the political unrests in Venezuela also led to sharp price prices. In January 1999 to September 2000, oil prices more than tripled as a result of increasing oil demand, low level oil inventory, OPEC production cutbacks and weather disturbances. Production cutbacks by OPEC in 2003 increased the price of oil.

The first impact of weather disturbances on the price of oil was felt in 2004 when prices increased to US$47/barrel. Hurricane Ivan caused long term damage to the oil infrastructure of the Gulf of Mexico which disrupted the supply of oil and natural gas to the US. This was repeated in 2005 as tropical storm Cindy and hurricanes Dennis, Katrina and Rita hit the same area pushing back rehabilitation efforts and limiting them to just putting back the oil plants to normal operation levels.

Figure 1. World Nominal Oil Price Chronology, 1970 to 2005



2. OPEC begins to assert power; raises tax rate & posted prices
4. Oil embargo begins (October 19-20, 1973)
13. Iranian revolution; Shah deposed
14. OPEC raises prices 14.5% on April 1, 1979
23. First major fighting in Iran-Iraq War
42. Iraq invades Kuwait
50. Nigerian oil workers' strike
51. Extremely cold weather in the US and Europe
52. U.S. launches cruise missile attacks into southern Iraq following an Iraqi-supported invasion of Kurdish safe haven areas in northern Iraq.
58. OPEC pledges additional production cuts for the third time since March 1998. Total pledged cuts amount to about 4.3 million barrels per day.
59. Oil prices triple between January 1999 and September 2000 due to strong world oil demand, OPEC oil production cutbacks, and other factors, including weather and low oil stock levels.
63. OPEC oil production cuts, unrest in Venezuela, and rising tension in the Middle East contribute to a significant increase in oil prices between January and June.
69. Hurricane Ivan causes lasting damage to the energy infrastructure in the Gulf of Mexico and interrupts oil and natural gas supplies to the United States. U.S. Secretary of Energy Spencer Abraham agrees to release 1.7 million barrels of oil in the form of a loan from the Strategic Petroleum Reserve.
70. Continuing oil supply disruptions in Iraq and Nigeria, as well as strong energy demand, raise prices during the first and second quarters of 2005.
71. Tropical Storm Cindy and Hurricanes Dennis, Katrina, and Rita disrupt oil supply in the Gulf of Mexico.
72. President Bush authorizes SPR release.

2.0 Effect of Oil Price Increases on the Philippines

Table 1. Impact of 10% Increase in Oil Prices on Selected Asian Economies, 2006.

Countries	Real GDP Growth Oct 2006 (% change)	Inflation Oct 2006 (% change)	Current Account as % of GDP Oct 2006 (% change)
Philippines	-0.33	0.61	-0.20
Thailand	-0.33	0.72	-0.39
Singapore	-0.33	0.52	-0.39
Malaysia	-0.20	0.60	0.20
India	-0.13	0,78	-0.26

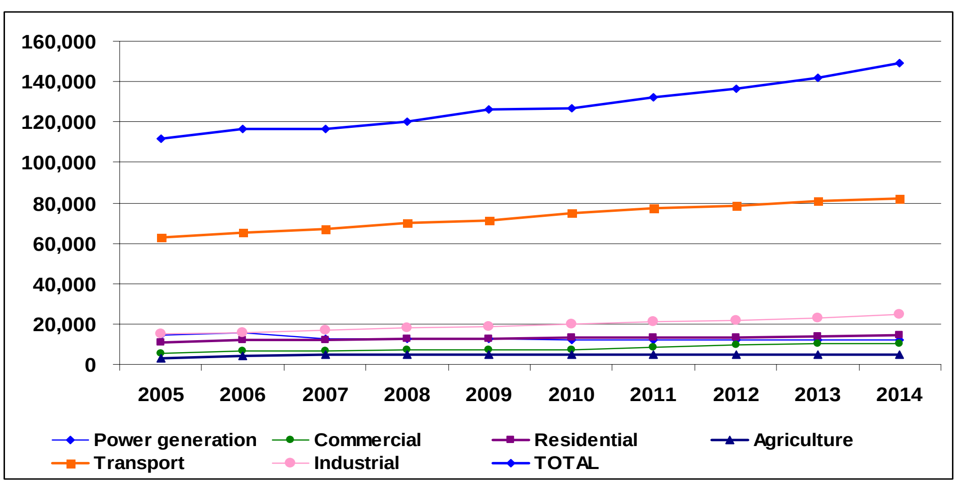
Source: UNESCAP calculations, 2006.

The impact of these oil price increases was felt more by the Asian economies than the rest of the world. A study by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) showed that an increase of 10% in oil prices reduced the real GDP growth ranging from -0.13% to -0.33% of some Asian countries as shown in Table 1.

For the Philippines, real GDP growth was reduced by 0.33% as a result of 0.61% change in inflation due to a 10 % increase in oil prices. In addition, the percentage of current account as a percentage of GDP dropped to 0.20%. Clearly, this shows that increasing dependence on petroleum oil imports by the country will have a significant negative impact on the growth of its economy.

The Philippines is highly dependent on imports of fuel oil for its energy requirements. About 65% of this goes to the transport sector. Gasoline and diesel comprise the bulk of this importation. As shown in Figure 2, consumption of these commodities has steadily grown over time.

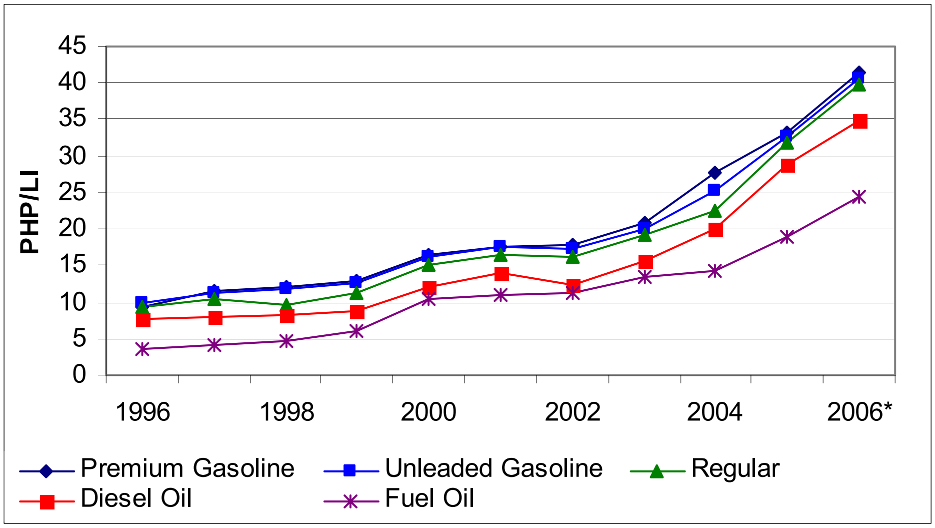
Figure 2. Oil demand by sector, Philippines, 2005-2014



Source: DOE, 2006.

The cost of inputs has sharply increased due to price increases. In the last five years, the prices of gasoline and diesel reached very high levels due to growing tensions in the Middle East and disruptions in production from the U.S. while Venezuela and Nigeria tightened oil supply (Figure 3).

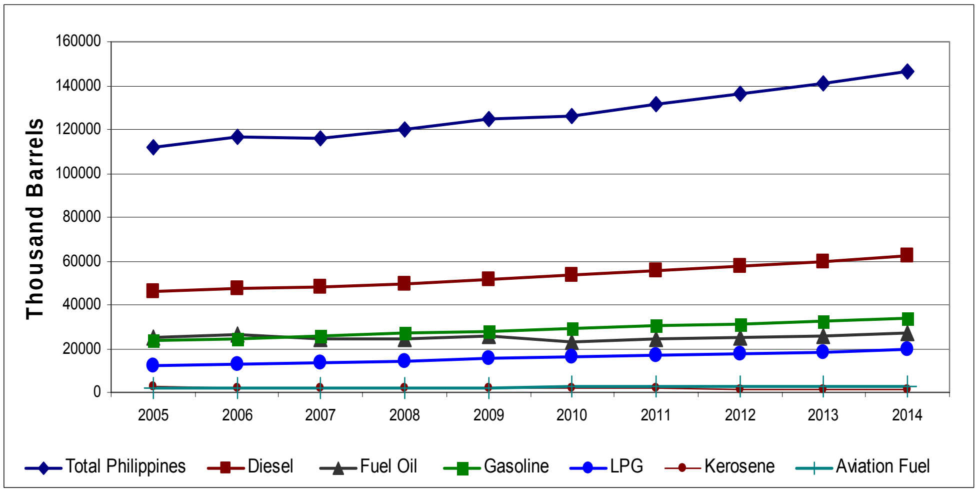
Figure 3. Petroleum products prices, 1990-2006.



Source: DOE, 2006.

Economic growth and population increase (Figure 4) will also lead to a further increase in demand for gasoline and diesel. By 2014, gasoline consumption is projected to reach 33,780.93 thousand barrels while diesel consumption will rise to 62,384.75 thousand barrels. It is believed that future growth will be adversely affected if there is no respite from the price increases and if there is a growing supply uncertainty.

Figure 4. Projected oil demand by product, thousand barrels, Philippines, 2005-2014.



Source: DOE, 2006.

There are indications however those countries which have slowly reduced the demand for oil (oil demand as a percentage of GDP) by slowly switching to alternative fuels and increasing the efficiency of oil utilization are less vulnerable to inflationary effects of oil price spikes and consequent reduction in economic growth. For example, Brazil the leading bioethanol producer in the world has replaced half of its petroleum fuel consumption with bioethanol in transport and thus shielded itself against the inflationary effects of oil price increases.

3.0 Impact of Fuel Oil on the Environment

The transportation sector is a major contributor to environmental pollution. The increase in the burning of gasoline and diesel fuel due to the increase in number of vehicles in urban centers is a major contributor to carbon dioxide build-up in the atmosphere. The accumulation of GHG in the atmosphere has been identified as the main cause of global warming.

In 2006, the UN Intergovernmental Panel on Climate Change (IPCC) reported that there was at least a 90% probability that human activities are causing most of the warming of the earth for the past 50 years. It foresees global average temperature rising to 2 ^{0}C to 4.5^{0}C above pre-industrial level by 2100 with a best estimate of 3 ^{0}C. The report which draws on research by 2,500 scientists from more than 130 countries and taken six years to compile, urges world leaders to act now to combat global warming. The passage of Biofuel Act of 2006 is one of the Philippines' contributions to combat global warming.

From the time that the US started the systematic recording of CO_2 build-up in 1958 to the present, CO_2 concentration has continued to rise at a decade average rate of 4% (Henry and Heinki, 2000). The buildup of GHG inevitably influences the temperature of the atmosphere and the earth's surface. If its concentration increases, the atmosphere offers increased resistance to the escape of solar radiation to space. As a result, the earth's surface temperature rises. A buildup of earth temperature can lead to permanent climatic changes that can have unpredictable consequences on the environment. The unusual increase in the frequency and strengths of typhoons according to scientists is just one of the manifestations of these climatic changes.

4.0 Using Biofuels

Some countries have turned to renewable and clean alternative fuels or popularly known as biofuels in response to economic and environmental concerns arising from the utilization of fuel oil. The transport sector has exploited the use of biofuels such as bioethanol and biodiesel as outright substitutes for fuel oil or as a blend of gasoline or diesel. Anhydrous ethanol is used for gasoline-fueled vehicles while biodiesel for diesel powered vehicles. Anhydrous alcohol should have at least 99.3% purity and have a maximum water content of 0.5% v/v based on the Philippine National Standard (PNS DOE 008).

Most countries have concentrated their biofuel program on the production of bioethanol compared to biodiesel because of additional advantages. As of 2003, there were some 13 countries using bioethanol as a fuel component. The advantages of bioethanol as a substitute fuel for gasoline include the following:

a. It can be blended with gasoline up to 10%
b. It can be used as an octane booster without change of existing engine design.
c. It can replace gasoline in dedicated engines.
d. The feedstock for the production of the fuel is renewable.
e. It substantially reduces GHG emission.
f. It generates employment and income in the rural sector.
g. It provides economic opportunities for other sectors of the economy.

The success of any biofuel program depends on three major considerations, namely: 1) the type and sustainability of feedstock, 2) technology availability and development, and 3) government policies and support.

5.0 Type and Sustainability of Feedstock

Cost is the main criterion in selecting a distillery's feedstock because it typically comprises 60% to 80% of bioethanol cost. There are several feedstock used in the production of bioethanol which include among others sugarcane, corn, sugar beet, cassava, sweet sorghum and cellulosic materials. Sugarcane and corn are the two most common feedstock used for bioethanol production worldwide.

Brazil and other South American countries such as Peru and Colombia, India in Asia are the major users of sugarcane as feedstock. Endowed with suitable agro-climatic conditions and wide tracks of available agricultural lands, these countries can adequately supply the feedstock requirement of their bioethanol distilleries. The US on the other hand uses corn as its feedstock to supply its bioethanol production. Excess production from current corn producing areas and expansion of corn farming in new areas are the sources of additional production of bioethanol in this country. European countries mainly use sugar beet as their feedstock.

The Philippine Government's biofuel production development programs have focused mainly on sugarcane, coconut oil and Jathropa. Lately however, sweet sorghum has been showing great promise as a bioethanol feedstock in these countries.

The use of sweet sorghum (*Sorghum bicolor*) as bioethanol feedstock is gaining popularity because of its adaptability and the wide range of products that can be produced from it. The plant is very tolerant to arid and saline growing conditions. Unlike sugarcane, sweet sorghum is considered a "crop with a universal value" since it is photo thermal insensitive and drought resistant and can be grown in tropical, sub-tropical, temperate, and even in semi-arid regions. A native crop of Africa belonging to the grass family, it is very similar to sugarcane (but has higher recovery rate of bioethanol). Moreover, production cost is lower since cultural management requirements such as fertilization, weeding and irrigation are less demanding. Also, it does not compete with food crops in land resource allocation as it can adapt to existing cropping systems. India and China are the two leading countries in the production of ethanol from sweet sorghum (SSE).

In the Philippines for example, sweet sorghum can serve as a secondary crop after rice in rainfed areas. It exhibits positive energy balance from production to processing. Bioethanol and other industrial products can be produced from its stem and grains. In addition, it is also a source of forage and silage for animal feed. Compared to bagasse from sugarcane, silage from sweet sorghum has higher biological value when used as feed for animals.

The production of ethanol from sweet sorghum will not only save enormous amount of foreign exchange but also reduce pollution and provide cleaner air for a constantly growing population (Pablico, as cited in the Agriculture Magazine, August 2006). The use of bioethanol fuel is beneficial to the environment and expected to encourage capital investment, create additional employment and livelihood activities especially in rural areas and promote economic development in the country.

To meet the current demand of about 400 million liters of ethanol annually, the Philippines would need some 20 ethanol plants, each with a maximum output of 20 million liters annually. The San Carlos Bioenergy Inc. in San Carlos City, Negros Occidental is building the first ethanol plant with that production capacity (The Manila Times, August 16, 2006). According to Congressman Miguel Zubiri, at least 25 ethanol plants are needed for the Philippines to meet the demand for bioethanol gasoline additive in the next three to four years.

6.0 Availability of Technology

The technologies in the production of bioethanol from various feedstocks are proven and established technologies. The process generally involves the extraction of juice through crushing of cane, juice purification, fermentation, distillation and dehydration. This is the same technology used by distillery plants producing ethanol for beverage companies and industrial users.

7.0 Biofuel Policies and Future Directions

Governments have started to realize the need to support the biofuel production programs especially that of bioethanol and biodiesel given the need to address the fuel energy requirements of their respective countries. Because of market imperfections in the biofuel industry for example, there is a need for government to provide input and output subsidies for the biofuel production programs. The input subsidies take the form of feedstock price and capital cost support to encourage the sustainable production and supply of feedstock. The output subsidies on the other hand include excise tax concessions, captive or mandated markets, price guarantees and direct price support that can encourage investors and other market players to go into the business of bioethanol processing and marketing.

The implementation of government support varies from country to country. In the Philippines, the Biofuel Law (RA9367) was signed only last January 17, 2007. It mandates the blending of 5% and 10% bioethanol to gasoline and 2% biodiesel to diesel fuel within 4 years from the enactment of the law. There is still a need however to formulate the implementing rules and regulations of the law.

Government has also partnered with private companies in the establishment of a bioethanol plant, the San Carlos Bioenergy Inc. (SCBI) and extended loans with concessional terms to the joint venture. The listings of the different kinds of support provided in selected countries are found in Appendix 42.

C. PHILIPPINE GOVERNMENT SUPPORT AND INCENTIVES FOR BIOETHANOL PRODUCTION

1.0 Government Incentives

The following is the set of relevant incentives provided for producers of Bioethanol.

1.1 Financial Incentives

The Philippine government offers the following incentives as provided for in the Biofuel Law to encourage investors to engage in the production, distribution and use of Biofuel.

1.1.1 Financial Assistance (Loan Windows)

Financial Assistance will be given by Government fiscal institutions. Financial Institutions such as the Development Bank of the Philippines, Land Bank of the Philippines, Quedancor and other government institutions providing financial services are mandated to extend their financing services to individuals willing to engage in the production, storage, marketing and even blending of biofuels with petroleum.

1.1.2 Income Tax Holiday (ITH)

The BOI has existing incentives which cover biofuel production or bioethanol production in particular. These include income tax holidays and a bonus year incentive.

BOI-registered biofuel plants shall be exempt from the payment of income taxes reckoned from the scheduled start of commercial operations, as follows (www.boi.gov.ph):

a. New projects with a pioneer status for six (6) years;
b. New projects with a non-pioneer status for four (4) years;
c. Expansion projects for three (3) years. As a general rule, exemption is limited to incremental sales revenue/volume;
d. New or expansion projects in less developed areas (LDAs) for six (6) years regardless of status;
e. Modernization projects for three (3) years. As a general rule, exemption is limited to incremental sales revenue/volume.

Export traders are also entitled to the Income Tax Holiday (ITH) but only on their income derived from the following (www.boi.gov.ph):

a. Export of new products, i.e. those which have not been exported in excess of US$100,000 in any of the two (2) years preceding the filing of application for registration, or
b. Export to new markets, i.e., to a country where there has been no recorded import of a specific export product in any of the two (2) years preceding the filing of the application for registration.

New registered pioneer and non-pioneer enterprises and those located in LDAs may avail themselves of an additional year for income tax exemption in each of the following cases (www.boi.gov.ph):

a. the indigenous raw materials used in the manufacture of the registered product must at least be fifty percent (50%) of the total cost of raw materials for the preceding years prior to the extension unless the Board prescribes a higher percentage; or
b. the ratio of total imported and domestic capital equipment to the number of workers for the project does not exceed US$10,000 to one (1) worker; or
c. the net foreign exchange savings or earnings amount to at least US$500,000 annually during the first three (3) years of operation. In no case shall the registered pioneer firm avail of the ITH for a period exceeding eight (8) years.

1.2 Specific Tax

Based on the Biofuel Law (RA9367), the specific tax on biofuels, per liter of volume capacity, shall be zero (0).

1.2.1 Duties on Plant Investments

Investors accredited by the DOE are entitled to exemption from import duties such as machinery and equipment which are exclusively for use in the production of biofuels for a period of five years from the date of 'DOE accreditation; Provided however that the imported machinery and equipment *are* not manufactured domestically or that the quantity of comparable quality is not sufficient and thus prices are not competitive.

1.2.2 Board of Investments (BOI) Incentives

All investments in the production, blending, and distribution of biofuels and the use of biofuel compliant vehicle technologies shall be benefited by fiscal and non-fiscal incentives under the Omnibus Investment Code.

1.2.3 Water Effluents

Water effluents from the production of biofuels used as liquid fertilizer and for other agricultural purposes are considered reuse, and are therefore, not covered under Section 13 of Republic Act No. 9275, also known as the Philippine Clean Water Act; Provided, however, that such application shall be in accordance with the guidelines issued pursuant to R.A, No. 9275, subject to the monitoring and evaluation by DENR and approved by DA.

1.2.4 Other incentives

As mandated by law, government agencies such as the Department of Science and technology, through the Philippine Council for Industry and Energy Research and Development (PCIERD), the Department of Agriculture and the Department Energy shall be providing assistance such as policy recommendation and technical support regarding the biofuel industry.

2.0 Policies and Other Interventions

2.1 Biofuels Act of 2006

The Philippine government is now taking action to address the problem related to fuel importation pursuant to Biofuel Law (RA9367) or “the biofuels act of 2006.”

The main thrust of the biofuels act is to reduce the Philippine dependence on imported fuel given the erratic oil price fluctuations by providing a local supply of alternative and renewable energy. As stated in the Biofuel law, the country is mandated to use liquid fuel which is blended with locally-sourced products. Bioethanol shall contain a minimum of five percent of the total volume of gasoline being distributed and sold to the country provided that the quality of the blended biofuel conforms to the Philippine National Standards (PNS).

The biofuel law of the Philippines also provides incentives (Section C-1.0) to encourage investors to go into the production, distribution and use of locally produced biofuel. Some of the incentives contained in the biofuel law include specific tax exemptions such as the exemption from the water affluent fines and financial assistance to those who will engage in the biofuel business.

Moreover, the government, through the biofuel law, creates the Philippine Biofuel Board of the Philippines that will assess the performance of programs and projects directed towards biofuel industry development and growth. The PBB is composed of a Chairman who is either the secretary of the Department of Energy or his assigned undersecretary. Members of the board are secretaries or undersecretaries of various government agencies such as the Department of Trade and Industry (DTI), Department of Science and Technology (DOST), Department of Agriculture (DA), Department of Finance (DOF) and the Department of Labor and Employment.

In addition, government agencies such as the Department of Finance (DOF), Department of Agriculture (DA), Department of Science and technology (DOST) through the Philippine Council for Industry and Energy Research and Development (PCIERD) are mandated to develop, implement and monitor the biofuel production and utilization technology programs of the government.

CHAPTER II. SWEET SORGHUM BIOETHANOL PROCESSING

A. MARKETING OF BIOETHANOL FROM SWEET SORGHUM

1.0 Marketing

The recent signing of the Biofuel Law (RA9367) by President Gloria Macapagal Arroyo has created a captive market for fuel grade (anhydrous) bioethanol producers and traders in the Philippines. The law requires petroleum companies to blend at least 5% fuel grade bioethanol to gasoline for the period 2007 to 2010 and increasing to a 10% blend from 2010 to 2017. The domestic demand may go beyond the 10% blend and reach 20% if there will be supply shocks in fuel oil as a consequence of growing tensions in major oil producing countries in the Middle East. Aside from the domestic market, foreign markets (i.e. Japan, South Korea, and China) offer a lucrative market for bioethanol fuel. Although the cost of producing bioethanol is currently higher than petroleum fuel, the continuous increase in the world price of the latter and the support given by government to the development of alternative fuel sources will eventually reduce the price gap. Furthermore, technology innovations and advances in feedstock production and processing will ultimately make bioethanol competitive with gasoline as shown by the Brazilian experience.

1.1 Product Definition

The main product of the sweet sorghum bioethanol distillery is anhydrous alcohol which is 99.3% ethanol by volume and has a maximum of water content of 0.05%. The alcohol will be blended with gasoline at 5% and 10% levels. In Brazil, modified car engines or flex cars can use as fuel a wide range of blends of bioethanol and gasoline from 0% to 100% anhydrous alcohol.

The acceptance of ethanol as a blending compound for gasoline by the transport fuel industry depends on the octane boosting property and practically zero emission of green house gases (GHG). A Food and Agricultural Organization (FAO) report mentioned that blending ethanol with gasoline at 0.1% increases the power to about 0.1%. Power rises steadily as the mixture reaches an equivalence ratio of about 1:4. Soot formation does not occur because of the oxygenate property of alcohols. Emissions of NOx (Nitrogen Oxides), another pollutant produced by the transport industry are very low because of ethanol's lower flame temperature. The ethanol-gasoline blend permits smooth engine operation even at very lean mixtures due to the wider flammability limits property of ethanol. A minor drawback of the fuel mixture is a noticeably higher emission of acetaldehyde. This can be addressed by increasing the engine's compression ratio from 9 to 14, which reduces the acetaldehyde by 50%, a level comparable to that of gasoline (FAO, Integrated Energy Systems in China, 1989). It can take advantage of trading in carbon credits because of lower pollution emission properties.

The fuel properties of ethanol based on laboratory analysis are shown in Appendix 35. In conjunction with the Biofuel Law, the Philippine Bureau of Products Standard has formulated the standards for Philippine bioethanol PNS DOE QS 008. This is patterned after the ASTM D4806 of the US. Table 2 shows the Philippine standard (PNS DOE QS 008) and ASTM D4806 standards for bioethanol fuel. As seen in Table 2, the Philippine standard closely follows the ASTM D4806 but sets stricter limits on some properties such as lower water content per volume of bioethanol and higher minimum level of ethanol content. Furthermore, it requires the use of only unleaded gasoline as denaturant and does not set a standard for solvent-washed gum as the ASTM standard does.

Table 2. Philippine standards and ASTM D 4806 STANDARDS for Bioethanol, 2006.

PROPERTY	ETHANOL	
	PNS DOE QS 008	ASTM D 4806
1. Appearance	Clear and bright, visibly free of suspended or precipitated contaminants	Clear and bright, visibly free of suspended or precipitated contaminants
2. Acidity/Alkalinity	6.5-9.0	6.5 – 9.0
3. Copper, as Cu, mg/kg, max	0.1	0.1
4. Ethanol content, % v/v, min	96.9	92.1
5. Denaturant*, % v/v	1.96-2.44* (unleaded gasoline)	1.96 – 4.76
6. Inorganic Chloride content, mass ppm, max	40	40
7. Methanol, % v/v, max	0.5	0.5
8. Total acids (as ascetic acid), % w/w, max	0.007	0.007
9. Water content, % v/v, max	0.5	1
10. Solvent washed gum	None	5mg/100ml

**2% v/v at the point of denaturing*
Source: Bureau of Products Standards, Philippines, 2006

1.2 Demands for Bioethanol as Blending Agent for Transport Fuel

There are two possible markets for Philippine bioethanol, the domestic market and foreign markets such as Japan, Taiwan, South Korea and China. The domestic market for bioethanol as a transport fuel is however a captive market given the recent enactment of the Biofuel Law.

1.2.1 The Domestic Market

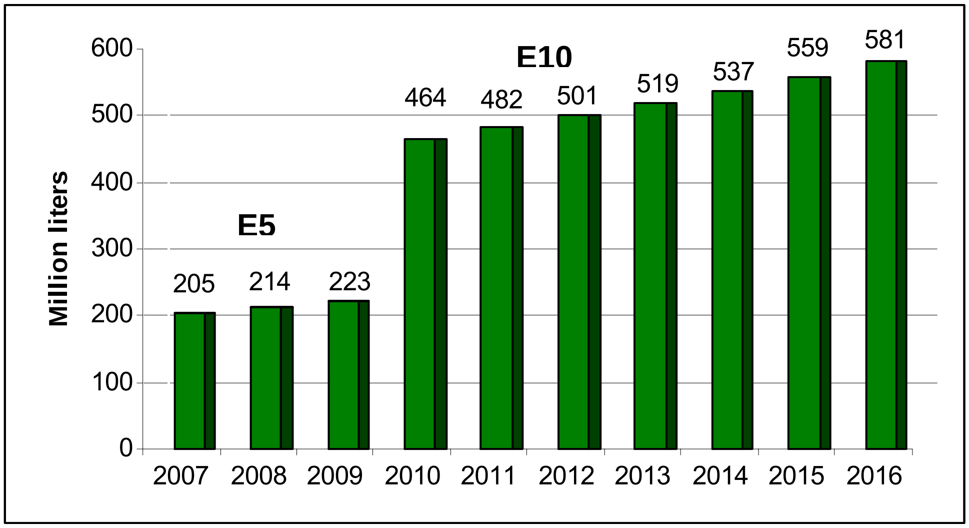
The DOE projected that the country will need about 4,091 million liters of bioethanol for the transport sector this year to comply with the 5% blending as required by the Biofuel Law. By 2010, this will increase to 464 million liters and to 581 million liters by 2016 as demand for transport fuel grows at an annual average growth rate of 4% (DOE, 2006). Table 3 and Figure 5 show the trend in gasoline and bioethanol requirements for the said period.

Table 3. Projected Bioethanol Demand based on Projected Gasoline Consumption, Philippines 2005 to 2014.

Fuel (MMli)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Gasoline*	4,091	4,274	4,458	4,639	4,823	5,006	5,188	5,371	5,586	5,809
Bioethanol- E5	205	214	223	232	241	250	259	269	279	290
Bioethanol-E10	409	427	446	464	482	501	519	537	559	581

**Source: Department of energy (DOE), Philippines, 2006*

Figure 5. Projected Bioethanol Requirement, Philippines, 2007 to 2016

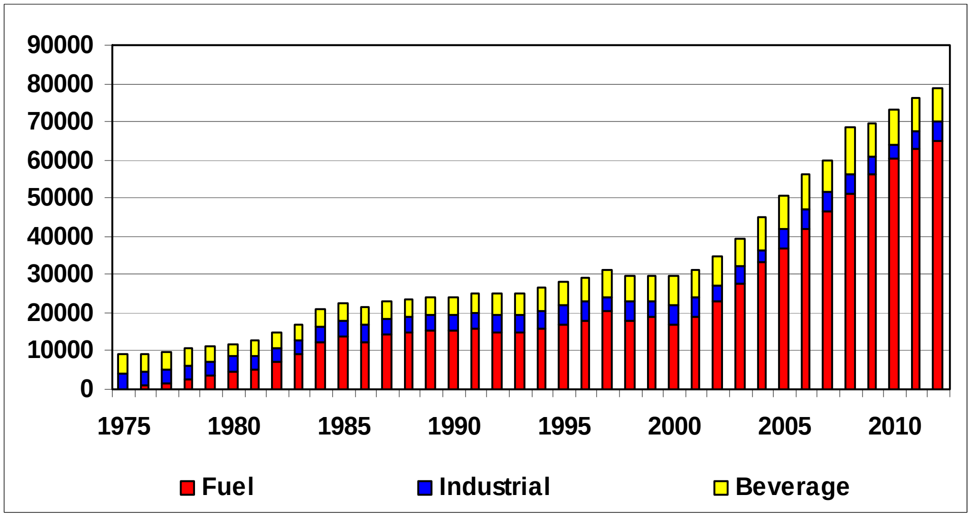


The growing geopolitical tensions in the petroleum oil producing regions in the world and the increasing frequency of weather disturbances in these regions have created a higher level of uncertainty in the global supply of fuel oil. It is thus highly likely that the Philippine Government will push for an E20 mixture to support its long term energy security goals. Given this scenario, the requirement for bioethanol by 2015 will double from 559 million liters to 1,118 million liters.

1.2.2 The Export Market

From 1975 to the early 1980s, ethanol was produced mainly for beverage and industrial uses. Interest in the use for ethanol as transport fuel started to gain support after the oil crisis of 1977. Faced with growing supply uncertainty and rising prices, global demand for the product steadily and sharply increased over time. By the later part of the 1980s, the demand for ethanol as transport fuel surpassed the demand for use of the beverage and industrial sectors and is projected to increase to 65,000 million liters by 2010 (Berg, 2004). This is shown in Figure 6.

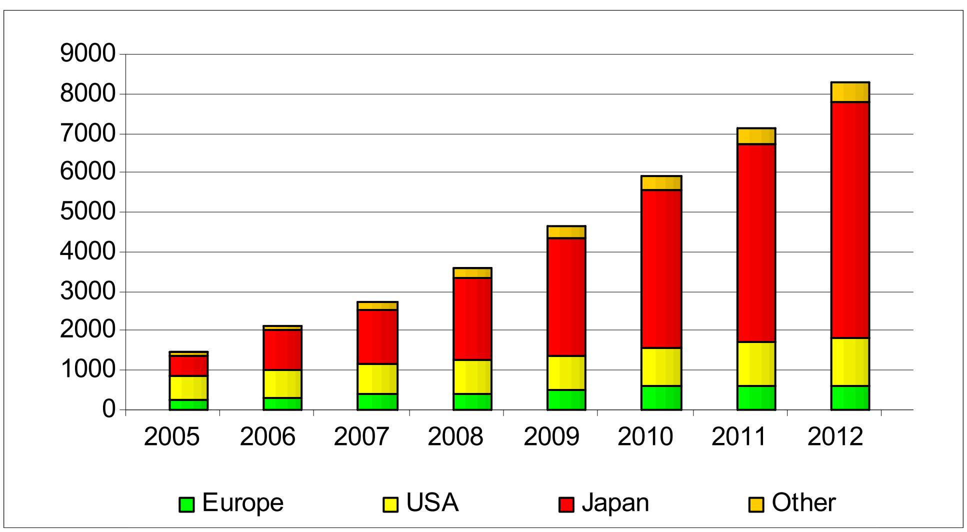
Figure 6. World Demand for Bioethanol (million liters), 1975 to 2010



Source: http://www.distill.com/World-Fuel-Ethanol-A&O-2004.html WORLD FUEL ETHANOL ANALYSIS AND OUTLOOK By Dr. Christoph Berg, April 2004.

Of particular interest is the market of Japan. If Japan will meet its commitment to the Kyoto protocol and given a highly optimistic scenario, the bioethanol requirement will increase from 1,800 million liters in 2006 to 6,100 million liters by 2010, an 836% increase in a span of 5 years (Figure 7). There is a possibility that the demand will go beyond the level that will comply with the Kyoto protocol as geopolitical tensions continue to build up in the major oil producing countries in the Middle East and Africa.

Figure 7. World Fuel Bioethanol Imports under an Optimistic Scenario, 2005 to 2012



Source: http://www.distill.com/World-Fuel-Ethanol-A&O-2004.html WORLD FUEL ETHANOL ANALYSIS AND OUTLOOK By Dr. Christoph Berg, April 2004.

1.3 Supply of Bioethanol as Transport Fuel

The supply of bioethanol for domestic consumption will come from local production and imports. Japan, Europe, USA and other developed countries will be net importers of bioethanol.

1.3.1 The Domestic Market

Under an optimistic scenario, petroleum companies will depend mainly on imports for the next two to five years as bioethanol processing plants establish themselves in the country. Currently, Shell Philippines and some petroleum companies import bioethanol from Brazil.

It will require eight 100,000 liters per day capacity processing plants to meet the country's 2007 bioethanol requirement of 205 million liters at an E5 blend scenario. Consequently, there will be more plants needed to supply the growing requirements and this is projected to reach 22 plants by year 2010. How fast these plants can be constructed depends on the ability of government to attract investments into this venture. Investment requirement in constructing and operating a bioethanol processing plant ranges from PhP400 million for a capacity of 40,000 liter per day to PhP2 billion (@ PhP50 to a US dollar exchange rate) for a 200,000 liter per day capacity. Investment will vary depending on location and type of feedstock used. The feedstock being considered for bioethanol processing are sugarcane, sweet sorghum and cassava.

Sugarcane remains as the more favored feedstock because of best practices that can be adopted from leading bioethanol producing countries such as Brazil and Peru. However, sweet sorghum as a feedstock for bioethanol production has become an attractive alternative for sugarcane given its different qualities in contrast to sugarcane. Although sugarcane remains a viable feedstock for bioethanol production, its major drawback is the limited availability of suitable agricultural lands to grow the crop. Sweet sorghum on the other hand can tolerate a wide range of agro-climatic conditions and allows more flexibility in the selection and establishment of production areas and location of processing plants as well as system of production such as plantations. Aside from its ability to grow in marginal and upland areas, sweet sorghum can adapt to existing cropping systems and can in fact be used as a secondary crop to rainfed rice. There are about 1 million hectares of rainfed rice lands in the Philippines which is more than sufficient to meet the feedstock requirement for bioethanol production. Thus, sweet sorghum shows great promise as feedstock.

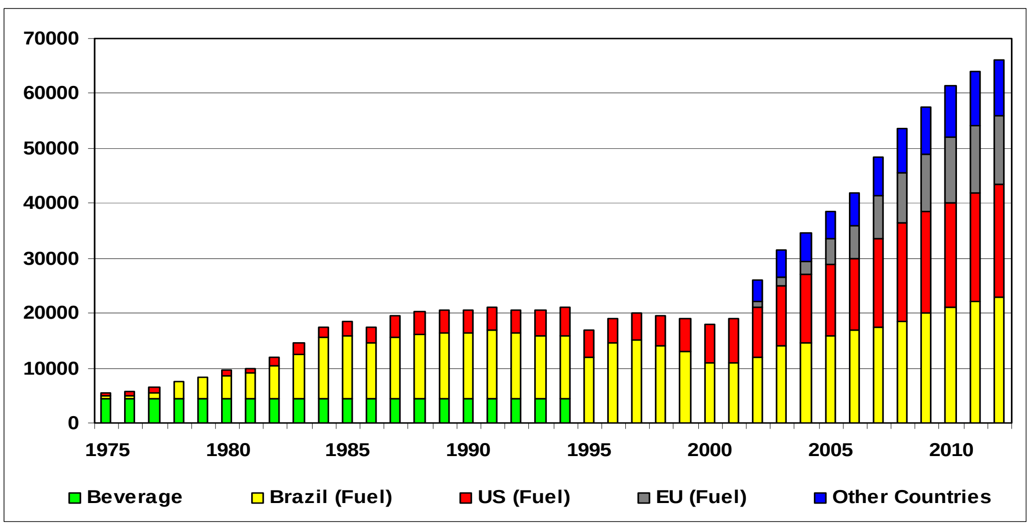
The Biofuel Law provides the incentives for investors to enter the bioethanol agro-industry development. Lately, the government through the National Development Co. (NDC), an attached agency of the Department of Trade (DTI), partnered with Bronzeoak Philippines, Inc. (BP) to construct and operate the first bioethanol fuel plant in the Philippines, the San Carlos Bio-energy Inc. (SCBI). Ownership of the joint venture is 40% NDC and 60% SCBI. The plant will produce bioethanol from sugarcane which will be contracted to Petron for blending into ethanol-gasoline. Government has completed its equity investments in SCBI valued at PhP211.14 million, representing a 25% share in the company. The total investment for the plant is about Php2.0 billion, with Php1.778 billion representing syndicated loan from the Development Bank of the Philippines (DBP). Construction will take about 1 ½ years to 2 years.

Government's investment and support for the development of the bioethanol industry will serve as a catalyst for private investors to invest in similar undertakings. This will in the process accelerate the construction of more plants to meet domestic requirement and supply a portion of the requirement of foreign markets.

1.3.2 Supply to the Japanese and Other Foreign Market

By 2007, world bioethanol production is expected to reach 49,000 million liters and then increase to 65,000 million liters by 2012 (Berg, 2004). There will be a concentration of production in three countries namely Brazil, USA and Australia. About 84% of total world production (Figure 8) will come from these countries. Brazil and Australia will dominate the world trade of bioethanol because of comparative advantage in terms of access to wide tracks of feedstock production areas, economies of scale in feedstock production and processing and technological know how. Brazil is at present the top bioethanol producing country in the world accounting for 46% of total bioethanol production in 2004.

Figure 8. World Bioethanol Production, 1975 to 2012

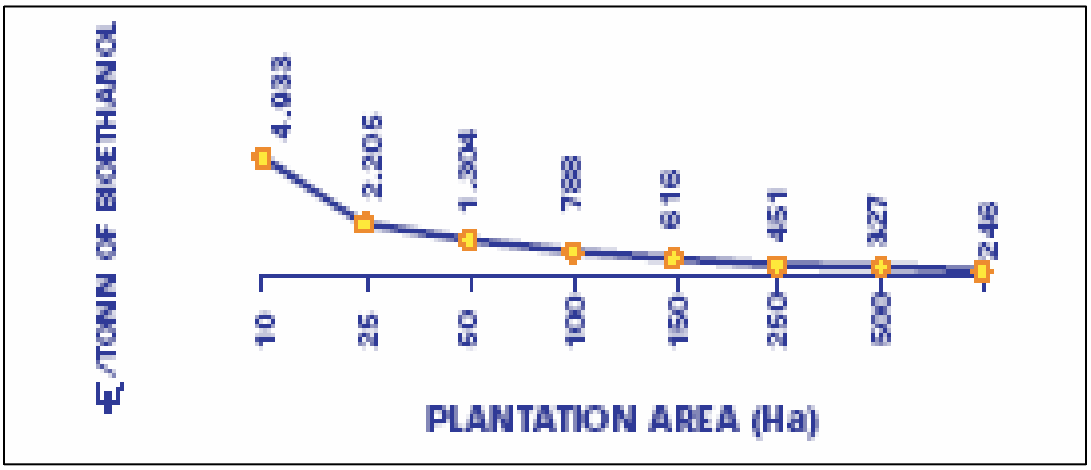


Source: http://www.distill.com/World-Fuel-Ethanol-A&O-2004.html WORLD FUEL ETHANOL ANALYSIS AND OUTLOOK by Dr. Christoph Berg, April 2004.

Although Brazil looms as a major exporter of bioethanol, there is still enough room for other countries to share in the global market for the product. As in the case of the Japanese market and other Asian markets for bioethanol, the Philippines are in a position to become a major exporter to these countries. The country is strategically located relative to these countries allowing access to their markets. It has sufficient production areas not only to meet the feedstock requirement of processing plants supplying the needs of the domestic market but also the export market. Japanese and other foreign investors visited the Philippines recently to initiate joint venture agreements in bioethanol processing plant construction and operation. For example, Bantug-Palanca Holdings Inc. has recently finished its survey of production areas in the Philippines suitable for growing sugarcane as a dedicated crop for bioethanol production. The processing plants that will be established will supply both the domestic and Japanese markets for bioethanol.

The targeted capacities of the plants range from 100 kld to 200kld. With these capacities, the plants will have the economies of scale and flexibility to meet changes in market requirements. Figure 9 shows a substantial decrease in distillation cost with an increase in plant capacity. For a 10-hectare capacity processing plant, the distillation cost is €4,033.00 per metric ton of bioethanol. Scaling up the capacity to 600 hectares substantially decreases the cost by 94% (€246.00). Generally, the optimal level of operation of agro-industrial plants is at 80% of rated capacity. At this level, the plant has an extra 20% capacity that allows it to respond to sudden changes in market demand and avoid possible loss in sales.

Figure 9. Bioethanol distillation cost, 2006.*



**Does not consider the effects of co-products. Only took into account the processing of sugar-juice. Source: Latin America Network on Bioenergy, 2006*

1.4 Prices

The price of bioethanol is set at 25% to 30% less than gasoline because of its lower thermal capacity. However, the price gap is fast narrowing down given the expected continuing increase in the price of gasoline and the economies of scale in the production of feedstock and processing, technology advances and incentives given by government. This has happened in Brazil, the leading producer of bioethanol in the world (15 billion liters as of 2005), where the average selling price (December 2002 before taxes) of anhydrous bioethanol is US$25.00 per barrel (US$160 per cubic meter) produced in large industrial plants. This is lower by US$10.00 compared to the refinery gate price of gasoline of US$35.00 per barrel.

The success of Brazil's bioethanol industry lies in continuous productivity improvements in feedstock production and processing. From 1975 to 2000, sugarcane yields in the São Paulo region rose by 33 percent, ethanol production per unit of sucrose rose by 14 percent, and the productivity of the fermentation process rose by 130 percent. These productivity improvements radically reduced the cost of bioethanol production. Moreover, emerging technologies such as the fast absorption regeneration technology using low cost crystal hydrated compounds that will selectively absorb ethanol molecules from water ethanol solutions will further radically reduce energy cost and investment in bioethanol production (Grassi, European Biomass Industry Association, 2006). Another is the use of alternative or complementary feedstock such as sweet sorghum that can further reduce production cost and therefore, the price of bioethanol. Continuing studies on sweet sorghum productivity using conventional genetic improvement have resulted to more high yielding and adaptable varieties. Compared to sugarcane this feedstock requires less energy, fertilizers, chemicals and irrigation besides being adaptable to a wide range of agro-climatic conditions which further reduce production costs.

Government incentives in the form of tax subsidies also play an important role in reducing the price of bioethanol. In the case of Thailand, the tax on E10 is lower by 1.9693 baht or $0.50/li ethanol compared to 95RON (Research Octane Number) gasoline. This tax difference offsets the higher ex-refinery price of ethanol at 16.71 baht, which is 3% higher than the 16.1956 price of 95RON resulting to a higher marketing margin (Table 4). Adopting the same tax policy incentives and incorporating it in the implementing guidelines of the Biofuel law (RA 9367) can make Philippine bioethanol competitive with gasoline under domestic market conditions.

Table 4. Price Structure of Bioethanol and 95RON Gasoline, Thailand, 2006

	95RON	**E10**
Ex-refinery (baht/li)	16.1956	16.7100
Excise tax	3.6850	3.3165
Municipal tax	0.3685	0.3317
Oil fund	2.5000	0.9400
Conservation fund	0.0400	0.0360
Marketing margin	1.9212	1.9742
VAT	1.7297	1.6316
Retail	26.4400	24.9400
Differences in taxes	**1.9693 = $0.50/li ethanol**	

Source: ESMAP: Potentials for Biofuels for Transport in Developing Countries, October 2006.

To be competitive in the foreign market, the price of Philippine bioethanol should approach the price in India and possibly Brazil in the future. Bioethanol is usually priced at 70% to 75% the price of gasoline to compensate for its lower energy value which is 70% to 75% of gasoline. In India and Thailand, the asking prices for bioethanol from sweet sorghum are Rs22.50/li ($0.52) and 22 to 23 baht/li ($0.56 to $0.59), respectively. These values are computed based on 75% of the price per liter of gasoline equivalent. For the Philippines at PhP32.48/li gasoline equivalent, the resulting asking price is Php27.60 per liter or $0.55/li (exchange rate of PhP50.00). This price is comparable with Thailand and slightly lower than that of India (Table 5).

Table 5. Price Comparisons of Bioethanol in India, Thailand and the Philippines, 2006

	India Bioethanol*	Thailand Bioethanol*	Philippine Bioethanol**
Asking Price	Rs22.50/li ($0.52)	22 – 23 baht/li ($0.56 – 0.59)	PhP27.60/li ($0.55)
Fixed Price	Rs19.75 ($0.45) (Rs24.70 - 28.20/li of gasoline equivalent	19.50 baht ($0.50) (24.20 – 27.90/li of gasoline equivalent	PhP24.01 ($0.48) (PhP32.48/li of gasoline equivalent)

**Source: ESMAP: Potentials for Biofuels for Transport in Developing Countries, October 2006.*
***Computed by the Study Team*

B. TECHNICAL ASSESSMENT

Ethanol (CH_3CH_2OH) is a flammable, colorless, slightly toxic chemical compound commonly found in alcoholic beverages. It is also used as an additive or alternative fuel for cars and other spark-ignited engines. Ethanol with at most 1% water (or anhydrous ethanol) can be blended with gasoline in varying quantities to reduce consumption of petroleum fuels, as well as to reduce air pollution. It is most commonly used, however, as an additive to increase octane and improve the emission quality of gasoline. It is also used as oxygenate to improve fuel combustion.

1.0 Sweet sorghum as Feedstock

The bioethanol plant will use sweet sorghum as the feedstock in producing bioethanol. Ethanol can be produced from either the grain of sweet sorghum or from its sweet stalk juice. The grain is processed in the same way as corn in the dry milling process while the stalk undergoes the same process as that for cane sugar ethanol production.

Sweet sorghum is comparable with other types of feedstock in terms of yield, bioethanol productivity and cost. Table 6 shows that the ethanol yield of sweet sorghum per hectare is comparable with corn and cassava but lower than sugarcane. But in terms of bioethanol productivity, that is the ethanol yield per ton of feedstock, sweet sorghum is the most productive with a production of 425 li/ha (50 li/ton from stalk and 375 li/ton from grains). Table 6 also shows that sweet sorghum is cost competitive compared to molasses, corn and cassava and with sugarcane for cane-extracted alcohol but not for grain-extracted alcohol.

Brazil has demonstrated that sugarcane can be used directly as raw material in ethanol production. The juice is extracted, prepared, fermented and distilled to yield ethanol. For the purpose of this study, it is assumed that sugarcane harvest is around 85 MT/hectare with an alcohol yield of 72 liters/MT. Based on this, the estimated ethanol yield of sugarcane is 6,120 liters/hectare/year.

Molasses, by-product of the sugar production process, is one of the raw materials traditionally used for ethanol production. In fact, almost all Extra Neutral Alcohol (ENA), or 94.5-95% pure ethanol, currently produced in the Philippines are derived from molasses. Since no data in the Philippine context was available at the time of the conduct of the study, the molasses yield is based on the Thai sugar industry and is estimated at 3-1/3 MT/hectare/year for the 2004-2006 milling seasons. Also, an ethanol yield of 241.8 liters/MT of molasses based on the US experience are used for lack of local data. Based on these, the estimated ethanol yield per hectare per year of molasses is quite low.

Cassava is currently being used by the country's largest distiller, Distilleria Bago, Inc., as a raw material in ENA production. They constructed the country's first cassava milk production facility in Bago City in Negros Occidental. Cassava has long been cultivated in the Philippines. Unfortunately, the yields for 2001-2005 based on data from the Bureau of Agricultural Statistics were quite low at around 8 MT/hectare/year. Tests done at the Leyte State University in Baybay, Leyte have shown, however, that yields of 35MT/hectare can be attained with the use of new varieties which can produce 4,900-6,545 liters/hectare/year of ethanol. The figure used in this study which is based on the estimated yield of NSIC CV-22 shows that ethanol yield is comparable with other feedstock.

Unfortunately, however, the ethanol productivity of cassava is very dependent on its post harvest handling. Studies by the FAO have shown that the starch content of cassava drops dramatically after harvest. As such, it is strongly suggested that the cassava be processed within 48 hours from its harvest. Cassava chips have dramatically reduced starch content which accounts for its low ethanol productivity in industry. FAO has recommended that mini-distilleries be set-up in order to process cassava into ethanol. However the proof of this concept has yet to be tested.

In the US, corn producers are considering ethanol production as an alternative business because it is the predominant ethanol feedstock. Unfortunately, the low productivity of local corn production, coupled with high demand in the feeds industry has limited its adoption. Thus the opportunity for using corn in local ethanol production will only arise if corn yields are high and some corn harvests are rejected by industry. The yields will increase only if Bt corn is used and if somehow the feeds industry can be convinced by zealous environmental groups such as Greenpeace not to use the GM crop. Unfortunately, this scenario is a bit far-fetched at the moment.

Sweet sorghum on the other hand holds great promise as an ethanol feedstock because both its grain and its sweet stalk juice can be used. Furthermore, with advances in cellulosic ethanol production, even its bagasse holds potential for ethanol production.

Initial tests conducted at the Mariano Marcos State University in Batac, Ilocos Norte for the past two years using parent lines provided by ICRISAT showed that the crop can be harvested 3 to 4 times a year with grain yields ranging from 3.28 to 4.4 MT/hectare and stalk yields from 43-65 MT/hectare. The crop experiment also did not fail despite a typhoon which caused it to be waterlogged for 14 days.

For the purpose of this study, it is assumed that grain yield is 3 MT/hectare/crop while that for stalk yield is 55 MT/hectare/crop. It is further assumed that the crop will be planted and ratooned once. As a result, the estimated average ethanol productivity per year is placed at 8,138 liters/hectare/year.

Table 6. Feedstock Cost Comparison, Cost/liter, Philippines, 2004-2005.

Feedstock	**Price (Php)/MT**		**liter/ha/year**	**Feedstock (PhP)/liter**	
	Min	**Max**		**Min**	**Max**
Sugarcane	1,000	1,100	6,120	13.89	15.28
Molasses	4,550	5,400	806	19.06	22.62
Cassava	1,500	5,800	5,549	8.38	32.40
Corn	8,500	10,000	5,282	20.92	24.61
Sweet Sorghum				13.98	15.67
Stalk	550	600	5,625	12.22	13.33
Grain	6,000	7,000	2,513	17.91	20.90

Sources: GAIN Report on RP sugar industry, GAIN Report on Thai sugar industry, bas.gov.ph, Leyte State University Report on cassava, Biotechnology Coalition of the Philippines Speech, MMSU field tests, FAO & ICRISAT, 2004-2005.

Aside from productivity, another major consideration is the feedstock cost, which is the biggest component of ethanol production cost. Given in table 6 are estimates of the feedstock cost per liter.

As can be gleaned from the above, the average cost of feedstock per liter of ethanol of sweet sorghum is comparable to that of sugarcane. While potentially feedstock from cassava can be produced at the lowest cost, its price is too unstable, varying widely across regions from as low as P1.50/kg. to as high as P21/kg. The cost of feedstock per liter of ethanol from molasses and corn are high and would be more appropriate to use for beverage rather than for fuel ethanol.

Another concern of a potential distillery owner is the availability of raw material. This depends a great deal on the decision of farmers to plant the crop. This, in turn, is dependent on the potential income that the farmer can realize. Given in Appendix 2 is a comparison between the farmer's annual revenue from sugarcane, Bt Corn and sweet sorghum monocrop. So while sugarcane is favorable to the distillery, it generates less revenue per hectare per year for the farmers than Bt corn and sweet sorghum. The revenue per hectare from Bt corn, a genetically-modified crop, is comparable with an Open Pollinated Variety of sweet sorghum. In other words, the farmer's revenue from an improved variety of corn is comparable to a regular variety of sweet sorghum. This means that the farmer has the potential to earn even more without increasing the distillery's feedstock cost given a slight improvement in sweet sorghum productivity through say hybridization.

There is great potential in using sweet sorghum as a source of feedstock for ethanol production given its high productivity and low production cost. The potential revenues are increased while reducing the distillery feedstock cost given this high level of productivity. Other advantages of the crop are its hardiness in the face of extreme weather conditions, as well as the huge potential for improvement through hybridization. Given the advantages of using feedstock from sweet sorghum over other potential ethanol feedstock, it will then be important to consider the processing and other technical considerations in putting up a sweet sorghum fed anhydrous ethanol distillery.

2.0 Product forms and specifications

2.1 Fuel ethanol

PNS DOE QS 008, the Philippine standard for bioethanol, sets the requirements and testing procedures for bioethanol and fuel bioethanol. Bioethanol "refers to the pure ethanol, produced from a variety of feedstock including grains, agricultural wastes, and other biomass resources" while fuel bioethanol is "bioethanol denatured with unleaded gasoline for use as blending components to unleaded gasoline." The complete standard is available for copying at the Bureau of Product Standards of the Department of Trade and Industry in Makati City and is shown as Table 2.

Table 7. Physical properties of bioethanol*

Specific gravity	0.79 gm/cm^3
Vapor pressure (38^0)	50 mm Hg
Boiling temperature	78.5^{0}C
Dielectric constant	24.3
Water solubility	∞

Table 8. Chemical properties of bioethanol*

Formula	C_2H_5OH
Molecular weight	46.1
arbon (wt)	52.1%
Hydrogen (wt)	13.1%
Oxygen (wt)	34.7%
C/H ratio	4.0
Stechiometric ratio (Air/ETOH)	9.0

Table 9. Thermal properties of bioethanol*

Lower heating value	6,400 kcal/kg
Ignition temperature	35^{0}C
Specific heat (kcal/kg-^{0}C)	60
Melting point	-115^{0}C

**Source: Latin America Thematic Network on Bioenergy, 2006.*

Related to the Biofuel Law, the Philippine Bureau of Products Standard has formulated the standards for Philippine bioethanol fuel as PNS DOE QS 008. This is patterned after the ASTM D4806 of the US. Table 2 shows the Philippine standard (PNS DOE QS 008) and

ASTM D4806 standards for bioethanol fuel. As shown in Table 7, the Philippine standard closely follows the ASTM D4806 but sets stricter limits on some properties such as lower water content per volume of bioethanol and higher minimum level of ethanol content. Furthermore, it requires the use of only unleaded gasoline as denaturant and does not set a standard for solvent-washed gum as the ASTM standard does. Solvent washed gum causes deposits on carburetors.

Bioethanol can also be sold as industrial alcohol, and Extra Neutral Alcohol. Sweet Sorghum bioethanol is also easier to transform into pharma grade ethanol due to the sulfur-free characteristic of the plant. The specifications for pharmaceutical grade ethanol and food grade ethanol are shown in Appendix 3, 4 and 5.

2.2 Bioethanol product regulation

Right now, there are interim guidelines that regulate the sale and transfer of ethanol blended gasoline products but no guidelines for producers with regards to bioethanol production and trading protocol. The guidelines should especially be able to address the possibility that bioethanol will be diverted to non-fuel purposes such as in the pharmaceutical and beverage alcohol industries.

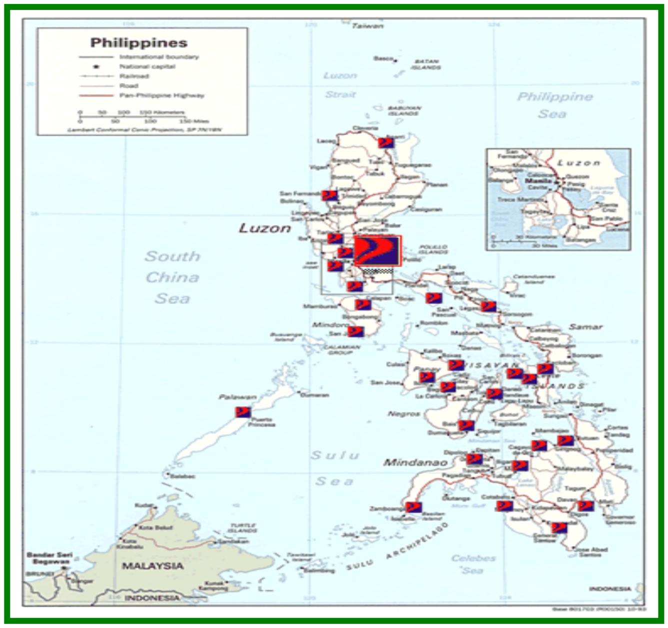
In the United States, bioethanol is denatured in order to prevent its use in the alcoholic beverage and pharmaceutical industries, where alcohol is subject to excise and other taxes. In India, however, there is no such requirement in contrast to the Philippines where as a result of Republic Act No. 9334 the alcohol specific taxes range from 20% to 50% with an 8% increase every two years until 2011. Hence, there is a risk that low cost bioethanol may end up as beverage alcohol if the provision against the diversion of biofuels in the Biofuels Law is not implemented properly.

3.0 Location Strategy

The major factor to consider in the selection of the distillery site is proximity to sweet sorghum production areas. Ideally the distillery location should be strategically located relative to the production areas and consumption center – the depots of the oil companies, since the depots will serve as the blending facility for the production of E5 and E10 mixtures. The other factors to consider are logistics (i.e. road infrastructure, port and handling facility, appropriate transport, storage) and site size.

Since feedstock accounts for about 60% to 80% of the total production cost of bioethanol, the distillery plant should locate near the farm production areas. This will reduce inbound logistics costs of raw material. Furthermore, this will facilitate delivery schedules important in addressing ethanol yield reduction resulting from transport delays. Sweet sorghum has a five day knife-to-knife shelf life, which becomes a constraint in large commercial production of ethanol.

Figure 10. Petron Locations from distilleries to depots, Philippines, 2006



After a general location has been identified, it will be important to consider the following factors for micrositing the bioethanol distillery. It should be located near the source of raw materials as well as the five day knife-to-knife shelf life of sweet sorghum stalk and the high costs of hauling. It should also have access to power supply. The distillery uses a number of pumps and motors that require a reliable three-phase power source for operation. Hence, in order to reduce costs, it is advantageous for the plant to be located near a high voltage three-phase tapping point, even if it has its own power generator. Furthermore, the distillery may want to export power generated using the sweet sorghum bagasse. This is only possible if it is economically feasible to tap it to a substation. Also, the power quality of the local utility has to be investigated in order that the pump motors do not get damaged easily.

The availability of water is yet another factor in site selection. Distilleries use a lot of raw water, with consumption in the range of 25-175 liters of water per liter of alcohol for both process and non-process applications (Uppal 2004). Distilleries depend on ground and surface water (rivers, canals, etc.) for their raw water requirement. In the Rusni Distilleries biodistillery in Andhra Pradesh, India, 10MT of water is needed per hour for steam production alone. The water requirement is higher for feedstock such as jaggery and sweet sorghum grain because additional water is needed in the process to dilute jaggery and to turn the grain into mash. No figures are available at the moment because the said plant was still being commissioned at the time of the researchers' visit.

Bioethanol is hygroscopic and cannot be handled by the current petroleum infrastructure without modification in the infrastructure. The current petroleum transport infrastructure, such as ships and pipelines rely on water to move petroleum products. Mixing ethanol into gasoline modifies its characteristics, making it difficult to separate out water. And too much water in the fuel affects the engine performance and service life.

An engineering expert of Petron, one of the large local oil companies, explained that ethanol will be blended in-line as a truck tanker is being loaded at any one of the depots in order to minimize moisture absorption of ethanol-blended gasoline. Of particular importance is the Pandacan depot in Manila, because this is where 40% of the country's requirement for unleaded gas is transshipped and eventually sold. Distilleries located in the main island of Luzon will therefore have a distinct advantage over those in other islands. Distilleries on other islands will have to transship their bioethanol via Subic, because this is the only port in Luzon that will have the infrastructure to handle it. Figure 10 is a map of the Philippines showing the general locations of Petron's depots.

The Luzon mainland is therefore the preferred location for serving the local market considering that this is where the majority of unleaded gasoline is consumed. Also, compared to distilleries based in the Visayas and Mindanao, there are fewer constraints on transshipment. Prospective distillery investors however should also consider exporting their ethanol, especially if they are located outside the Luzon mainland.

After a general location has been identified, it will be important to consider the following factors for micrositing the bioethanol distillery. It should be located near the source of raw materials as well as the five day knife-to-knife shelf life of sweet sorghum stalk and the high costs of hauling. It should also have access to power supply. The distillery uses a number of pumps and motors that require a reliable three-phase power source for operation. Hence, in order to reduce costs, it is advantageous for the plant to be located near a high voltage three-phase tapping point, even if it has its own power generator. Furthermore, the distillery may want to export power generated using the sweet sorghum bagasse. This is only possible if it is economically feasible to tap it to a substation. Also, the power quality of the local utility has to be investigated in order that the pump motors do not get damaged easily.

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Feedstock

- historic prices of feedstock
- competition for feedstock
- feedstock availability or easy acceptance and handling of trucks
- proximity of feedstock to plant
- seasonality of the feedstock

Water

- well water (actual availability and water quality must be thoroughly investigated)
- river water (for non contact cooling)
- water quality (mineral content)
- adequate wastewater disposal options

Energy

- proximity to three-phase tapping point
- reliability of local utility
- low utility rates
- availability of good long term contracts
- access to technologically established alternative energy sources
- power cogeneration potential

Transportation

- access to good roads
- access to rail for larger distilleries (e.g. Negros and Central Luzon)

Market Access

- geographical market potential
- proximity to gasoline blending terminals
- adequate trucking
- adequate port and shipping services
- potential for carbon dioxide market

Site Size

- ample room for future capacity expansion
- adequate space for truck traffic to move with ease
- adequate space for feedstock storage
- space for water treatment facility
- space for composting of distillery slops and other wastes
- space for run-off lagoon, if required, on the plant property
- proper ethanol and denaturant storage facilities with adequate storage volumes
- ample space for efficient ethanol and co product loading facilities

4.0 Inbound logistics strategy

The sweet sorghum cane will be transported to the distillery in the same way that sugar cane is brought to sugar centrals – via truck (Figure 11). If the location selected is near a sugar production area, the prevailing arrangements for cane handling may be adopted for sweet sorghum stalks. The problem, though, is the relative inefficiency of this system because trucks capable of hauling a ‘bagon’ carrying 10 to 12 tons per trip are used. Based on measurements done at the MMSU, a cubic meter of sweet sorghum weighing around 303-328 kgs. is less dense than neatly bundled sugarcane which weighs around 400.5 kgs/m^3. The trucks therefore will have to make more trips per equivalent weight of sugar cane.

Figure 11. Sugarcane Transport via Truck, Philippines, 2006.

In areas which traditionally do not produce sugarcane, the investors are encouraged to use larger trucks and explore the use of transfer stations, particularly since sweet sorghum is harvested at least twice as often as sugar cane. Furthermore, it takes around 50% more sweet sorghum stalks to produce the same amount of ethanol from sugar cane. It is therefore recommended that plantations around 50 kilometers away from the distillery will convert its stalk into syrup or jaggery (*panutsa*) (Figure 12).

Figure 12. Jaggery Produced from Sweet Sorghum, Philippines, 2006.

Syrup and jaggery (*panutsa*) can be produced near the farm using traditional methods. This is done by crushing the sweet sorghum stalk to extract the juice and then collecting, filtering and boiling it to produce jaggery. Most *panutsa* producers use a simple crusher consisting of three metal rollers driven by an engine. A 5HP diesel could process around 300 kgs. of stalk per hour. Usually, the crusher is connected by flexible hose to the drying vats where the juice is concentrated. The bagasse or dried cane residue can be used as fuel for this process. Syrup of 80 to 85 degrees Brix and jaggery at 90-95 degrees Brix can be produced with this process. The difference is in the boiling time as jaggery is produced after 3 ½ hours of boiling.

On the other hand, the sweet sorghum grain can be handled in the same way as rice and corn grain – that is, in 50 kg. sacks transported via truck or even jeepney.

Figure 13. Machine Used to Crush Sweet Sorghum Stalk to Extract the Juice to Produce Jaggery, Philippines, 2006.

Figure 14. Juice from Sweet Sorghum Stalk Boiled to Produce Jaggery, Philippines, 2006

5.0 Process and Technology Strategy

The traditional process of producing ethanol from starch and sugar-based feedstock is the same process that can be used for producing ethanol from sweet sorghum. Hence, technologies are commercially available for bioethanol production using sweet sorghum stalks and grain. Research is being conducted for the economic production of cellulosic alcohol although commercially viable technologies are not yet available. Nevertheless, there are several options for the production of bioethanol from sweet sorghum:

a. Distillery using both sweet sorghum stalk and sugar cane as feedstock
b. Distillery using sweet sorghum grain, cassava and corn as feedstock
c. Distillery using sweet sorghum jaggery as molasses substitute
d. Multiple feedstock distillery using both sweet sorghum cane and grain as feedstock

5.1 Ethanol from cane and sorghum stalk

Several firms are planning to put up bioethanol distilleries in the Philippines that will use sugarcane as feedstock. According to news reports, there are "already five ethanol processing plants being planned for construction," three in Negros Island, one in Bukidnon and another in Tarlac. Thus, this study does not deal with the feasibility of a sugar cane/sweet sorghum cane fed distillery given that a number of investors are already willing to put up sugarcane based bioethanol distilleries.

Some modifications will be required if distilleries designed for sugar cane is also used for sweet sorghum. First, sweet sorghum stalks need more trucks and hauling equipment because more sweet sorghum is needed to produce an equal amount of ethanol as that derived from sugar cane. Also, adjustments must be made in the juice extraction system. Finally, sweet sorghum juice can be treated with enzymes to maximize ethanol yield.

More sweet sorghum is needed than sugarcane for ethanol production. In India, sugarcane can produce 36 liters/MT, as compared to 60 liters/MT for sweet sorghum stalk. This means that around 9 more trucks will be needed to haul sugar cane in order to produce 40,000 liters of ethanol. On the other hand, around 45 trucks, or 25% more than sugarcane, will be needed to haul sweet sorghum stalks to produce the same amount of ethanol. Furthermore, it will require more time to haul the sweet sorghum stalks from the trucks and thus it may be necessary to rent an additional unit of crane.

Sweet sorghum cane has a smaller diameter and is softer than sugarcane and thus may require some adjustment in the juice extraction process. The stalks need only be passed through two mills in series which can be economical in a labor-intensive operation, as is being done in Rusni Distilleries in India. The sugar mill tandems, on the other hand, are generally composed of 4 to 7 mill units connected in series to maximize juice extraction. Sweet sorghum can pass though the mill tandem with some adjustments. Also, the roll mills will have to be run faster in order to produce the same amount of juice per day as sugar cane.

Enzyme treatment is an additional step recommended for ethanol production from sweet sorghum. There is some starch in the stalk juice because sweet sorghum produces grains. Thus, sweet sorghum juice is treated with enzymes in order to convert this starch into glucose and increase ethanol production. The additional yield from this process is determined by the starch content in the juice, which in turn is influenced by the maturity of the plant at the time of the harvest of the stalk.

Some adjustments are needed in distilleries designed to use sugar cane juice when used for processing sweet sorghum. This will include adjustments in stalk handling, juice extraction and juice treatment. Downstream of the juice treatment, the process is the same.

5.2 Starch distillery

Some Philippine beverage alcohol producers use starch in the production of beer and other alcoholic beverages. San Miguel Corporation has been using corn and wheat in beer production, and is considering the use of cassava. Production of alcohol from starch is more expensive than using sugar because of the high price of the feedstock. The use of starch-based feedstock has been feasible for beer and spirit production due to the relatively high price of the finished product. However, there is some concern on the use of starchy food for fuel alcohol since bioethanol is meant to be sold at a much lower price per liter than alcoholic beverages.

The US is the largest producer of fuel ethanol from sorghum grain. Bioethanol production from sorghum is possible in the US because of its low cost and the feasibility of co-production of high value byproducts. Despite cross subsidy, the production cost of sorghum grain derived anhydrous ethanol is still higher than that from sugar cane.

The process by which the sweet sorghum grains are utilized for ethanol production is as follows. First, it will be processed by converting the starch into glucose. Conversion takes place through the following enzymatic chemical reactions:

$$2\ (C_6H_{10}O_5) + H_2O \rightarrow C_{12}H_{22}O_{11}\ \text{(maltose)}$$

$$C_{12}H_{22}O_{11} + H_2O \rightarrow 2\ C_6H_{12}O_6\ \text{(glucose)}$$

$$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH\ \text{(ethanol)} + 2\ CO_2$$

Conversion of the starch to glucose starts with cooking to gelatinize the starch mash. The starch mash is typically conveyed or pumped to a cooker where it is heated by steam until it is gelatinized. Gelatinization starts at 60°C when cooking is done under normal atmospheric and slow cooking conditions. Cooking under pressure on the other hand requires that the mash be heated to 140 to 175 °C for gelatinization to occur. Cooking time for this method is much shorter by about 20 minutes or less.

Continuous cooking is required however to produce anhydrous ethanol. In this process, starch mash and a pre-liquefying enzyme are sent to a mash mix tank where they are agitated to keep the starch in suspension. Introduction of a pre-liquefying enzyme is necessary to prevent the gelatinization of the starch mash in the mix tank which makes pumping difficult. The mash is then continuously fed to a jet cooker where it is mixed with steam at 10 bars (g). The cooking process occurs at a temperature of 105 to 150 °C. Mash and steam are held at high temperature and pressure in the cooker for about 20 minutes. An alternative to direct steam injection is indirect cooking where steam is passed through tubes to cook the mash. From the cooker, the mash is sent to a flash tank to cool and separate from the injected steam. Steam from the flash tank can be recovered and used in drying fermentation residues, which may be used or sold as livestock feeds, or condensed and recycled in the process. The cooled mash which now has a temperature of about 60°C flows by gravity to the liquefaction tank.

In the liquefaction tank, alpha-amylase, a liquefying enzyme, is added to the mash. The mixture of mash and enzyme are circulated in the tank to ensure proper mixing and liquefaction. The temperature of the mixture must be kept at about 93°C to effect liquefaction. A residence time of 20 to 45 minutes is needed to complete liquefaction of starch.

Once liquefaction is complete, the mash is cooled in mash coolers to the optimum saccharification temperature of about 50 to 60°C. Prior to cooling in the mash coolers, beer slops may be added to dilute the mash and reduce its pH. Sulfuric acid may also be added to reduce the pH to 3.7 to 4.5.

From the mash coolers, the liquefied mash is pumped to a fermentation tank, which is also used as the saccharification tank. Glucoamylase enzyme is then added to the mash prior to the start of the saccharification process. Glucoamylase will convert the dextrin (liquefied mash) to glucose. In the tank, the mash is either agitated or circulated to ensure proper mixing of the enzyme and mash.

A bioethanol distillery using only the sweet sorghum grain as feedstock is not feasible and will not be evaluated in this study.

5.3 Sugar ethanol using sweet sorghum jaggery as molasses substitute

Molasses is the predominant feedstock used in the local beverage alcohol production industry. Unfortunately, the industry is experiencing a shortage in the supply of molasses, forcing some firms to consider substitutes such as cassava milk. The use of sweet sorghum jaggery can be used to address this shortage.

Jaggery is the concentrated juice of sugar cane or sweet sorghum. It can also be produced by traditional methods used to produce "panutsa," with some adjustment. Enzymes may need to be added in order to prevent gelling of the jaggery.

Jaggery can be stored for a reasonable amount of time so that it can be used at the end of the milling season or when prices are high. Based on information from ICRISAT, it can be stored for 6 to 9 months.

Producing alcohol from jaggery is practically the same as that from molasses. The jaggery is diluted to 40 brix and pasteurized in order to kill off stray microorganisms that can cause problems in the fermentation

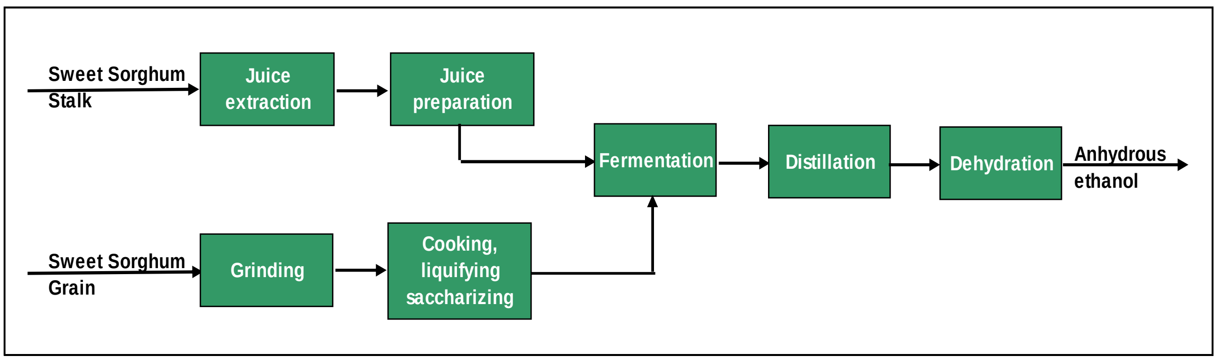
5.4 Multi-feedstock sweet sorghum distillery

A bioethanol distillery plant using sweet sorghum stalk and grain has been put up by Rusni Distilleries in Andhra Pradesh with the help of ICRISAT (Figure 15). The facility is said to be designed to produce 40 kilo-liters per day (klpd) or approximately 12M liters/year.

An overview of the process of producing anhydrous ethanol from sweet sorghum stalk is shown in the figure below (Figure 16).

Figure 15. Rusni Distilleries in Andhra Pradesh, India, 2006.

Figure 16. Sweet Sorghum Ethanol Production, Process Overview.



Source: Rusni Distilleries interview, 2006.

Ethanol production from stalks will not be done simultaneously with that from grain. It will take around 3-5 days to process sweet sorghum stalk juice into ethanol; on the other hand it will take 4-6 days to process the grain.

To start, sweet sorghum stalks are brought to the plant site and weighed. Based on data from ICRISAT, the knife-to-knife time is not as critical as that of sugarcane because the sugars in sweet sorghum stalk do not crystallize as it does in cane. In fact, under traditional methods in the US, sweet sorghum stalks are aged for three days after harvest in order to allow for sucrose inversion. Based on the experience at the MMSU, the knife-to-knife time is 5 days or 120 hours, in contrast to 24 hours for sugar cane. This is further supported by studies undertaken in China sponsored by FAO that showed that the degree Brix of juice increases after stem harvest.

Figure 17. Bioethanol Distillery Facility, India, 2006.

At Rusni, the stalks are prepared by removing the leaves and cutting to length. However, it is possible to already remove the leaves at the field and then cut to length which is also done with sugarcane to improve juice extraction. This will help reduce the transportation cost of the feedstock. If it is not possible to remove the leaves in the field, it is advised that the leaves be allowed to dry after cutting since some juice resides in the leaf midrib. This will further increase juice production. In India, juice is then extracted by passing the stalks through two vertical two-roller mills where feeding and transfer between mills is done manually. The developer has the option of using a manual three-roller vertical mill, which can reduce the manpower requirement by half. Other methods that may be used are to use a three-roller vertical mill tandem or a cane juice diffuser, as is being done in the sugar industry. The advantage of these is that juice extraction is maximized, hence increasing the ethanol productivity per unit of feedstock. An added benefit is that with this process, the bagasse is drier and thus can be used more readily in the boiler for steam and power cogeneration.

The juice is then prepared for fermentation, through pH control, concentration and pasteurization. In the Rusni process, lime is used for pH control, but in other processes, sodium hydroxide and sulfuric acid are usually used. The juice is usually made slightly acidic to control the action of undesirable microorganisms as well as to promote yeast action.

For grains, water is added to the ground sweet sorghum to form slurry. The slurry is then cooked with the use of jet cookers like those at Rusni Distilleries. Enzymes are then added to convert the starch into sugar. After this, the batch is pasteurized.

After pasteurization, yeast is added and the batch is allowed to ferment for 48 to 54 hours using Turbo Yeast. There are other Turbo Yeasts available, including those that can expedite the fermentation process to 24 hours. The characteristics of the yeast are a critical part of the process design. Yeasts are being made more temperature and alcohol tolerant for better alcohol processing. There are also other yeasts that work well with continuous fermentation. Continuous fermentation has the advantage of using less equipment, less effluent and higher ethanol yield. Also, the risk of contamination is reduced with some systems, a problem encountered with batch fermentation. The final selection of the fermentation technology is left to the investor.

CO_2 is recovered during the fermentation process which then can be sold. After fermentation, the batch is distilled to 190 proofs (95% purity). The distillery slops are collected and treated and used as liquid fertilizer. The alcohol is then further dehydrated using a molecular sieve to 99.98% purity. Other options are azeotropic distillation and extractive distillation which are more energy-intensive. Still, another option is to use membrane separation. The prospective investor will have to look into the individual merits of these technologies.

In India, the alcohol is stored in a temporary storage tank after dehydration, while awaiting purity tests and government approval. Once approved, they are transferred to certified bioethanol storage tanks.

Companies can license the proprietary sweet sorghum anhydrous alcohol production technology of Rusni Distilleries or other companies for the distillery process design. Processes used for sugar cane can also be adapted to sweet sorghum, such as the continuous fermentation process of Alfa Laval.

6.0 Environmental Considerations

It is the general consensus that the use of bioethanol has a positive effect on the environment. Its use results in a reduction in greenhouse gas (GHG) emissions and a good energy balance. However, bioethanol production has some local adverse impacts. These however can be easily mitigated.

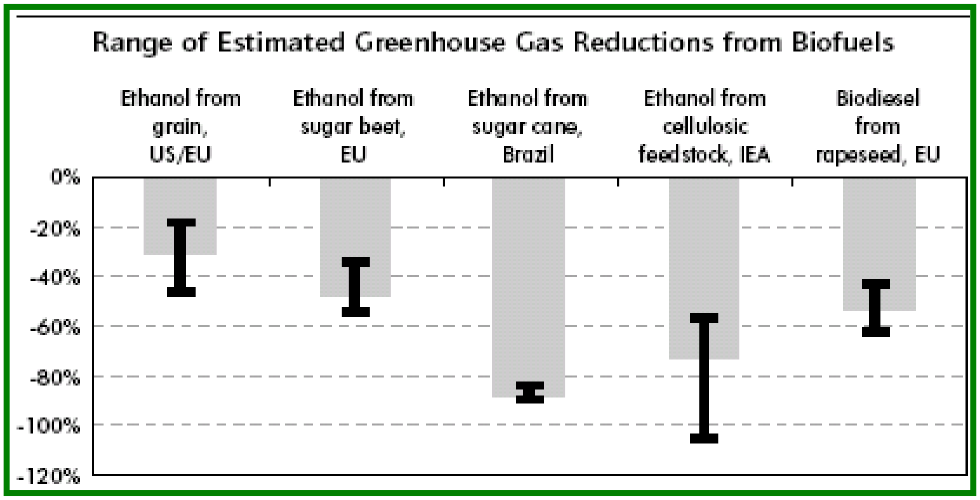
6.1 Greenhouse Gas Reduction

Several studies such as those conducted by the US Center for Transportation Research at the Argonne National Laboratory and the International Energy Association show that on a "well-to-wheels" basis, the use of any alcohol as fuel results in reduced greenhouse gas emission as compared to gasoline. While the estimates may vary, they all agree that the reductions in CO_2-equivalent emissions are significantly reduced with ethanol as compared to petroleum. New studies further show higher reduction in GHG estimates than before because of improvements in both agricultural production and ethanol technology.

The International Energy Association estimates large reductions in GHG's for ethanol from cellulose and from sugar cane, as can be seen in the Figure 18.

It would be safe to say that sweet sorghum ethanol's impact is better than grain because the sweet sorghum stalks yield considerable amount of fermentable sugar. This can be verified by undertaking a Life Cycle Analysis in conjunction with the Department of Energy.

Figure 18. Range of Estimated Greenhouse Gas Reductions from Biofuels

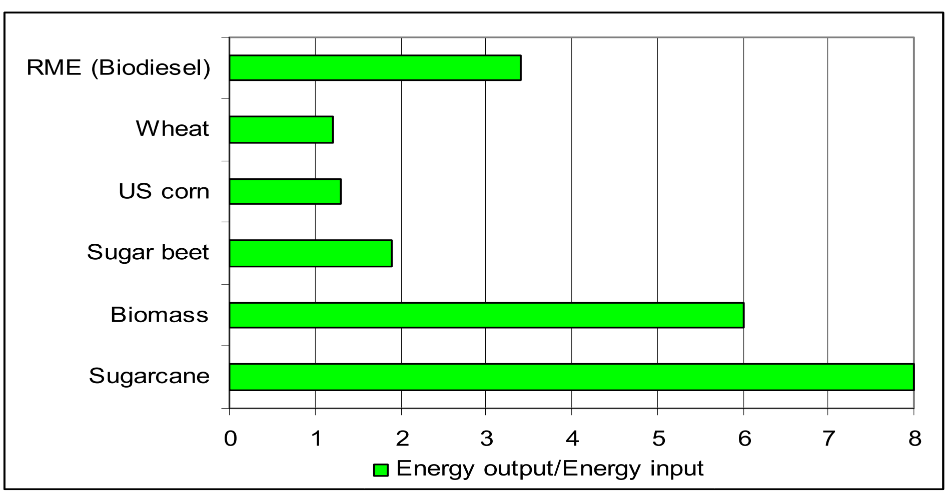


Source: IEA, 2004.

6.2 Energy Balance

The other issue is that of energy balance. While there has not yet been any study on the energy balance of ethanol production from sweet sorghum, there are a lot of studies on the energy balances of corn and sugar cane derived ethanol. As shown in Figure 19, the production of bioethanol yields more energy than the petroleum energy used in production. However, the energy balance estimates vary widely from crop to crop, from country to country, as well as from researcher to researcher.

Figure 19. Energy Balance by Feedstock



Source: F.O. Litch, 2004.

One contention is that corn-derived ethanol in the US has a negative energy balance. The controversy was started by a study published by Professors Tad Patzek and David Pimentel. They argued that corn ethanol takes 71% more energy to produce than what it yields in the form of ethanol. This has been contested by a number of studies. One such study was prepared by a US Department of Agriculture team led by Dr. Hosein Shapouri. The team estimated that the net energy balance of corn ethanol in the year 2001 was 1.67, meaning that the energy output was 1.67 times that of the input. Furthermore, Dr. Michael Wang of the Argonne National Laboratory's Center for Transportation Research in the US found that the ratio of energy output to petroleum energy input of corn ethanol is 0.74. The said researches employed a variety of approaches, fuelling further debate between proponents and opponents of corn ethanol.

One of the major contributors to energy intensity in the US is the heavy use of fertilizer in corn cultivation. According to Prof. David Pimentel, fertilizer production and fuels for mechanization account for two-thirds of the energy inputs for corn production or approximately 36,867 BTU per gallon of corn ethanol. In contrast in the Philippines, agriculture is labor-intensive and does not require any fuel while at the same time, the fertilizer requirement of sweet sorghum is lower than sugar cane and corn. Hence, it is safe to say that the energy input of sweet sorghum in crop production may be considerably lower than that of corn.

Furthermore, natural gas is used in the production of ethanol from corn, particularly in cooking and distillation. Prof. Pimentel estimates that 74,300 BTU energy equivalent of fossil fuels are needed to produce one gallon of corn ethanol. In the case of sugarcane and sweet sorghum, however, bagasse can be burned for the cooking, pasteurization, power generation, distillation and other heating requirements.

This information indicates that the energy balance of sweet sorghum-derived ethanol is better than corn. A more detailed estimate of the energy balance of sweet sorghum can be obtained through a Life Cycle Analysis of the well-to-wheel cycle of sweet sorghum ethanol, which can be done in coordination with the Department of Energy.

6.3 Local Environmental Effects

Aside from their huge water requirement, distilleries also dispose a lot of wastewater. The amount of wastewater is typically in the range of 8-15 liters per liter of alcohol produced, irregardless of feedstock. The wastewater effluent has a high BOD (45-60 000 mg/L), high COD (80-160 000 mg/L), and dark color and in many cases, foul order. Distillery slops and floor wash are main contributors to water pollution.

Table 10. Wastewater generated in different operations, Philippines and Vietnam, 2003

Distillery operations	Average wastewater generation (kiloliters/day)	Specific wastewater generation (Li wastewater/ Li alcohol)
Spent wash (from distillation)	511.4	11.9
Fermenter cleaning	108.2	2.5
Fermenter cooling	307.7	7.2
Condenser cooling	34.2	0.8
Floor wash	47.6	1.1
Others *	33.3	0.8

** Domestic wastewater, wastewater from steam generation*
Source: TERI, 2003.

A study done in the Philippines and in Vietnam evaluated the use of alcohol distillery slops for irrigation. The best option, according to the study, was anaerobic treatment of slops prior to irrigation because of the low cost of BOD load reduction (PHP 1,117/mg/l) and of color reduction (PHP 5,029/Pco). In this process, slops go through a biological reactor called a biodigester and are treated using a technique called Upflow Anaerobic Contact (UAC). The biodigester has a separate sludge separator, which is suitable for treating wastewater with a large amount of solids. This technology has been successfully implemented in Distilleria Bago in Bago City which has 153,000 Kg COD/day and in the Dyzum Distillery that has 126,000 Kg COD/day.

Irrigating fields with distillery slops resulted in increases in harvest, water availability, and residual soil fertility after harvest. Applying slops to sugarcane increases production by 28 tons per hectare, valued at P23T/ha. The additional value due to the residual soil fertility is P53T/ha., due primarily to increase in potassium levels. The volume of residual nutrients also increases, particularly phosphorous at an equivalent of 5,860 kgs of phosphorous oxide per hectare. In addition to lower costs of feedstock production, the distillery also saves on energy costs through biogas production.

On the other hand, there are some costs associated with use of slops for irrigation. These are the costs of river clean-up (P42-88T/hectare of slop-irrigated field) and the cost of groundwater contamination due to leaching of about (P8-18T/hectare).

An unexpected benefit of the use of distillery slops is added employment due to the need for additional labor for monitoring slop application, increased weeding and slops hauling. While there are increases in labor costs, these are offset by a decrease in fertilizer cost.

The benefits of distillery slop reuse are recognized in the Biofuels Act of 2006. It provides exemptions to fuel ethanol distillery slops from wastewater charges as provided for under R.A. No. 9275 or the Philippine Clean Water Act. This is however subject to DENR's monitoring and DA's approval, and as long as the use of slops is in accordance with the Clean Water Act's provisions.

7.0 Carbon Sequestration Potential

It is widely recognized that the use of biofuels results in lower net carbon emissions as compared to the use of petroleum fuels. This is despite the fact that distilleries emit carbon dioxide and methane in the production and even in the use of ethanol. The rationale for this is that biofuels are carbon neutral, meaning that they sequester carbon dioxide in the atmosphere. Whatever carbon dioxide is emitted is roughly equivalent to that which the plants absorb.

An anhydrous ethanol distillery can earn substantial carbon credits, the most significant of which is the displacement of petroleum fuel by the bioethanol produced. However, this source of income will not improve the returns significantly. The improvement in the Internal Rate of Return (IRR), based on experience in the World Bank's Prototype Carbon Fund (PCF) is 1-2½ %. While this is not enough to make infeasible projects attractive, it does provide an additional incentive to those who pursue such projects.

There is a precedent for fuel ethanol projects carbon credit determination – the Khon Kaen bioethanol project in Thailand with methodology number NM0082. Under NM0082, the carbon credits were determined with the use of Life Cycle Analysis (LCA) supplemented with data from the experience of Brazil with sugar cane. Based on this methodology, the distillery's carbon credit will be based the reduction in human activity related emissions of greenhouse gasses (GHGs) that will result from the displacement of gasoline and MTBE by the bioethanol produced. The emission reductions arising from the production of 12M liters of ethanol are estimated at 21,500 MT of CO_2 equivalents per year, worth US$ 107-215T based on World Bank. This carbon credit can provide the distillery owners an additional source of financing because the carbon credit forwards are usually bought by carbon credit traders in European markets.

The distillery can earn additional carbon credits from bagasse electric power generation and methane from biomass decay through wastewater treatment. The carbon credits that can be earned by adopting these options will depend not only on the size of the distillery but also on the specific equipment and technology adopted. For example, in a continuous fermentation process, the distillery will have a higher electricity parasitic load but less wastewater effluent. Carbon credits from the use of these options will have to be determined on a case-to-case basis.

8.0 Capital Requirements and Operating Expenses

Aside from capacity, the final cost of the distillery will depend on a number of factors such as country location, site-specific factors, technology used and project scope. Since there is limited information about sweet sorghum distillery equipment costs, capital costs will be approximated using sugarcane juice distilleries. This is because most of the alcohol produced (approx. 65%) will come from the sweet sorghum stalk, whose processing is similar to that of sugarcane.

The capital cost is reduced considerably due to the economies of scale. For example, Praj Industries, an-Indian-based turnkey contractor for anhydrous ethanol distilleries estimates the capital cost of a 20M gallon per year (approx. 216 klpd) distillery using sugar cane feedstock at US$2.10-2.20/gallon (US$ 0.55-0.58/liter) of annual capacity. They further estimate that the capital cost for a 40M gallon per year (approx. 432 klpd) distillery using sugarcane feedstock is US$ 1.63-1.68/gallon (US$ 0.43-0.44/liter) of annual capacity.

The investment cost of a 40 klpd distillery using sweet sorghum as feedstock is US$ 9.5M, based on a quote by Rusni Distilleries. Assuming that feedstock is harvested for 200 days/year the plant can produce 12M liters a year. The estimated average capital cost of the sweet sorghum ethanol plant comes out as $0.61/liter of annual capacity. The capital requirements of sweet sorghum fed anhydrous ethanol plants are shown in Appendix 10.

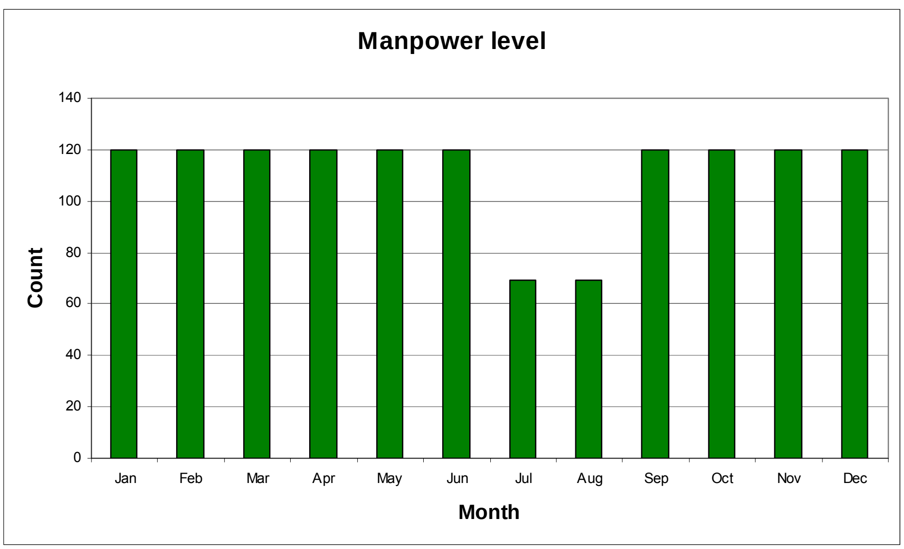
Investment cost estimates for the Philippine case were made for 40 kld, 100 kld and 200 kld distilleries, as shown in Appendix 7, 8 and 9.

The 40 kld distillery cost estimate was based on a quotation by Rusni Distilleries. The larger distilleries, on the other hand, were based on cost estimates from western suppliers.

9.0 Manpower Requirements

The distillery will employ 120 people, 77 of whom are regular employees and the remaining 43 are contractual. The contractual employees will be hired from September to June of the following year. From September to March, the distillery will use the stalks as feedstock and from April to June grains will be used.

Figure 20. Projected Manpower Requirement for Ethanol Distillery Plant, Philippines, 2006.



10.0 Product forms and Specifications

Bioethanol from sweet sorghum can be produced from the processing of stripped stalks, grains and jaggery. The stalks are stripped during or after harvest and then brought directly to the distillery for processing. Stripping may be done manually (Figure 23) or through the use of harvesting machines (Figure 24). For both harvesting practices, the panicles are first separated from the stalks followed by the collection of the grains which are eventually dried and stored in the farm or in the distillery for future processing into bioethanol.

An advantage of sweet sorghum over the other feedstock for ethanol production is that it can be converted and sold in solid or semi-solid form which is easy to transport from the farm to the distillery plant. This is especially important for small farms supplying feedstock to a distillery plant in a neighboring area. A case in point is a small rainfed rice farmer who may wish to plant sweet sorghum after rice.

There are three feedstock forms which can be produced from sweet sorghum. These include:

10.1 Jaggery

The cane juice can also be converted into jaggery in the farm before processing into bioethanol. Jaggery is raw sugar which when solidified can be wrapped in plastic sheet (Figure 21) and stored for up to 6 to 9 months under normal environmental conditions without deterioration of quality. With a longer inventory period, there will be greater flexibility in the scheduling of harvest of sweet sorghum canes. The jaggery can be directly processed into bioethanol in the distillery. Transport and other logistics costs are reduced as the quantity of sugar per unit weight and volume is reduced significantly. Figure 22 shows jaggery being produced from sugar cane juice.

Being almost in solid form, the advantage of jaggery is that it can be wrapped with plastic bag. Compared to other forms, jaggery is very easy to transport at also much lower cost per unit of ethanol produced. Jaggery can be stored at room temperature without significant deterioration for 6 to 9 months. In this form, it will still pay off for a farmer with a half hectare or less or located more than 20 kms. from the distillery to plant sweet sorghum.

Figure 21. Sweet Sorghum Jaggery, ICRISAT, India, 2006

Figure 22 Jaggery produced from sugarcane juice, Batac, Ilocos Norte, Philippines, 2006.

10.2 Stripped stalk

The leaves and panicles are removed leaving only the cane. Milled /stripped stalk will yield relatively clear juice. This product is appropriate for areas within a 30 km. radius from the mill-distillery and has an abundant supply of labor.

Figure 23. Hand stripping of harvested sweet sorghum canes, Mariano Marcos State University (MMSU), Batac, Ilocos Norte, Philippines, 2006.

Figure 24. Mechanized harvesting, stripping of canes and separation of grains,

Source: Grassi, Giulliano, European Biomass Industry Association (EUBIA), 2006.

10.3 Raw stalk with intact leaves

This product form is appropriate when the mill-distillery is fitted with a mechanical leaf stripper. The raw stalks are loaded into the trucks right after cutting and panicles harvested. The advantage of this product form is the shorter period between “knife to knife” (cuttings to milling) which may result to higher ethanol yield. Another advantage is the bigger volume of biomass for energy production in the distillery. This is appropriate for areas within a 30 km. radius from the mill-distillery.

11.0 Marketing Arrangements

A contract arrangement between agro-processing firm and farmers is often suggested to ensure the timely availability of the necessary inputs for production, access to credit and technical assistance as well as a ready market for the farm products of farmers. For the firm, they are assured of the source of their raw material inputs. This is an important form of vertical integration.

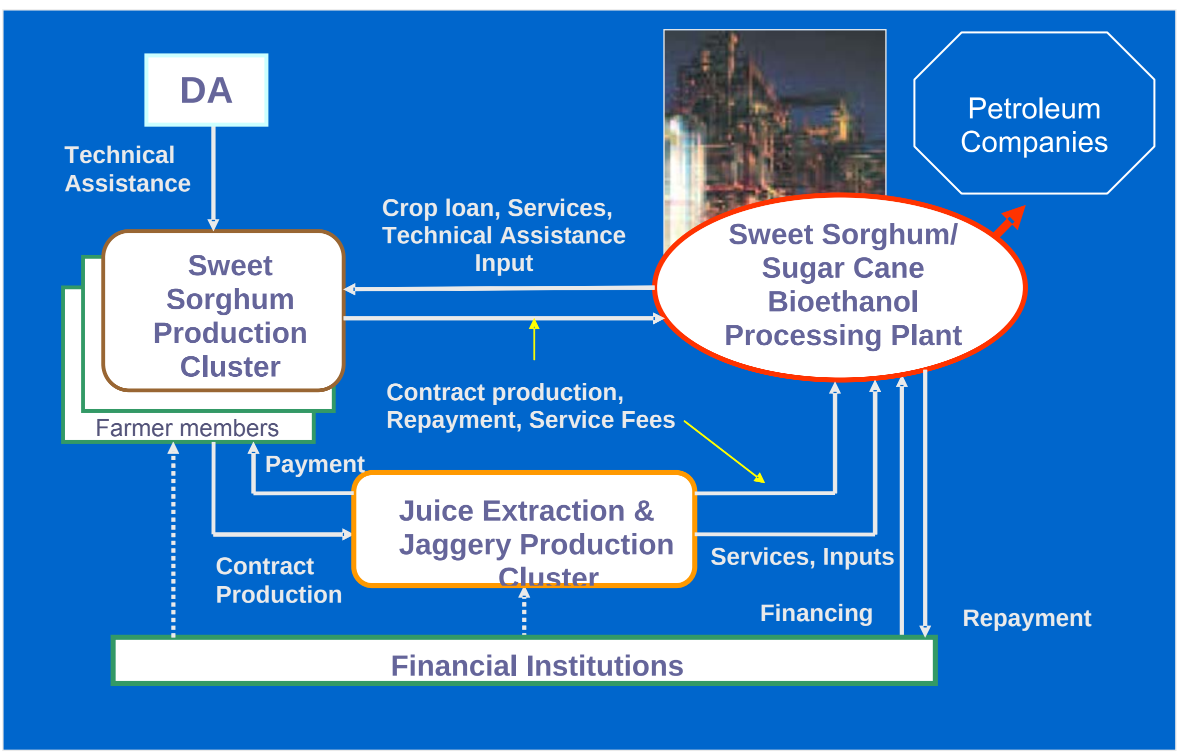
A centralized contract growing scheme with nucleus estate and a corporative scheme are two contractual arrangements that the distillery plant can adopt for the production of sweet sorghum for the distillery plant. These schemes allow the distillery plant to control the supply chain and manage risks and uncertainties.

In the first model, the supply of raw material will come from contracted growers, maybe individuals or group of farmers and an estate. The level of production support by the distillery plant can include the provision of production inputs such as seeds and agrochemicals to providing credit to pay for the cost of land preparation, irrigation and post-harvest facilities. The distillery plant will then deduct these costs from its payment to farmers after harvest. Such production arrangement assures the distillery plants that they will have enough raw materials to continue operating the processing plants at least at a minimum level. In addition, the farms can serve as an avenue for undertaking on-farm research and development for new varieties of crops or hybrids.

The corporative model is suitable for areas where land is fragmented and transport access is difficult. In the Philippines, with the implementation of agrarian reform, lands were distributed to many farmers with a consequent loss of economies of scale. It would thus be important to organize them as one production area or possibly production clusters that can produce enough raw materials to supply the requirements of a distillery plant. The aggregated production areas managed and operated as a corporate farm allows more mechanization of operation. Priority in hiring workers for the farm is given to farmers and their immediate family members.

Production clusters will be contracted by the distillery to produce the jaggery. These will be located in strategic areas around the distillery plant. A mobile cane crusher will extract the cane juice that will be converted into jaggery. However, it will be important for concerned government agencies to provide technical assistance as well as ensure that the terms and conditions of the agreements between the farmers and corporate group are met. Figure 25 shows the relationships and functions of the farmers, the corporate group and government in this kind of arrangement.

Figure 25. Corporative Model of Sweet Sorghum Production to Supply the Raw Material Requirement of a Bioethanol Processing Plant



12.0 Production Technology

12.1. Inbound Logistics Strategy

Trucks with capacities of 10 to 12 MT will be used to haul stripped stalks from the farm directly to the bioethanol distillery plant for processing. These are similar hauling trucks used in sugarcane farms to deliver stripped canes to sugar mills. During a 10-hour operation, a 40,000 liter per day bioethanol processing plant should be able to process at least eight trucks of delivered cane per hour.

It is recommended that the sweet sorghum farms should be located no farther than around 15 to 20 kilometers from the distillery plant. For areas beyond this radius, it is recommended that the raw material should be in the form of jaggery. The jaggery can be inventoried in centrally located production areas where they can later be collected and brought to the plant.

During the wet season when there is difficulty in reaching the production areas with poor access roads, then the feedstock can be stored as jaggery which then can be transported to the distillery mill when weather permits and the roads are passable.

The distillery mill can provide the trucks to haul the harvested stalks and grains from the farms and jaggeries from the processing centers. It would be best if the mill has its own transport fleet so it can ensure better control, flexibility, and better scheduling of harvesting and hauling operations. However, it may decide to contract another company to provide the transport services and reduce the risk to the distillery.

12.1.1 Seed Production Scheme

The seed certification procedure must conform to RA 7308. The isolation distance between varieties should be at least 300 m for foundation seed and 200 m for certified seed. There are two possible schemes that may be adopted:

a. Smallhold Farmer Seed Producer on Contract to Commercial Seed Company - A seed company will engage the services of small-scale farmer to produce seeds and buys the produce subject to specific quality requirements embodied in a contract.
b. Barangay-based Seed Production Scheme - This scheme is being pilot tested in barangay Bungon, Batac, Ilocos Norte. It is supervised by DA-BAR/MMSU personnel. Seed produced is equivalent to certified or good seeds. Initially, in the absence of a National Seed Quality Control Services for sweet sorghum, the quality or genetic value, purity and viability is certified by DA-BAR/MMSU researchers.

C. FINANCIAL ASPECTS

1.0 Feedstock Pricing

One concern of potential distillery owners is the pricing of raw materials, especially since feedstock cost comprises the biggest portion of bioethanol production cost in the Philippines. While the prospective distillery will be able to process both sweet sorghum stalks and grain, the feedstock pricing strategies will have to be different since these products have different alternative uses.

1.1 Stalks Pricing

The preferred scheme for pricing feedstock is to base it on the cost of feedstock per unit volume of ethanol produced. This is the most convenient way of initially determining the price. This however can be revised to be responsive to the market conditions. Since the price is a function of the sugar content of the harvested stalks, a monitoring system and control system should be developed and implemented to ensure full compliance of the procedure and maintain the integrity of the testing procedure in the field and plant. However, since the products may be direct substitutes for competing products, adjustments will have to be made to the pricing scheme as deemed appropriate. Such a simple system may be needed during initial operation in order to encourage farmers to plant sweet sorghum. Also, it gives the distillery some time to cope with start-up delays. It is suggested that the cane price be set at around P500-600/MT at the farm. This feedstock pricing policy initially adopted may be in effect during the first to second years.

The distillery should provide incentives to encourage more farmers to produce and improve the quality of their feedstock. Hence, while the distillery may use a base price for the stalks, it should compensate farmers for efforts to improve the sugar content of the stalks and its juice yield. These can be determined in the same way as is done for sugarcane farmers. This can be implemented when the distillery has gained the confidence of farmers.

Sugar content can be determined using a relatively inexpensive hand refractometer, which measures sugar content in degree Brix. This test gives the distillery and the farmer a quick and simple way of assessing sugar content. Since it is visual, the distillery's inspector can show the result to the farmer on the spot, hence giving credence to this test. One degree Brix may result to as much as 20% increase in ethanol yield at the same level of juice yield. However, caution must be exercised in using the ^{o}Brix reading in production planning since the reading is subject to a variety of factors, such as sugar composition.

The juice extraction rate is measured in terms of juice weight over the stalks weight. It can be measured by passing a small volume of stalks through a small two-roll or three-roll mill and weighing the extracted juice.

1.2 Grains Pricing

The price of the grain will depend on the targeted price of bioethanol and its opportunity cost. The opportunity cost of the grain is the price of the grain when used in livestock feed production. Based on interviews by the study team, the grain will be bought by feed mills if the price is 80-85% that of corn. A sweet sorghum distillery may thus want to consider the use of more stalks in ethanol production rather than grain considering that corn prices, and hence sweet sorghum grain prices, are likely to be high in the near future.

The grain should be dried to its equilibrium moisture content (14%) so it can be safely stored. At harvest the moisture content of the grain is around 18% to 20% depending on the time of the year. With this level of moisture the grains are susceptible to fungal (i.e. aflatoxin) and bacterial contamination.

1.3 Jaggery Pricing

Jaggery is an intermediate product that may be used in ethanol production.

Given below are the parameters for the production of jaggery from the ICSR 93034 variety of sweet sorghum. The stalk was harvested February 13, 2007.

Table 11. Parameters for the production of jaggery from the ICSR 93034 variety of sweet sorghum, Philippines, 2007.

Parameters	ICSR 93034 (Stripped)
Weight of 1.0 cu. m (kg of stalk)	330.6
Juice volume, liters	73.5
Milling time, min (small mill)	60.8
Sugar content, ^{o}Brix	18
Cooking time min.	155
Jaggery volume, liters	13.6
Juice volume liter/kg stalk	0.2223
Jaggery volume, liters/liter juice	0.1850
Jaggery volume, liters/kg stalk	0.0411
Weight of Jaggery kg/kg stalk at 1.18 spg	0.0485
Average stalk yield, MT/ha	49
Volume of stalk cu.m/ha	161.99
Volume of juice, liters/ha	10,893.83
Volume of jaggery liters/ha	2,015.73
Weight of jaggery kg/ha	2,378.56
Sugar content of Jaggery, ^{o}Brix	87-92

Based on the sugar content of the sweet sorghum jaggery, the ethanol productivity is estimated at 350-370 liters/MT of jaggery. The feedstock cost of sweet sorghum stalk is P11-12/liter, excluding P2.50/liter transportation cost of the stalks from the field to the distillery. Based on this information, the price of sweet sorghum jaggery should be around P4,725 to 5,365/MT delivered to the distillery.

Around 48.5 kgs of jaggery can be produced per metric ton of stripped sweet sorghum stalk. Hence, it would take around 20 MT of stripped sweet sorghum stalk to produce a metric ton of jaggery. If the stalks are bought at P550/MT, then the material cost alone will cost P11,340.20. It goes without saying that the farmer stands to lose a great deal of money if he is not able to sell his stalks unprocessed. At such times, it may be better for him to sell his produce at a great discount to give distillery owners sufficient incentive to use sweet sorghum stalks.

2.0 Operating Expenses of Sweet Sorghum Ethanol Production

Estimates are only available because at the time of data gathering, the Rusni Distilleries plant in Andhra Pradesh was just being commissioned and prepared for operations. The costs excluding the capital costs of producing anhydrous ethanol from sweet sorghum as estimated by the Indian National Research Centre is shown in Table 12:

Table 12. Cost of Producing Anhydrous Ethanol from Sweet Sorghum, India, 2004.

PARTICULARS	US$/1000 liters
Manpower	10.9
Steam	21.7
Electricity	21.7
Yeast	2.2
Management/administration	2.2
Pollution control	Nil
Raw Material	226.3
Total	**285.0**

Source: D. Rao, National Research Centre for Sorghum, 2004.

The production cost per liter of sweet sorghum ethanol in the Philippine context is estimated at P22.79/liter (equivalent gasoline price of PhP30.38 at depot level or about PhP32.88 at retail pump level). This is based on interviews and review of publicly available documents at the DENR-EMB. The cost estimate for yeast and enzyme use is drawn from figures from the USDA's 2002 Cost of Production. It is assumed that the stalks will be used to produce 66.67% of the ethanol and the 33.33% balance would use grain as feedstock. The stalk price is set at P550/MT while that for the grain is P6/kg. These are based on their parity price compared to substitutes, cane sugar for the stalks and corn for the grain. The details of the cost estimates are shown in the Appendix 6.

As shown in the above table, the main component of the production cost in the Philippines is the cost of the feedstock. The feedstock cost represents more than 50% to 75% of the production cost for sweet sorghum. Hence, efforts should be exerted to reduce the cost of raw material. The feedstock costs however may be reduced significantly without sacrificing the farmer's income by developing high-yielding varieties.

Estimates of the cost of producing ethanol using various feedstocks available in the Philippines are shown in Table 13. The details of the computations for sweet sorghum ethanol are included in Appendix 6.

Table 13. Estimates of the cost of producing ethanol using various feedstocks available in the Philippines. 2006.

Feedstock	Production Cost (PhP/liter)	Days Used as Feedstock	Average
Sugarcane	22.19.	150	25.73
Molasses	29.26	150	25.73
Corn	31.46	300	31.46
Sweet Sorghum	22.79	300	22.79

As shown in Table 13, the cost of producing ethanol from sweet sorghum is comparable to that of cane sugar. The differences are in the number of days that cane sugar can be used and chemicals used. A 150-day operation for sugarcane ethanol production is assumed based on an interview with a sugar mill operator in Northern Luzon. This may be due to the fact that they are located in an area frequented by typhoons.[1] The difference in production cost between sugarcane ethanol production and that from sweet sorghum is due to the use of chemicals in pH control. Sugarcane juice is treated with either sulfuric acid or sodium hydroxide to control the pH in various stages of the ethanol production process. In the Rusni Distilleries' process for sweet sorghum, pH control is achieved only with the use of lime prior to fermentation. Corn ethanol is expensive because of price competition with the feed milling industry. The costs of production from cassava are not shown here due to lack of data, as well as concerns regarding its high perishability. As a whole, it may be concluded that the use of sweet sorghum for ethanol production is very cost competitive vis-à-vis other feedstock.

3.0 Plant Capacity Sensitivity Analysis

The study sought to determine the effect of plant size on net income. The net income of three plant sizes, namely: 40 kld, 100 kld and 200 kld were evaluated at a production level of 60M liters/year. The three plants differ with regards to the investment requirement (and hence the annual depreciation expense), the manpower level, and the production efficiency. Adjustments were made to the initial production cost estimate, as discussed below, to take into account the effects of economies of scale on production efficiency. A comparison of the net income estimates is shown in Table 14.

The investment requirements are based on figures provided by Rusni Distilleries for the 40kld plant and an amalgamation of western suppliers for the 100kld and 200kld plants. It should be noted that the investment requirement per thousand liters of capacity of the

[1] The Sugar Regulatory Administration website shows a 9-month operation.

100kld plant is higher than the 40 kld plant. This can be attributed to the fact that the 100kld plant has a higher level of automation and mechanization as compared to the 40kld plant. The cost estimate for the 100kld plant is corroborated by the cost estimate for a similarly sized sugarcane ethanol plant in Negros Occidental while the 40 kld plant cost estimate is based on the actual quotation of Rusni Distilleries.

The manpower requirement for the 40 kld distillery is 120 people per plant comprised of both direct and indirect labor. The manpower requirement for a 100kld plant is conservatively placed at 100 people, although with automation and outsourcing, this figure can go down to as low as 20 people as is the case in the US. The headcount of a 200kld plant is estimated at 180 people, although it can go down to as low as 20, as is the case of a 100kld plant in the US.

The USDA's 2002 cost of production survey revealed that there are economies of scale in fuel ethanol production. Using the figures in the production survey, it is estimated that a 100 kld distillery is 1.37% more efficient than a 40kld distillery and that a 200 kld distillery is 3.4% more efficient than a 40 kld distillery. These efficiencies are expressed in the higher output and cost savings in processing raw materials, maintenance, pollution control and other expenses.

Another difference between the 40 kld and the larger distilleries is in its use of yeast. The 40 kld distillery of Rusni Distilleries uses Turbo Yeast in production, just as the larger distilleries do. However, the 40 kld plant does not recycle yeast, resulting in higher yeast utilization. Based on figures from the Indian National Research Centre for Sorghum, the yeast cost for the 40kld is estimated at US$0.022/liter of ethanol. The cost of yeast for larger distilleries however is assumed to be similar to that of the US, with some cost reductions due to economies of scale and the practice of yeast recycling.

The investment costs and the cost of production, with the adjustments as discussed in the foregoing used in the plant sensitivity analysis are shown in Table 14.

Table 14. Comparison of the Net Incomes for Different Plant Sizes of Bioethanol Plant from Sweet Sorghum, 2006.

Income Statement	Base Case	100,000	200,000
	40,000 kld x 5	100,000 kld x 2	200,000 kld x 1
Number of plants	**5**	**2**	**1**
Sales			
Ethanol	1,656,000,000	1,656,000,000	1,656,000,000
Organic Fertilizer	195,000,000	195,000,000	195,000,000
CDM Credits	26,355,659	26,355,659	26,355,659
DDG Sales	128,000,000	128,000,000	128,000,000
CO_2 gas produced	201,527	201,527	201,527
Total Sales	**2,005,557,186**	**2,005,557,186**	**2,005,557,186**
Less: Cost of Sales			
Feedstock			
Stalks	440,000,000	440,000,000	440,000,000
Grains	320,000,000	320,000,000	320,000,000
Other Raw Materials			
Stalks Processing Materials	261,956,847	258,629,995	253,050,314
Grains Processing Materials	111,278,265	89,574,479	87,642,000
Total Cost of Raw Materials	**1,133,235,112**	**1,108,204,474**	**1,100,692,314**
Direct Labor	23,693,333	7,897,778	7,108,000
Manufacturing overhead	71,080,000	23,693,333	21,324,000
Total Cost of Sales	1,228,008,445	1,139,795,585	1,129,124,314
Less: Operating Expenses			
Management/administration	1,320,000	1,320,000	1,320,000
Research & Development			
Pollution Control	5,973,087	5,897,229	5,770,002
Maintenance	24,745,646	24,431,377	23,904,294
Depreciation Expense	285,390,000	317,209,524	215,222,982
Realty Tax	550,000	550,000	550,000
Others	2,715,040	2,680,559	2,622,728
Total Operating Expense	320,693,773	352,088,688	249,390,007
Income Before Interest & Tax	456,854,967	513,672,912	627,042,865
Interest Expense	-	-	-
Income Before Tax	456,854,967	513,672,912	627,042,865
Tax	155,330,689	174,648,790	213,194,574
Net Income	**301,524,278**	**339,024,122**	**413,848,291**

The result of the analysis shows that it is more advantageous for a company to put up a large distillery plant. The economies of scale become apparent especially when a 200 kld distillery plant is compared to a group of 40 kld distillery plants.

4.0 Financial Assumptions:

Table 15. Production of Ethanol based on Rusni Distillery in India, 2006.

A. Yield	**Assumptions**
from stalks	66.67%
from grains	33.33%
ethanol production	55 li/MT
water effluents	13 li/liter of ethanol
ethanol	In final form Bioethanol as per PNS DOE 008
By-Products	
CO_2	95.90% of ethanol production (MT basis)
Carbon credits	sold at US $5/MT
Organic fertilizer	Sold at Php 0.25/li
B. The Distillery	**Assumptions**
	10 years life span
Components of a multi-feedstock distillery plant	batch type fermentation and distillation unit
	Liquefaction and saccharification unit with molecular sieve.
	Sugarcane milling unit

4.1 Yields

Around 66.67% of the ethanol produced will come from the sweet sorghum stalks while the balance will come from the sweet sorghum grains. The ethanol that can be produced from stalks is 55 liters/MT while the yield from grains is 375 liters/MT. The ethanol productivity of these feedstock are based on the experience of Rusni Distilleries in India, as related by ICRISAT. Recent studies by the European Union show that yields can be higher using new breeds. It is further assumed that the feedstock is picked up from the farm site by the distillery company.

It is assumed that the water effluent of the distillery will be 13 liters/liter of ethanol produced. This is consistent with the effluent discharge of distilleries using other feedstock. It is further assumed that the distillery company will be able to sell this at a marginal price in semi-processed form, that is, after anaerobic digestion to the surrounding farmlands. This is currently being practiced by distilleries in Batangas.

The carbon dioxide produced from the fermentation process can be purified and used in soda and dry ice manufacture. Based on the experience of sweet sorghum distilleries in Italy and China, it is assumed that 95.9% of the carbon dioxide can be recovered and sold to other industries. A 40 kld distillery will produce 403,053 MT/year, a 100 kld distillery 1,007,634 MT/year, and a 200 kld distillery 2,015,267 MT/year.

It is further assumed that the sweet sorghum distillery will gain carbon credits from the production of ethanol and sold at US$5/MT. A World Bank report estimates that the future price of carbon credits is in the range of US$5 to $10/MT. Also, additional carbon credits can be gained through anaerobic digestion of distillery slops as well as through cogeneration of steam and electricity from sweet sorghum bagasse.

4.2 The Distillery Plant

The distillery equipment is assumed to last for 10 years after commissioning. This is based on the Modified Accelerated Cost Recovery System (MACRS) of the US which says that the depreciation period for chemical plants is around 9.5 years. This assumption is very conservative since the prescribed depreciation periods are always lower than the actual useful lives,

The sweet sorghum distillery is essentially multi-feedstock which can process both sugar-based and starch-based feedstock. Thus, it is more expensive than conventional distilleries, almost all of which only use either sugar or only starch-based feedstock. Specifically, the sweet sorghum distillery will use batch-type fermentation and distillation unit, plus a liquefaction and saccharification unit, and a sugar cane milling unit. It is assumed that the sweet sorghum distillery will have a larger cane milling unit than an equivalent-sized sugar cane distillery plant.

5.0 Financing Scheme

It is assumed that the equity of the investor is fifty percent (50%) of the initial capital investment. The rest can be borrowed from the bank at 13% percent interest payable in five years starting in the 4th year of operation. The Development Bank of the Philippines, however, has a more attractive financial package compared to that used in this study.

6.0 Results of the Analysis

As estimated, the project will require an initial investment of PhP 421.28 M to cover the acquisition of land, plant and machineries, building and civil works and working capital. This figure is based on a quotation provided by Rusni Distilleries Pvt. Ltd. of India The construction will take 1 ½ to 2 years, a sample implementation schedule of which is provided in the Appendix 37.

As base case scenario, a selling price of PhP 27.60 was assumed for ethanol based on a gasoline price of PhP36.80/li, and a total investment of PhP 421.28M. The cost of sweet sorghum as feedstock accounts for 56% of the total cost of bioethanol production. The cash flows for the project during the initial and 1st year of operation are expected to be negative at PhP -202.8M and PhP -2.4M, respectively. During the 2nd year of operation (Year 3 of the worksheets) and in the subsequent years, there will be sales from ethanol and by- products such as organic fertilizer, CDM Credits and CO2 gas produced. Given these, a 40 KLD distillery plant with plant utilization efficiency of 80% should earn an annual income of Php63.8 M for a 300 days/year operation. The expected net present value for the project is PhP 66.6M for the 10-year operation (2nd to 11th) with an Internal rate of Return (IRR) of 21%. It suggests that the project is highly viable as an investment venture although the recovery of the total investment is on the 9th year of operation.

6.1 Sensitivity Analysis

The result of the sensitivity analysis at the processors' level (distillery plant) using the assumptions for the base case scenario are shown in Table 17. It shows the change in annual income, NPV and IRR as a result of changes for the different scenarios as illustrated by the best case to the worst case scenarios, cases 1-7.

Table 16. List of Assumptions Used for the Sensitivity Analysis of Distillery Plant with 40 kld, with 80% Utilization Rate, Philippines, 2006.

Scenarios	Price of Ethylene (PhP/li)	Cost of Raw Materials Grain (PhP/kg)	Cost of Raw Materials Stalks (PhP/mt)	No. of Days Plant Operations	Ethanol Yield (li/mt) Stalks	Ethanol Yield (li/mt) Grains
Base Case	27.60	6.00	550.00	300	55	375
Case 1	30.36	6.00	550.00	300	55	375
Case 2	27.60	6.00	550.00	300	66	450
Case 3	27.60	6.00	550.00	300	60.5	412.5
Case 4	27.60	5.40	495.00	300	55	375
Case 5	27.60	6.60	605.00	300	55	375
Case 6	27.60	6.00	550.00	270	55	375
Case 7	24.84	6.00	550.00	300	55	375

Note:
Base Case Scenario: 40 KLD, 300 Days Operation, 80% Utilization Rate
Case 1: High Ethanol Price (10% increase) (Best Case Scenario)
Case 2: Using high yielding variety: 20 % increase in ethanol yield
Case 3: Using high yielding variety: 10 % increase in ethanol yield
Case 4: With 10% decrease in the cost of raw materials
Case 5: With 10% increase in the cost of raw materials
Case 6: With the decrease in the days of operation of 10% (from 300 to 270 days)
Case 7: Low Ethanol Price (10% decrease) (Worst Case Scenario)

Table 17. Sensitivity Analysis (base case and 7 case scenarios).

Financial	Base Case Scenario	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Annual Income (Million Pesos)	63.8	81.3	76.5	70.7	71.4	56.2	54.8	46.3
% Increase in Income (from the base case scenario)		27%	20%	11%	12%	(12%)	(14%)	(27%)
NPV (Million Pesos)	66.6	139	122.4	97.4	110.1	33.2	27.1	(5.70)
IRR (%)	21	27	26	24	24	18	18	14
Payback Period (Years)	9	7	8	8	8	10	10	10

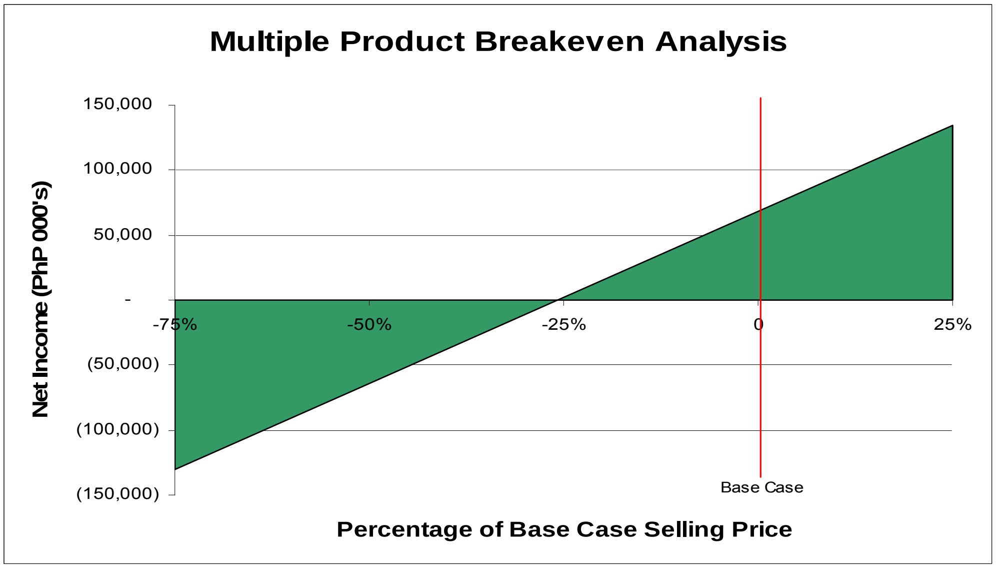
The sensitivity analysis is undertaken with reference to a base case scenario which is based on the current plant operation of the Rusni Distillery. The results of the sensitivity analysis show that with the base scenario as the reference point, the annual income will be higher compared to the base scenario for cases 1 to 4, that is, if the price will increase by 10 % or yields will increase by 10 to 20% or a decline in cost of raw materials by 10%. The income will decline with increases in cost of raw materials, a decrease in the number of days of operation from 300 to 270 days or a decrease in ethanol price by 10%. On the other hand, the Net Present Values are positive except for case 7 when the price of ethanol decreases by 10%. The IRR are all high ranging from 14% for the worst case scenario to 27% for the best scenario. The payback period ranges from 7 years for the best case scenario to 10 years for cases 5 to 7.

7.0 Breakeven Analysis

Multi-product breakeven analyses were undertaken for a 40 kld distillery. This is because the production of ethanol yields a number of co-products such as organic liquid fertilizer, distiller's dry grain, carbon dioxide and carbon credits. The profitability of the distillery was assessed against the selling price, production volume (approximated using number of days of operation), and raw material feedstock price. Of these factors, the net income was found to be most sensitive to the selling price.

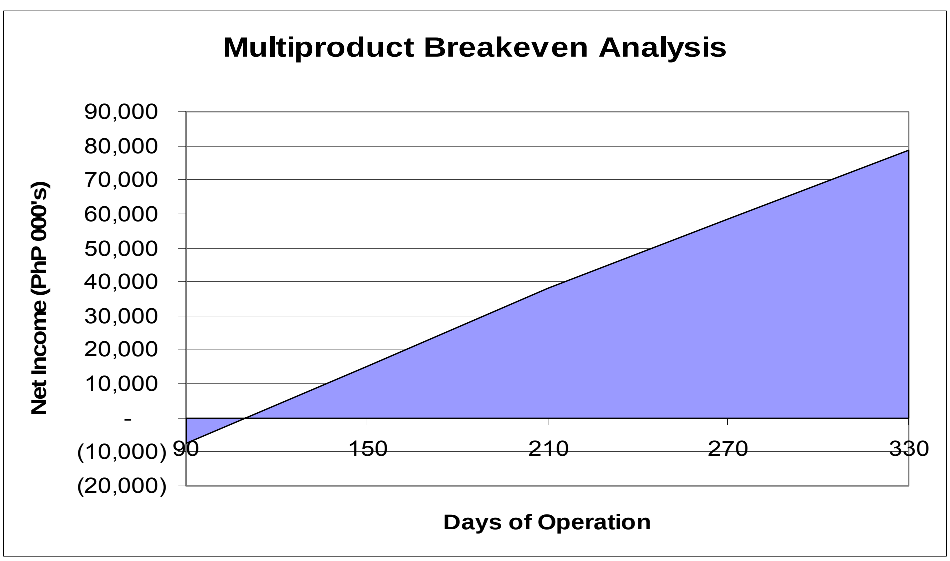
The breakeven selling price for ethanol and its co-products was found to be 75% of their current selling price. This means that the distillery can still be profitable even if ethanol is sold at P20.70/liter.

Figure 26. Multiple Products Breakeven Analysis of Percentage Change in Base Case Selling Price, 2006.



Since the costs of operation were proportionate to the number of days of operation, the breakeven number of days of operation was found to be very low at 100 days per year. This is because most of the costs are variable and the biggest fixed costs of the distillery were the depreciation costs of the equipment, labor costs, overhead costs and equipment maintenance.

Figure 27. Multiple Products Breakeven Analysis of Changes in Days of Operation, 2006.



Finally, the sensitivity of the net income against the feedstock price was tested. Since both grains and stalks will be used by a sweet sorghum distillery, a multi-product approach was also adopted. Based on the analysis, the cost of the feedstock will have to increase by

68.15% before the distillery becomes unprofitable. This is because the profit margin from selling ethanol and its co-products is quite high compared to the costs of production.

Figure 28. Multiple Products Breakeven Analysis of Changes in Raw Material Price, 2006.

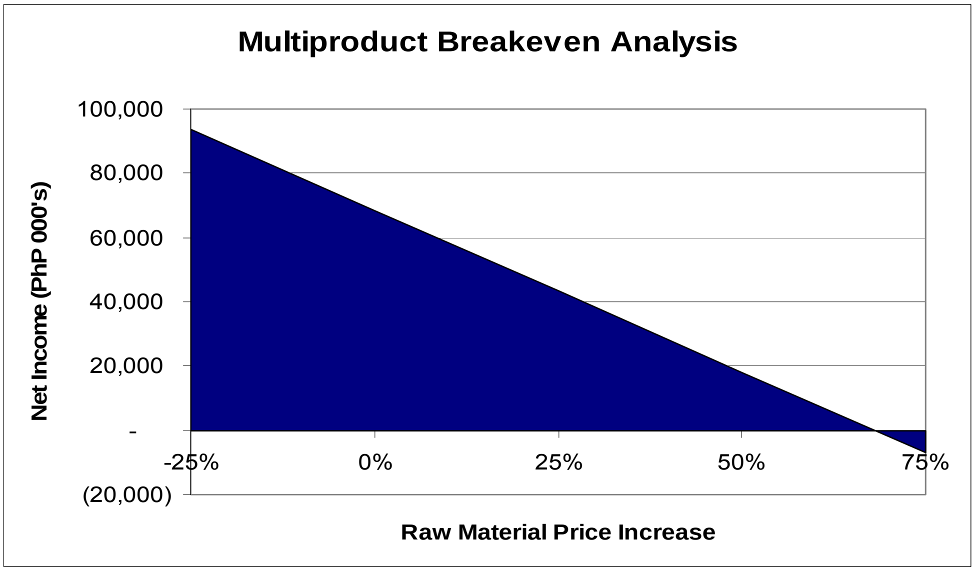


Table 18. Breakeven Analysis of Different Selling Price Conditions of Primary or By-Products of a 40 kld Distillery Plant with 300 days operation at 80% utilization rate, Philippines, 2006.

	Selling Price +-0.75	**Selling Price +-0.5**	**Selling Price +-0.25**	**Base Case**	**Selling Price +0.25**
Sales					
Ethanol	82,800,000	165,600,000	248,400,000	331,200,000	414,000,000
Organic Fertilizer	9,750,000	19,500,000	29,250,000	39,000,000	48,750,000
CDm Credits	1,317,783	2,635,566	3,953,349	5,271,132	6,588,915
DDG Sales	6,400,000	12,800,000	19,200,000	25,600,000	32,000,000
CO_2 gas Produced	10,076	20,153	30,229	40,305	50,382
Total Sales	100,277,859	200,555,719	300,833,578	401,111,437	501,389,296
Less: Cost of Sales					
Feedstock					
Stalks	88,000,000	88,000,000	88,000,000	88,000,000	88,000,000
Grains	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000
Other Raw Materials					
Stalks Processing Materials	52,391,369	52,391,369	52,391,369	52,391,369	52,391,369
Grains Processing Materials	22,255,653	22,255,653	22,255,653	22,255,653	22,255,653
Total Cost of Raw Materials	226,647,022	226,647,022	226,647,022	226,647,022	226,647,022
Direct Labor	4,738,667	4,738,667	4,738,667	4,738,667	4,738,667
Manufacturing overhead	14,216,000	14,216,000	14,216,000	14,216,000	14,216,000
Total Cost of Sales	245,601,689	245,601,689	245,601,689	245,601,689	245,601,689
Less: Operating Expenses					
Management/administration	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000
Research & Development					
Pollution Control	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617
Maintenance	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129
Depreciation Expense	43,358,000	43,358,000	43,358,000	43,358,000	43,358,000
Realty Tax	550,000	550,000	550,000	550,000	550,000
Others	543,008	543,008	543,008	543,008	543,008
Total Operating Expense	51,914,755	51,914,755	51,914,755	51,914,755	51,914,755
Income Before Interest and Tax	(197,238,584)	(96,960,725)	3,317,134	103,594,993	203,872,853
Interest Expense	-	-	-	-	-
Income Before Tax	(197,238,584)	(96,960,725)	3,317,134	103,594,993	203,872,853
Tax	(67,061,119)	(32,966,647)	1,127,826	35,222,298	69,316,770
Net Income	(130,177,466)	(63,994,079)	2,189,309	68,372,696	134,556,083

Table 19. Breakeven Analysis of Different Production Volumes Based on Days of Operation of a 40 kld Distillery Plant at 80% utilization rate, Philippines, 2006.

	90 days operation	160 days operation	210 days operation	270 days operation	330 days operation
	90	150	210	270	330
Sales					
Ethanol	99,360,000	165,600,000	231,840,000	298,080,000	364,320,000
Organic Fertilizer	11,700,000	19,500,000	27,300,000	35,100,000	42,900,000
CDm Credits	1,581,340	2,635,566	3,689,792	4,744,019	5,798,245
DDG Sales	7,680,000	12,800,000	17,920,000	23,040,000	28,160,000
CO_2 gas Produced	12,092	20,153	28,214	36,275	44,336
Total Sales	120,333,432	200,555,719	280,778,006	361,000,293	441,222,581
Less: Cost of Sales					
Feedstock					
Stalks	26,400,000	44,000,000	61,600,000	79,200,000	96,800,000
Grains	19,200,000	32,000,000	44,800,000	57,600,000	70,400,000
Other Raw Materials					
Stalks Processing Materials	15,717,411	26,195,685	36,673,959	47,152,232	57,630,506
Grains Processing Materials	6,676,696	11,127,827	15,578,957	20,030,088	24,481,218
Total Cost of Raw Materials	67,994,107	113,323,512	158,652,916	203,982,320	249,311,725
Direct Labor	3,317,067	3,317,067	3,317,067	4,264,800	5,212,533
Manufacturing overhead	9,951,200	9,951,200	9,951,200	12,794,400	15,637,600
Total Cost of Sales	81,262,373	126,591,778	171,921,182	221,041,520	270,161,858
Less: Operating Expenses					
Management/administration	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000
Research & Development					
Pollution Control	358,385	597,309	836,232	1,075,156	1,314,079
Maintenance	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129
Depreciation Expense	43,358,000	43,358,000	43,358,000	43,358,000	43,358,000
Realty Tax	550,000	550,000	550,000	550,000	550,000
Others	162,902	271,504	380,106	488,707	597,309
Total Operating Expense	50,698,417	51,045,942	51,393,467	51,740,992	52,088,517
Income Before Interest and Tax	(11,627,359)	22,917,999	57,463,357	88,217,781	118,972,206
Interest Expense	-	-	-	-	-
Income Before Tax	(11,627,359)	22,917,999	57,463,357	88,217,781	118,972,206
Tax	(3,953,302)	7,792,120	19,537,541	29,994,046	40,450,550
Net Income	(7,674,057)	15,125,879	37,925,815	58,223,736	78,521,656

Table 20. Breakeven Analysis of Different Feedstock Price of a 40 kld Distillery Plant with 300 days of operation at 80% utilization rate, Philippines, 2006.

	-0.25 of RM price	0 of RM price	0.25 of RM price	0.5 of RM price	0.75 of RM price
	-25%	0%	25%	50%	75%
Sales					
Ethanol	331,200,000	331,200,000	331,200,000	331,200,000	331,200,000
Organic Fertilizer	39,000,000	39,000,000	39,000,000	39,000,000	39,000,000
CDm Credits	5,271,132	5,271,132	5,271,132	5,271,132	5,271,132
DDG Sales	25,600,000	25,600,000	25,600,000	25,600,000	25,600,000
CO_2 gas Produced	40,305	40,305	40,305	40,305	40,305
Total Sales	401,111,437	401,111,437	401,111,437	401,111,437	401,111,437
Less: Cost of Sales					
Feedstock					
Stalks	66,000,000	88,000,000	110,000,000	132,000,000	154,000,000
Grains	48,000,000	64,000,000	80,000,000	96,000,000	112,000,000
Other Raw Materials					
Stalks Processing Materials	52,391,369	52,391,369	52,391,369	52,391,369	52,391,369
Grains Processing Materials	22,255,653	22,255,653	22,255,653	22,255,653	22,255,653
Total Cost of Raw Materials	188,647,022	226,647,022	264,647,022	302,647,022	340,647,022
Direct Labor	4,738,667	4,738,667	4,738,667	4,738,667	4,738,667
Manufacturing overhead	14,216,000	14,216,000	14,216,000	14,216,000	14,216,000
Total Cost of Sales	207,601,689	245,601,689	283,601,689	321,601,689	359,601,689
Less: Operating Expenses					
Management/administration	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000
Research & Development					
Pollution Control	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617
Maintenance	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129
Depreciation Expense	43,358,000	43,358,000	43,358,000	43,358,000	43,358,000
Realty Tax	550,000	550,000	550,000	550,000	550,000
Others	543,008	543,008	543,008	543,008	543,008
Total Operating Expense	51,914,755	51,914,755	51,914,755	51,914,755	51,914,755
Income Before Interest and Tax	141,594,993	103,594,993	65,594,993	27,594,993	(10,405,007)
Interest Expense	-	-	-	-	-
Income Before Tax	141,594,993	103,594,993	65,594,993	27,594,993	(10,405,007)
Tax	48,142,298	35,222,298	22,302,298	9,382,298	(3,537,702)
Net Income	93,452,696	68,372,696	43,292,696	18,212,696	(6,867,304)

CHAPTER III. SWEET SORGHUM PRODUCTION

A. MARKET ASSESSMENT AND CHARACTERIZATION

The form and volume of sweet sorghum available for processing into bioethanol affect efficiency and operational cost of distillery plants. To be able to meet the daily optimal requirement of the distillery plant for feedstock, it would be necessary to properly schedule the planting and harvesting of the crop as well as properly balance production into the raw material forms (i.e. grains and stalks). It is also necessary to ensure the timely deliveries of raw materials as well as reduce transport, inventory and handling costs.

B. PRODUCTION OF SWEET SORGHUM

1.0 Location

The target of sweet sorghum production areas is the marginal lands for hybrid corn and rainfed rice areas which are left fallow during the second season. These include for example the provinces of Pangasinan, Ilocos Norte, Ilocos Sur, La Union, Cagayan, Isabela, Tarlac, Zambales, and Nueva Ecija or other places with a distinct wet and dry season (Table 21). Other potential growing areas are in Negros, Bukidnon and Tarlac where there are existing sugarcane mill-distilleries. As mentioned earlier, sweet sorghum, being a non-photoperiod, thermal sensitive crop can be planted anytime of the year such that harvesting will be done at the time sugarcane is at the growing period.

Agrarian Reform Communities (ARCs) are other potential sites for sweet sorghum production. The advantage of these sites is the existence of an organization of beneficiaries which is closely supervised by the provincial offices of the Department of Agrarian Reform. The provinces mentioned earlier have existing ARCs.

Table 21. Rainfed rice areas (ha), Philippines, 2005.

REGION	Area (ha)
Ilocos	117,447
Cagayan Valley	47,517
Central Luzon	79,177
Southern Tagalog	133,736
Western Visayas	287,779
Eastern Visayas	125,214
Western Mindanao	43,265
Northern Mindanao	3,194
Southern Mindanao	26,667
Central Mindanao	54,508
ARMM	133,331
CARAGA	36,179
TOTAL	**1,088,014**

The existence of a road network is another consideration. Areas with “all-weather” roads are preferred although this is not an absolute requirement in as much as sweet sorghum will be grown more as a dry season crop.

As of now, there are already 560 hectares of land dedicated for sweet sorghum production.

2.0 Organizational Set-up

2.1. Production cluster

Producers’ Cooperatives, Agrarian Reform Communities and Zanjeras (Irrigators Association) are existing organizations which can already be contracted to produce the desired feedstock.

2.2. Processing plant-production cluster partnership

The processor (mill-distillery) will enter into a production agreement with the farmer producers. The target production areas will be located within a 20 km radius of the distillery plant to ensure efficiency and economy of operation. The processor or government agency will provide farmers the necessary technical assistance on new production technologies as well as production of feedstock. A technician will be assigned to provide assistance to an area covering at least 200 hectares or one cooperative/association.

Decisions on the variety of sweet sorghum to plant, amount of fertilizer, pesticide and other inputs to apply, time and level of irrigation and date of planting will be made by the technicians in consultation with the farmers. The inputs will be provided to the farmers in kind to ensure the quality as well as the timely application of the inputs. Credit will also be provided for fuel and tractor rental for land preparation. The farmer on the other hand will pay for all labor, work/draft animals, land, equipment and facilities needed in crop production as its equity. A MOA will be executed between the farmer participants and the processor

3.0 Seed Classes

There are three seed classes that can be produced as follows:

a. ***Breeder Seed***-- Breeders will produce these seeds to maintain genetic purity. For the meantime and by virtue of a MOA signed between and among ICRISAT, DA-BAR and PCARRD in November 2005, ICRISAT will be the source of breeder seeds.

b. ***Foundation Seed***-- UPLB or MMSU sweet sorghum researchers/breeders can produce these seeds.

c. ***Certified Seed***-- Certified seeds will be produced by accredited seed growers who will undergo rigid raining at UPLB or MMSU with emphasis on site selection, field preparation, sowing, fertilizer rate/application, irrigation, pest management, population density, rouging/inspection, harvesting, threshing and post-harvest handling. These should be produced in areas there is a very distinct dry period such as in the Ilocos provinces.

3.1 Marketing and Pricing

There are 3 channels in the distribution chain. These include the following:

a. **Seed Integrator/ Commercial Seed Company --** They are responsible for the proper seed treatment and storage in bulk.

b. **Distributors** --. They are responsible for packaging seeds to 500g, 1 kg, 2kg or 5 kg. and selling them to retailers.

c. **Retailer** – Retailers sell these seeds to farmers/producers of feedstock.

3.2. Cultural Management Practices

Sweet sorghum is a tropical and sub-tropical plant which grows anywhere in the Philippines throughout the year being insensitive to photoperiod and temperature (photo thermal insensitive). It grows practically in all soil types although a deep and well-drained clay loam soil is preferred. It is easy to grow and demands less care and attention compared with other crops. Being an early maturing and drought tolerant crop, it needs less fertilizer and water compared to sugarcane. Only 25% of the water requirement of sugarcane is enough to produce a high biomass yield of sweet sorghum.

Five varieties developed by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) are found to grow very well in drought and flood prone areas in Ilocos, Philippines. The seeds of these varieties mature in 100 to 110 days after planting (DAP) and ratoon in 85-95 days after cutting. Thus, sweet sorghum will produce a higher yield per unit area per unit time than sugarcane. This is because sugarcane is harvested in 300-330 DAP during which time three cropping of sweet sorghum can already be harvested.

The sugar content (by Brix) of sweet sorghum is 15-23%, if stalks are harvested at grain maturity. If harvested at physiological maturity, when the grains are at hard dough stage, the sugar content is 16-23% with a high juice yield of 55-60%. The problem with harvesting the crop at this stage is that the grain is not yet fully developed, hence are shriveled upon drying. The grains therefore will not be good as feedstock for ethanol production.

3.3 Land Preparation

Two rotavations at a depth of 25-30 cm is desirable to attain a fine and good soil tilt. This is necessary to have uniform germination because sorghum seeds are small as compared to corn.

3.4 Setting of Furrow

It is possible to plant sweet sorghum for two seasons – the first during the wet season that is June-July planting with furrows set at 100 cms. apart and second during the September – October plantings with furrows set 75 cms. apart.

3.5 Fertilization

A fertilizer rate of 80-30-30 is generally recommended for a clay loam soil in both seasons. The basal fertilizer is 30-30-30 or 215 kg of 14-14-14 per hectare. This is 21-22g/linear meter of row in the 100 cm spacing and 16g/m in the 75 cm spacing. The fertilizer is drilled at the bottom of the furrow before planting.

Side dressing is done 21 days after planting (DAP). If ammonium sulfate (21-0-0) is used, the rate is 23-24g/m of row in the 100 cm spacing while 18g/m is applied in the 75 cm spacing. In case urea is used, 11-12g/m is side dressed in the 100 cm row spacing and 8-9g/m in the 75 m spacing. If the soil is dry, overhead irrigation should be provided especially during the dry season with the water directed to the planting furrow only. Since the area between the rows is dry, a double-moldboard plow should be used for hilling up using to cover the fertilizer and wet soil. The dry soil cover will serve as “soil mulch”.

3.6 Planting

The seeding rate is 5-8 kg ha^{-1} to attain a population density of 130,000-150,000 plants ha^{-1}. The seeds are drill-planted by hand or a planter can be used. During the June –July planting, the furrows are set 10 cm deep. The seeds are drill planted at the bottom of the furrow and then pass the spike tooth harrow twice to cover the seeds. First passing of the harrow will be along the furrows and the second will criss-cross with the first passing.

For the September – October planting, the depth of the furrows should be 15-20 cm deep to be able to make use of more residual soil moisture. The seeds are set at the bottom of the furrows but these are not covered anymore if the soil is dry. The seeds will be covered then by the impact of irrigation water running through a flexible hose which is directed at the side of the furrow. In cases where the soil is moist, the technique used during the June-July planting (wet months) is followed.

3.7 Irrigation

Sweet sorghum is remarkably drought-tolerant so that supplemental irrigation is rarely needed. However, it also requires some moisture to ensure uniform seed germination. Therefore it is recommended to provide overhead irrigation at planting when moisture is insufficient for germination.

3.8 Thinning

For the 75 cm row spacing, maintain 10-11 plants/m which is approximately 10 cms. between plants. For the 100 cm spacing, 13 plants are maintained per meter of row or about 11 cms. between plants. The population density to be maintained will be 130,000 plants/ha in the 100 cm row spacing for the wet season crop and 150,000 plants/ha in the 75 cm row spacing for the dry season crop. Thinning should be done before hilling-up or side dressing the second fertilizer dose.

3.9 Crop Protection

So far, sweet sorghum plantings are not affected yet by insect pests and disease. In areas where sweet sorghum have been grown for a long time already like India, it is reported that the major insect pests affecting the crop are shoot fly and stem borer. Shoot fly attacks soon after germination up to 30 DAP. The incidence of stem borer is at a later stage up to maturity. The manifestations of a shoot fly attack are the dead hearts in seedlings and the eventual profuse tillering in affected plants at a later stage. Shoot fly can be controlled with Carbofuran 3G at 8-10 kg/ha during planting applied at the bottom of the furrow. The same insecticide can be applied on leaf whorls (2-3 granules/whorl) to prevent stem borer tunneling.

3.10 Harvesting

The panicles should be cut first followed by the cutting of the stalks (similar to sugarcane) as close as possible to the ground leaving one node only. This ratoon will develop from this node.

3.11 Recommended Varieties

To date, sweet sorghum varieties found to be producing high biomass in the Philippines are from ICRISAT (Table 22). These are:

Table 22. Recommended varieties of Sweet sorghum, 2007.

Variety	Stripped Stalked Yield (t ha^{-1})		Grain Yield (tha^{-1})		Percentage Sugar by Brix's
	Seed Crop	Ratoon Crop	Seed Crop	Ratoon Crop	
NTJ 2	45-50	48-55	3.62	4.40	18.5
SPV 422	56-60	57-65	3.28	3.92	19.0
ICSV 700	43-48	45-50	3.46	4.11	18.0
ICSV 93046	47-52	48-55	3.40	4.08	15.0
ICSR 93034	46-52	47-53	3.46	4.25	18.0

4.0 Harvesting and Post Harvest Operation

4.1. Preparation of Feedstock

After cutting the stalks, the leaves are stripped to make sure the juice is relatively free from impurities normally laden in the leaves. The leaves are stripped right in the field. The stripped stalks are loaded into trucks or trailer and transported to the mill. While a stripped stalk is desirable, the whole plant can be milled if the cost of labor to strip the leaves is too high.

C. FINANCIAL ANALYSIS

1.0 Farm Income

During the September-October planting season, sorghum as second crop to rainfed rice (Rainfed Rice-Sweet Sorghum Cropping System) will give an estimated yield of 55 ton/ha for the seed crop and 3 ton/ha for the ratoon crop. Assuming a price of cane and seed of PhP 600/ton and PhP 6/kg respectively, and cost of production for seed crop at PhP 21,105.50 (Table 24) and for ratoon crop at PhP 9,019.50 (Table 25), a farmer can realize a net income of PhP 71,875.00 for 2 croppings/year as shown in Table 23.

A second case is presented in the same table where net income of PhP 66,375.00 (Table 23) is realized when price of cane drops to PhP 550/ton, assuming that the total yield of cane is still the same at 55 tons/ha and seed at 3 tons/ha.

Table 23. Farm Income from Sweet Sorghum Production (PhP/ha), 2 cropping/year, Philippines, 2007.

PARTICULARS	COST	
	Price of Cane	
	@ PhP 600/ton	@ PhP 550/ton
Wet Season Seed Crop		
Yield of Cane: 55 tons/ ha	33,000.00	30,250.00
Yield of Seed: 3 tons/ ha @ PhP 6/ kg	18,000.00	18,000.00
Gross Income	**51,000.00**	**48,250.00**
Less Cost of Production	21,105.50	21,105.50
Net Income	**29,894.50**	**27,144.50**
Wet Season Ratoon Crop		
Yield of Cane @ 55 tons/ ha @ PhP 600/ ton	33,000.00	30,250.00
Yield of Seed @ 3 tons/ ha @ PhP 6/kg	18,000.00	18,000.00
Gross Income	**51,000.00**	**48,250.00**
Less Cost of Production	9,019.50	9,019.50
Net Income	**41,980.50**	**39,230.50**
TOTAL FARM INCOME FOR ONE YEAR	**71,875.00**	**66,375.00**

Table 24. Cost of production/ha, sweet sorghum seed crop, wet season Ilocos Norte, Philippines, 2007.

PARTICULAR	COST
Seed	450.00
Plowing @ PhP0.45/sqm	3,500.00
Furrowing: 2 AD @ 200/day	700.00
2 MD @ 150/day	
Fertilizer: 14-14-14; 8.5 bags @ P750/bag	6,375.00
Urea; 1.33 bags @ P850/bag	1,130.50
Side dressing: 4 MD @ 150/day	600.00
Planting: 3 MD @ 150/day (to include basal fertilizer application)	450.00
Hill-up:3 MD @ 150/day	450.00
5 AD @ 200/day	1,000.00
Weeding: 10 MD @ 150/day	1,500.00
Pest Management:	
Spraying: 2 MD @ 150/day	300.00
Insecticide: 2 kg of Lannate	900.00
Harvesting: 18 MD @ 150/day	2,700.00
Threshing: 4 MD @ 150/day	600.00
Drying: 3 MD @ 150/day	450.00
TOTAL	**21,105.50**

Table 25. Cost of production/ha, ratoon crop, wet season in Ilocos Norte, Philippines. 2007.

PARTICULAR	COST
Urea 2.67 bags @ 850/bag	2,269.50
Side dressing; 4 MD @ 150/day	600.00
Weeding; 5 MD @ 150/day	750.00
Pest Management	
Spraying; 4 MD @ 150/day	600.00
Insecticide (2 kg Lannate)	900.00
Harvesting; 19 MD @ 150/day	2,850.00
Threshing: 4 MD @ 150/day	600.00
Drying: 3 MD @ 150/day	450.00
TOTAL	**9,019.50**

CHAPTER IV. ISSUES AND RECOMMENDATIONS

There is a big and growing market for bioethanol. This is due to concerns related to the pollution of the environment, the tightening supply of oil and the increase in fuel prices. The members of the European Union, Japan US, Australia, China, India, Brazil, Thailand and the Philippines are part of a growing list of countries that are recognizing the environmental and economic benefits of the use of bioethanol.

For the Philippines, consumption of gasoline will continue to increase as the economy improves and population continues to grow. Bioethanol will remain as the most viable substitute for gasoline and will go beyond the E10 requirement as mandated by law as supply of gasoline tightens. The Philippines needs around 400 million liters of bioethanol each year in order to comply with RA 9637 or the Biofuels Act of 2006. In order to meet this requirement, the country needs to put up 20 to 25 bioethanol distilleries. In the meantime, the supply of bioethanol will come from imports as the industry establishes itself. It takes 1 ½ to 2 years to construct a bioethanol plant depending upon its size.

One investor that has already responded to the demand for more bioethanol is the San Carlos Bioenergy, Inc., a joint venture between Bronzeoak Philippines and the National Development Corporation. It has a daily output of 100,000 liters and is expected to start operations in the second half of 2007 in San Carlos City, Negros Occidental. This plant however can only meet around 5% of the present total demand; hence many more distilleries will have to be put up in the next few years.

Aside from the domestic market, the export market will account for a big portion of production of bioethanol in the future. The Philippines is strategically located in relation to South Korea and Hongkong, the major consumption centers of bioethanol in Asia and Japan which is believed to be the largest export market with an estimated requirement of 1.8B liters per year.

1.0 Factors affecting success of the biofuel program

The success of a biofuel program depends on three factors, namely, government policies and support, availability of the processing technology and sustainability of the feedstock supply.

1.1 Government policies and support

To accelerate the development of a vibrant and sustainable bioethanol industry, it would be necessary to provide government support especially at this early stage of development. Considering that bioethanol from sweet sorghum and other feedstock such as sugarcane costs more to produce compared to gasoline, then it would be necessary to provide subsidies in the form of tax breaks and investment incentives to ensure that its price is competitive to that of gasoline.

The Philippine government has in fact been very supportive of the biofuels program. It has provided a number of incentives for local producers which are contained in the recently passed Biofuels Law. It provides for exemption from specific taxes, a major cost of both the petroleum and alcohol industries and fines which are provided for under the Clean Water Act for distillery slops of bioethanol distilleries, as long as these are used as organic fertilizer. These fines are a major cost of existing distilleries for beverage alcohol. Also, government financial institutions are required to give special financing to bioethanol distilleries. Finally, the law requires the blending of a minimum of 5% v/v of bioethanol in all gasoline products sold in the country by 2009. This assures the financial viability of bioethanol producers.

In addition to the incentives provided for under the biofuels law, it would also be necessary to improve the road networks in the sweet sorghum producing regions to reduce logistics costs and facilitate the movement of feedstock from the farms to the processing centers.

1.2 Availability of processing technologies

Since the local market for bioethanol is assured by law, the next question is how it should be produced. There are a number of feedstock currently being used by other countries such as sugarcane, corn, sugar beets, cassava, and recently, sweet sorghum. An analysis of the production costs using this various feedstock in the Philippines shows that sugar cane and sweet sorghum are the best options for local bioethanol production. The wide fluctuation in the prices of cassava, as well as the sharp decrease in starch content after harvest makes it less attractive as a feedstock, as was experienced by Distilleria Bago, Inc., the distillery of Ginebra San Miguel, Inc. It should be noted that sweet sorghum Open Pollinated Varieties (OPV's) were used in this study, as against hybrids for the sugar cane, corn and cassava. With simple hybridization, sweet sorghum ethanol productivity and cost will improve, making it even more attractive.

Ethanol from sweet sorghum can be economically produced from its stalks and its grains. Research is still ongoing for the economic production of ethanol from lignocellulosic feedstock such as sweet sorghum bagasse. The stalks can be processed in the same way as sugar cane, while the grain is processed in the same way as corn. The cost of sweet sorghum ethanol is estimated at P21.12/liter. The bulk of the processing cost is the cost of the feedstock.

One operating distillery that uses sweet sorghum as feedstock is that owned by Rusni Distilleries in Andhra Pradesh, India. It has a production capacity of 40,000 liters per day and uses both grain and stalks. Because of its multi-feedstock capability, the distillery is slightly more expensive than that of other feedstock, such as sugar cane. However, its inherent flexibility and the low cost and greater availability of the feedstock are able to make up for the higher incremental investment.

By using new technology, it is possible to improve the ethanol yield and reduce costs. One such technology is the use of super-yeasts such as those that are already available at the UPLB Biotech that reduces fermentation time and cost of processing. However, more research should be done to improve these strains and further reduce processing cost to make the locally produced bioethanol globally competitive. Another possibility is the further development of the crystal-hydrated compound absorption regeneration technology intended to accelerate the distillation process which will result to substantial savings in energy and investment cost.

1.3 Sustainability of the feedstock.

Since it is feasible to produce sweet sorghum at a competitive price using the available processing technology, the remaining question is the sustainability of the crop. Sweet sorghum as mentioned is a crop that can adapt to practically any climate, and under a variety of soil conditions. Local tests have shown its resistance to both drought and water logging and thus capable of coping with weather changes brought about by global warming. Although the cultural management practices of the crop are similar to that of corn, the fertilizer and water requirements are much lower.

Tests using OPV's of sweet sorghum at the Mariano Marcos State University show that the crop is hardy and yield more than that in India. Thus, it is projected that the returns to farmers per hectare will be better than that of sugar and comparable to that from Bt corn. This means that there is a big economic incentive for farmers to cultivate sweet sorghum

However, there are still possible avenues for improving the productivity of sweet sorghum and Bioethanol. The first is the improvement of cultural management practices which will reduce wastes in production and therefore improve cost efficiencies. The second is the improvement of varieties and hybrids to further increase yield and reduce feedstock cost. Tests at ICRISAT in India show a 30% increase in harvest with the use of hybrids compared to OPVs[2]. In addition, varieties resistant to sub-optimal growing conditions should be developed to allow utilization of marginal lands. This reduces uncertainty in supply of feedstock as it opens more production areas to support the requirement of bioethanol processing plants. Lastly, it is important to establish the right combination of jaggery and stripped stalk feedstock, and jaggery production arrangement. The reason is that part of the feedstock from sweet sorghum can be converted to jaggery to address the problem of logistics during wet season growing when roads become impassible to hauling trucks.

Another issue that should be addressed is where to locate the distillery plant. The ethanol distillery's location depends a great deal on the feasibility of sweet sorghum cultivation in the surrounding area. It is recommended that initially, sweet sorghum be cultivated as a second crop to rainfed rice. A 100 kld distillery needs to be supported by 3,870 hectares of sweet sorghum for its annual production requirement. For this purpose, different production arrangements can be adopted to enhance the efficient utilization of land and labor resources. There are three possible arrangements as mentioned earlier. The first is the processing plant-production cluster partnership where a contract arrangement between agro-processing firm and farmers is made. Another system of production is the centralized contract growing with nucleus estate and lastly, the corporative growing scheme which integrates small farms into large production 'corporate' farms with multi-partite participation.

[2] ICRISAT has recently signed a Memorandum of Agreement with UPLB's Institute of Plant Breeding for the development of new breeds for Philippine conditions.

Based on data from the BAS, there is sufficient area for sweet sorghum cultivation as a second crop to rice, with 1,088,014 hectares available in various parts of the country. Selection of the final site will depend on site specific criteria outlined in the Technical Assessment section of this report.

As a whole, the Philippine bioethanol firms should develop efficient production and processing capabilities to compete with low cost producing countries such as Brazil. Brazil and other South American countries are eyeing Japan and other growth centers in Asia as export markets for their bioethanol products.

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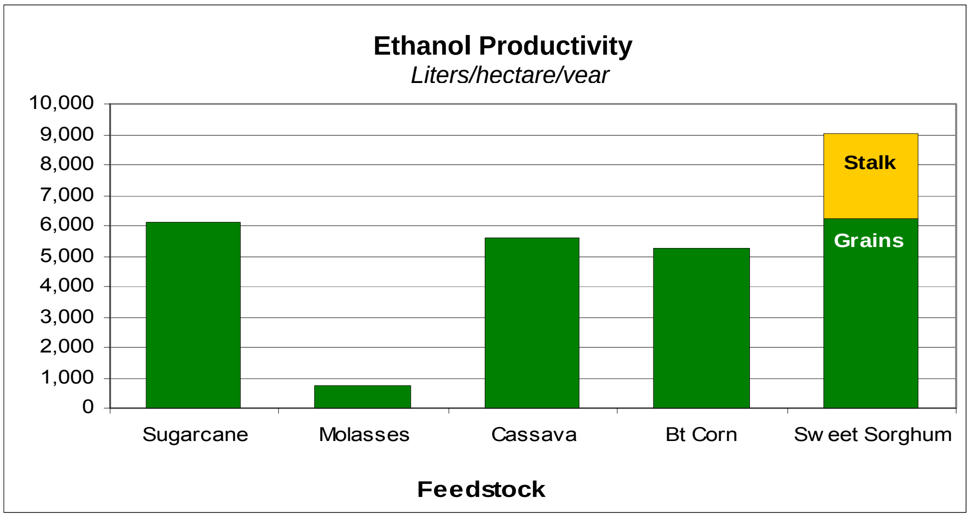
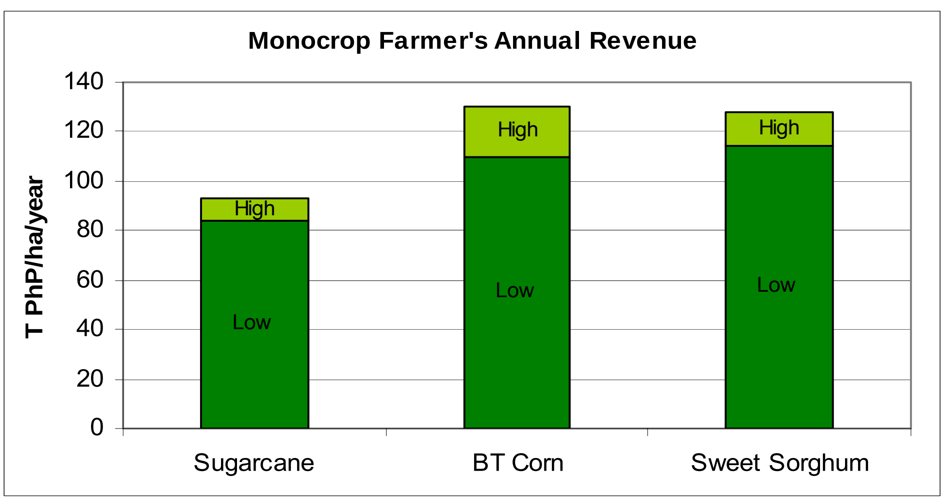
APPENDICES

Appendix 1. Ethanol Production, liters/hectare/year for Sugarcane, Molasses, Cassava, Bt Corn and Sweet Sorghum.



Sources: GAIN Report on RP sugar industry, GAIN Report on Thai sugar industry, Leyte State University Report on cassava, Biotechnology Coalition of the Philippines Speech, MMSU field tests, FAO & ICRISAT

Appendix 2. Monocrop Farmer's Annual Revenue: Comparison for Sugarcane, Bt Corn and Sweet Sorghum



Sources: GAIN Report on RP sugar industry, bas.gov.ph, Biotechnology Coalition of the Philippines Speech, MMSU field tests, FAO & ICRISAT

Appendix 3. Alcohol (Ethanol/Ethyl Alcohol) Specifications.

Pharmaceutical grade ethanol

The bioethanol distillery can also sell ethanol to the pharmaceutical industry. Ethanol is used not only in drug manufacture but also in cleaning. Most of the drug companies in the Philippines follow US standards. Hence, it is appropriate to examine the American pharmacopea for the pharmaceutical grade standard. Given in the table below is a condensed version based on the U.S. Pharmacopeia, 23rd Edition, 1995 and 8th Supplement, 1998 as published at http://www.distill.com/specs/US-4.html.

a) Definition:	Contains not less than 94.9% v/v (at 15.56°C), or 92.3% w/w, and not more than 96.0% v/v or w/w of ethanol.
b) Identification:	(1) Mix 5 drops in a small beaker with 1 ml of potassium permanganate solution (1 in 100) and 5 drops of 2N sulphuric acid, and immediately cover the beaker with a filter paper moistened with a recently-prepared solution of 0.1 g of sodium nitroferricyanide and 0.25 g of piperazine in 5 ml of water. An intense blue color is produced on the filter paper, and the color fades after a few minutes. (2) To 5 ml of a 1 in 10 solution, add 1 ml of 1.0 N sodium hydroxide, then slowly (over a period of 3 minutes), add 2 ml of 0.1 N Iodine. The odor of iodoform should develop, and a yellow precipitate should form within 30 minutes.
c) Specific gravity:	Between 0.812 and 0.816 at 15.56°C
d) Acidity:	To 50 ml of alcohol in a glass-stoppered flask, add 50 ml of recently-boiled water. Add phenolphthalein TS, and titrate with 0.02 N sodium hydroxide to a pink color that persists for 30 seconds. Not more than 0.9 ml of 0.02 N sodium hydroxide should be required for the neutralization.
e) Limit of non-volatile residue:	Evaporate 40 ml in a tarred dish on a water bath, and dry at 105°C for 1 hour. The weight of the residue should not exceed 1 mg.
f) Water-insoluble substances:	When diluted with an equal volume of water, the mixture should be clear, and remain clear for 10 minutes after cooling to 10°C.
g) Aldehydes and other foreign substances:	Place 20 ml in a thoroughly-cleaned glass-stoppered cylinder, cools to about 15°C, and add 0.1 ml of 0.1 N potassium permanganate. Note the precise time, and mix immediately by inverting the cylinder and allow it to stand at 15°C. The pink color should not completely disappear within 5 minutes.
h) Amyl alcohol and non-volatile	When 25 ml is allowed to evaporate spontaneously from

carbonizable substances, etc.:	a porcelain dish, (protected from dust), until the surface of the dish is barely moist, no red or brown color should be produced immediately on addition of a few drops of sulphuric acid.
i) Fusel-oil constituents:	When a piece of clean, odorless, absorbent paper is wetted with a mixture of 10 ml of alcohol, 5 ml of water and 1 ml of glycerin, which is then allowed to evaporate spontaneously, no foreign odor should be detectable as the last traces of the mixture evaporate.
j) Limit of acetone and isopropyl alcohol:	To 1 ml of alcohol, add 1 ml of water, 1 ml of saturated solution of dibasic sodium phosphate and 3 ml of a saturated solution of potassium permanganate. Warm the mixture to 45 - 50°C and allow standing until the permanganate color is discharged. Then add 3 ml of 2.5 N sodium hydroxide, and filter through a sintered-glass filter. Then prepare a control by mixing 1 ml of the saturated dibasic sodium phosphate solution, 3 ml of 2.5 N sodium hydroxide, 80 micrograms of acetone and 5 ml of water. To each solution add 1 ml of 1 in 100 furfural solution, allow to stand for 10 minutes, then to 1 ml of each solution add 3 ml of hydrochloric acid. Any pink color produced in the test solution should not be more intense than that in the control. (Revised in 8th Supplement, 1998.)
k) Methanol:	To 1 drop of alcohol, add 1 drop of water, 1 drop of a 1 in 20 solution of phosphoric acid and 1 drop of a 1 in 20 solution of potassium permanganate. Mix and allow standing for 1 minute, and then adding drops of a 1 in 20 solution of sodium bisulphite until the permanganate color is discharged. If a brown color remains, add 1 drop of the solution of phosphoric acid. To the colorless solution add 5 ml of freshly-prepared chromotropic acid T.S., and heat on a water bath at 60°C for 10 minutes. No violet color should appear.

Appendix 4. Dehydrated Alcohol Specifications.

a) Definition:	Contains not less than 99.5% v/v (at 15.56°C) or 99.2% w/w of ethanol.
b) Identification:	(1) Mix 5 drops in a small beaker with 1 ml of potassium permanganate solution (1 in 100) and 5 drops of 2N sulphuric acid, and immediately cover the beaker with a filter paper moistened with a recently-prepared solution of 0.1 g of sodium nitroferricyanide and 0.25 g of piperazine in 5 ml of water. An intense blue color is produced on the filter paper, and the color fades after a few minutes. (2) To 5 ml of a 1 in 10 solution, add 1 ml of 1.0 N sodium hydroxide, then slowly (over a period of 3 minutes), add 2 ml of 0.1 N Iodine. The odor of iodoform should develop, and a yellow precipitate should form within 30 minutes.
c) Specific gravity:	Not more than 0.7964 at 15.56°C.
d) Acidity:	Complies with the requirements for "Alcohol."
e) Limit of non-volatile residue:	Complies with the requirements for "Alcohol."
f) Water-insoluble substances:	Complies with the requirements for "Alcohol."
g) Aldehydes and other foreign organic substances:	Complies with the requirements for "Alcohol."
h) Amyl alcohol and non-volatile, carbonizable substances:	Complies with the requirements for "Alcohol."
i) Limit of acetone and isopropyl alcohol:	Complies with the requirements for "Alcohol."
j) Methanol:	Complies with the requirements for "Alcohol."
k) Ultraviolet absorbance:	Record the ultraviolet absorbance between 340 nm and 235 nm in a 1 cm cell, with water in a matched cell for a reference beam. The absorbance should not be more than 0.08 at 240 nm and 0.02 at 270 to 350 nm, and the curve drawn through these points should be smooth. (Revised in the 8th Supplement, 1998.)

Appendix 5. Specifications for Ethanol as a Food Additive.

Food grade ethanol

Given below is the standard for ethanol as a food additive as set by the Joint Expert Committee on Food Additives (J.E.C.F.A.) of the Food and Agriculture Organization and the World Health Organization, both United Nation agencies. This is contained in the Compendium of Food Additive Specifications - 52/1, Rome, 1992 and was published online at http://www.distill.com/specs/UN1.html. This is also applicable for the use of ethanol for beverages, although some companies are free to set their own standard for beverage ethanol.

1) Functional uses:	Extraction solvent, Carrier solvent
2) Description:	Clear, colorless, mobile, flammable liquid, with a mild, characteristic odor and a burning taste.
3) Characteristics:	
Parameter	Specification
(a) Ethanol content by volume	94.9% minimum
(b) Miscibility in water	Miscible in all proportions
(c) Refractive index n 20÷D	1.3635 - 1.3645
(d) Boiling point	About 78°C
(e) Residue on evaporation	2 mg/100 ml maximum (20 p.p.m)
(f) Acidity, as acetic acid, on a weight /volume basis	0.005% maximum (50 p.p.m)
(g) Alkalinity, as ammonia	0.003% maximum (30 p.p.m)
(h) Heavy metals	1 mg/kg maximum (1 p.p.m)
(i) Fusel oil	Passes test (Absence of foreign odor when mixture with glycerin and water is evaporated from a clean, odorless filter paper)
(j) Ketones, methanol and other impurities measured by gas chromatography Total: Methanol: Any other individual impurity:	0.5% maximum (5000 p.p.m) 0.02% maximum (200 p.p.m) 0.1% maximum (1000 p.p.m)
(k) Substances darkened by sulphuric acid (Amyl alcohols and non-volatile, carbonizable substances, etc.)	Passes test (No change of color)
(l) Permanganate time at 15°C	5 minutes minimum

Appendix 6. Production Cost Estimate of Sweet Sorghum Derived Bioethanol, Philippines.

Stalks	**PhP**	**Grains**	**PhP**
Feedstock	11.00	Feedstock	16.00
Processing Materials		*Processing Materials*	
Water	0.01	Water	0.01
Enzymes		Enzymes	0.49
Yeast	0.05	Yeast	0.05
Chemicals	0.30	Chemicals	0.30
Denaturant	0.76	Denaturant	0.76
Electricity	0.43	Electricity	0.43
Transport	2.50		
Fuel	0.01	Fuel	0.01
Processing Materials	*1.55*	*Processing Materials*	*2.04*
Labor		*Labor*	
Direct Labor	0.39	Direct Labor	0.39
Overhead	1.18	Admin	1.18
Labor	*1.58*	*Labor*	*1.58*
Operating Expenses		*Operating Expenses*	0.10
Pollution Control	0.10	Pollution Control	0.41
Maintenance	0.41	Maintenance	0.05
Others	0.05	Others	0.56
Operating Expenses	0.56	*Operating Expenses*	
Admin	4.62	*Admin*	*4.62*
Profit Margin		*Profit Margin*	
Sub-Total: Stalks (/liter ethanol)	21.81	Sub-Total: Stalks (/liter ethanol)	24.79

Appendix 7. Investment Requirement of Bioethanol Plant.

Investment Requirement	**Plant**
	Rusni 40klpd
	estimate
Land	8,700,000
Pre-Operative Expenses	38,710,000
Plant & Machineries	279,300,000
Building & civil works	15,190,000
Working Capital	14,700,000
Contingency	15,680,000
Consultancy/Contracting	49,000,000
TOTAL	**421,280,000**

Appendix 8. Investment Cost Estimates, Sweet Sorghum Bioethanol Plant, 100,000 liters/day, Philippines

Investment Requirement	Plant Evaluated		
	100,000 li/day		
	Specs		*Estimate*
Land	18	has	9,000,000
Plant and Machineries			
Cane handling and juice extraction	1,500	TCD	147,000,000
Boiler and genset	9	MW	200,529,302
Distillation	100,000	l/day	466,970,000
Piping and utilities	100,000	l/day	20,000,000
Milling and jet cooking	80	MT/h	48,605,575
Building and civil works	100,000	l/day	539,000,000
Working Capital			50,995,499
Contingency			74,105,019
Consultancy/Contracting			49,000,000
Total (PhP)			**1,605,205,395**

Note: cost of land is only PhP50.00 per square meter!

Appendix 9. Investment Cost Estimates, Sweet Sorghum Bioethanol Plant, 200,000 liters/day, Philippine

Investment Requirement	Plant Evaluated		
	200,000 li/day		
	Specs		*Estimate*
Land	25	has	75,000,000
Plant and Machineries			
Cane handling and juice extraction	3,000	TCD	222,810,335
Boiler and genset	20	MW	323,780,235
Distillation	200,000	l/day	466,970,000
Piping and utilities	200,000	l/day	30,314,331
Milling and jet cooking	140	MT/h	68,000,000
Building and civil works	200,000	l/day	742,701,118
Working Capital			202,046,997
Contingency			103,506,151
Consultancy/Contracting			49,000,000
Total (PhP)			**2,285,129,167**

Appendix 10. Capital Requirements of Sweet Sorghum Anhydrous Ethanol Distillery.

Item	Cost (in US$ million)	
Capacity	30 klpd	40 klpd
Land	0.11	0.11
Building and civil works	0.3	0.31
Plant and machineries	5.5	5.70
Pre-operative expenses	0.79*	0.79
Working capital	0.23*	0.30
Contingency	0.24*	0.32
Subtotal	***7.17***	***7.53***
Consultancy	1.0	1.0
TOTAL	***8.17***	***8.53***

*Source: Rusni Distilleries, * derived from 40 klpd estimates*

The above cost estimates cover the following components:

a. Truck scales, cranes and other stalk handling equipment
b. Crushing section;
c. Grain handling, milling and treatment section;
d. Fermentation section;
e. Distillation section;
f. Storage section;
g. Boiler with accessories;
h. Steam turbine and power co-generation (800 kVA, 3-phase);
i. Waste treatment and organic fertilizer plant;
j. Lab equipments;
k. Piping, valves, etc.;
l. Water cooling plant;
m. Electrical system; and
n. Erection and installation

It is unsure if the estimate is inclusive of piping insulation, as well as the instrumentation system since these were not installed in Rusni's Distillery. Yet, it should also be noted that Rusni Distillery was built using Indian standards whereas most facilities in the Philippines are constructed in accordance with ASTM and API standards.

Appendix 11. Income Statement Assuming High Ethanol Price (10% increase)* of Distillery Plant with 40 kld, 80% utilization rate, 300 days operation, Philippines, 2006.

Income Statement

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Sales												
Ethanol		-	291,456,000	291,456,000	291,456,000	291,456,000	291,456,000	291,456,000	291,456,000	291,456,000	291,456,000	291,456,000
Organic Fertilizer		-	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000
CDM credits		-	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905
CO_2 gas produced		-	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688
Total Sales		-	327,599,593	327,599,593	327,599,593	327,599,593	327,599,593	327,599,593	327,599,593	327,599,593	327,599,593	327,599,593
Less: Cost of Sales												
Feedstock												
Stalks		-	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000
Grains		-	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000
Other Raw Materials												
Stalks Processing Mats.		-	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095
Grains Processing Mats.		-	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363
Total Cost of Raw Materials		-	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458
Direct Labor		-	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933
Manufacturing overhead		-	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800
Total Cost of Sales		-	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192
Less: Operating Expenses												
Management/administration		1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000
Research & Development				-	-	-	-	-	-	-	-	-
Pollution Control		-	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617
Maintenance		-	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129
Depreciation Expense		-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Realty Tax		550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000
Others		543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008
Total Operating Expense		2,413,008	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755
Income Before Interest & Tax		(2,413,008)	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647
Interest Expense		-	-	-	-	-	-	-	-	-	-	-
Income Before Tax		(2,413,008)	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647	123,182,647
Tax		-	41,882,100	41,882,100	41,882,100	41,882,100	41,882,100	41,882,100	41,882,100	41,882,100	41,882,100	41,882,100
Net Income		(2,413,008)	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547

** From PhP 27.60 to PhP 30.36*

Appendix 12. Balance Sheet Assuming High Ethanol Price (10% increase)* of Distillery Plant with 40 kld, 80% utilization rate, 300 days operation, Philippines, 2006.

Balance Sheet	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Assets												
Current Assets												
Cash & Equivalents	9,199,021	6,786,013	88,086,560	169,387,107	193,028,665	216,670,223	240,311,780	263,953,338	287,594,896	368,895,443	450,195,990	531,496,537
Short Term Investments	-	-	-	-	-	-	-	-	-	-	-	-
Account Receivables	-	-	24,023,970	32,759,959	32,759,959	32,759,959	32,759,959	32,759,959	32,759,959	32,759,959	32,759,959	32,759,959
Inventory	5,500,979	-	40,787,558	40,787,558	40,787,558	40,787,558	40,787,558	40,787,558	40,787,558	40,787,558	40,787,558	40,787,558
Total Current Assets	14,700,000	6,786,013	152,898,089	242,934,625	266,576,182	290,217,740	313,859,298	337,500,856	361,142,413	442,442,960	523,743,507	605,044,055
Property, Plant & Equipment												
Land	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000
Plant, Equipment & Cap. Devt	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000
Less:Accumulated Depreciation	-	-	(38,220,000)	(76,440,000)	(114,660,000)	(152,880,000)	(191,100,000)	(229,320,000)	(267,540,000)	(305,760,000)	(343,980,000)	(382,200,000)
Property, Plant & Equipment	390,900,000	390,900,000	352,680,000	314,460,000	276,240,000	238,020,000	199,800,000	161,580,000	123,360,000	85,140,000	46,920,000	8,700,000
Total Assets	**405,600,000**	**397,686,013**	**505,578,089**	**557,394,625**	**542,816,182**	**528,237,740**	**513,659,298**	**499,080,856**	**484,502,413**	**527,582,960**	**570,663,507**	**613,744,055**
Liabilities												
Current Liabilities												
Accounts Payable	-	-	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292
Short/Current Long Term Debt	-	-	-	-	-	-	-	-	-	-	-	-
Other Current Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Total Current Liabilities	-	-	5,455,292	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66
Long Term Debt	202,800,000	202,800,000	202,800,000	202,800,000	171,505,011	136,141,673	96,181,101	51,025,654	(0)	(0)	(0)	(0)
Total Liabilities	**202,800,000**	**202,800,000**	**208,255,292**	**208,255,292**	**176,960,302**	**141,596,964**	**101,636,392**	**56,480,946**	**5,455,292**	**5,455,292**	**5,455,292**	**5,455,292**
Stockholder's Equity												
Common Stock	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000
Retained Earnings	-	(7,913,987)	94,522,797	146,339,333	163,055,880	183,840,776	209,222,906	239,799,910	276,247,122	319,327,669	362,408,216	405,488,763
Total Stockholder's Equity	**202,800,000**	**194,886,013**	**297,322,797**	**349,139,333**	**365,855,880**	**386,640,776**	**412,022,906**	**442,599,910**	**479,047,122**	**522,127,669**	**565,208,216**	**608,288,763**
Liabilities & Stockholder's Equity	**405,600,000**	**397,686,013**	**505,578,089**	**557,394,625**	**542,816,182**	**528,237,740**	**513,659,298**	**499,080,856**	**484,502,413**	**527,582,960**	**570,663,507**	**613,744,055**

** From PhP 27.60 to PhP 30.36*

Appendix 13. Cash Flow Assuming High Ethanol Price (10% increase)* of Distillery Plant with 40 kld, 80% utilization rate, 300 days operation, Philippines, 2006.

Cash Flows	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Operating Activities	-											
Net Income	-	(2,413,008)	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547	81,300,547
Other Operations	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation	-	-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Cash flow from Operating Activities	**-**	**(2,413,008)**	**119,520,547**	**119,520,547**	**119,520,547**	**119,520,547**	**119,520,547**	**119,520,547**	**119,520,547**	**119,520,547**	**119,520,547**	**119,520,547**
Investing Activities												
Capital Expenditures	(400,099,021)	-	-	-	-	-	-	-	-	-	-	-
Changes in Accounts Receivable	-	-	(24,023,970)	(8,735,989)	-	-	-	-	-	-	-	-
Changes in Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Changes in Inventories	(5,500,979)	-	(35,286,579)	-	-	-	-	-	-	-	-	-
Investments	-	-	-	-	-	-	-	-	-	-	-	-
Cash flow from Investing Activities	**(405,600,000)**	**-**	**(59,310,549)**	**(8,735,989)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing Activities												
Dividends Paid	-	-	-	-	-	-	-	-	-	-	-	-
Net Borrowings	202,800,000	-	-	-	-	-	-	-	-	-	-	-
Principal Repayments	-	-	-		(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)			
Cash flow from Financing Activities	**202,800,000**	**-**	**-**	**-**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**-**	**-**	**-**
Net Cash Flow	**(202,800,000)**	**(2,413,008)**	**60,209,998**	**110,784,558**	**61,861,558**	**61,861,558**	**61,861,558**	**61,861,558**	**61,861,558**	**119,520,547**	**119,520,547**	**119,520,547**

** From PhP 27.60 to PhP 30.36*

Appendix 14. Income Statement Assuming High Yielding Variety (20 % increase in ethanol yield)* of Distillery Plant with 40 kld, 80% utilization rate, 300 days operation, Philippines, 2006.

Income Statement

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Sales												
Ethanol		-	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000
Organic Fertilizer		-	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000
CDM credits		-	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905
CO_2 gas produced		-	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688
Total Sales		-	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593
Less: Cost of Sales												
Feedstock												
Stalks		-	53,333,333	53,333,333	53,333,333	53,333,333	53,333,333	53,333,333	53,333,333	53,333,333	53,333,333	53,333,333
Grains		-	42,666,667	42,666,667	42,666,667	42,666,667	42,666,667	42,666,667	42,666,667	42,666,667	42,666,667	42,666,667
Other Raw Materials												
Stalks Processing Mats.		-	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095
Grains Processing Mats.		-	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363
Total Cost of Raw Materials		-	123,276,458	123,276,458	123,276,458	123,276,458	123,276,458	123,276,458	123,276,458	123,276,458	123,276,458	123,276,458
Direct Labor		-	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933
Manufacturing overhead		-	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800
Total Cost of Sales		-	138,440,192	138,440,192	138,440,192	138,440,192	138,440,192	138,440,192	138,440,192	138,440,192	138,440,192	138,440,192
Less: Operating Expenses												
Management/administration		1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000
Research & Development				-	-	-	-	-	-	-	-	-
Pollution Control		-	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617
Maintenance		-	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129
Depreciation Expense		-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Realty Tax		550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000
Others		543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008
Total Operating Expense		2,413,008	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755
Income Before Interest & Tax		(2,413,008)	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647
Interest Expense		-	-	-	-	-	-	-	-	-	-	-
Income Before Tax		(2,413,008)	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647	115,886,647
Tax		-	39,401,460	39,401,460	39,401,460	39,401,460	39,401,460	39,401,460	39,401,460	39,401,460	39,401,460	39,401,460
Net Income		(2,413,008)	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187

** Stalks Yield from 55 li/MT to 66 li/MT*

** Grain Yield from 375 li/MT to 450 li/MT*

Appendix 15. Balance Sheet Assuming High Yielding Variety (20 % increase in ethanol yield)* of Distillery Plant with 40 kld, 80% utilization rate, 300 days operation, Philippines, 2006.

Balance Sheet	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Assets												
Current Assets												
Cash & Equivalents	9,661,243	7,248,235	83,733,422	160,218,609	179,044,807	197,871,005	216,697,202	235,523,400	254,349,598	330,834,785	407,319,972	483,805,159
Short Term Investments	-	-	-	-	-	-	-	-	-	-	-	-
Account Receivables	-	-	22,080,930	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359
Inventory	5,038,757	-	37,106,847	37,106,847	37,106,847	37,106,847	37,106,847	37,106,847	37,106,847	37,106,847	37,106,847	37,106,847
Total Current Assets	14,700,000	7,248,235	142,921,200	227,435,816	246,262,014	265,088,211	283,914,409	302,740,607	321,566,804	398,051,991	474,537,179	551,022,366
Property, Plant & Equipment												
Land	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000
Plant, Equipment & Cap. Devt	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000
Less:Accumulated Depreciation	-	-	(38,220,000)	(76,440,000)	(114,660,000)	(152,880,000)	(191,100,000)	(229,320,000)	(267,540,000)	(305,760,000)	(343,980,000)	(382,200,000)
Property, Plant & Equipment	390,900,000	390,900,000	352,680,000	314,460,000	276,240,000	238,020,000	199,800,000	161,580,000	123,360,000	85,140,000	46,920,000	8,700,000
Total Assets	**405,600,000**	**398,148,235**	**495,601,200**	**541,895,816**	**522,502,014**	**503,108,211**	**483,714,409**	**464,320,607**	**444,926,804**	**483,191,991**	**521,457,179**	**559,722,366**
Liabilities												
Current Liabilities												
Accounts Payable	-	-	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292
Short/Current Long Term Debt	-	-	-	-	-	-	-	-	-	-	-	-
Other Current Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Total Current Liabilities	-	-	5,455,292	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66
Long Term Debt	202,800,000	202,800,000	202,800,000	202,800,000	171,505,011	136,141,673	96,181,101	51,025,654	(0)	(0)	(0)	(0)
Total Liabilities	**202,800,000**	**202,800,000**	**208,255,292**	**208,255,292**	**176,960,302**	**141,596,964**	**101,636,392**	**56,480,946**	**5,455,292**	**5,455,292**	**5,455,292**	**5,455,292**
Stockholder's Equity												
Common Stock	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000
Retained Earnings	-	(7,451,765)	84,545,908	130,840,524	142,741,711	158,711,247	179,278,017	205,039,661	236,671,513	274,936,700	313,201,887	351,467,074
Total Stockholder's Equity	**202,800,000**	**195,348,235**	**287,345,908**	**333,640,524**	**345,541,711**	**361,511,247**	**382,078,017**	**407,839,661**	**439,471,513**	**477,736,700**	**516,001,887**	**554,267,074**
Liabilities & Stockholder's Equity	**405,600,000**	**398,148,235**	**495,601,200**	**541,895,816**	**522,502,014**	**503,108,211**	**483,714,409**	**464,320,607**	**444,926,804**	**483,191,991**	**521,457,179**	**559,722,366**

** Stalks Yield from 55 li/MT to 66 li/MT*
** Grain Yield from 375 li/MT to 450 li/MT*

Appendix 16. Cash Flow Assuming High Yielding Variety (20 % increase in ethanol yield)* of Distillery Plant with 40 kld, 80% utilization rate, 300 days operation, Philippines, 2006.

Cash Flows	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Operating Activities	-											
Net Income	-	(2,413,008)	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187	76,485,187
Other Operations	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation	-	-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Cash flow from Operating Activities	**-**	**(2,413,008)**	**114,705,187**	**114,705,187**	**114,705,187**	**114,705,187**	**114,705,187**	**114,705,187**	**114,705,187**	**114,705,187**	**114,705,187**	**114,705,187**
Investing Activities												
Capital Expenditures	(400,561,243)	-	-	-	-	-	-	-	-	-	-	-
Changes in Accounts Receivable	-	-	(22,080,930)	(8,029,429)	-	-	-	-	-	-	-	-
Changes in Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Changes in Inventories	(5,038,757)	-	(32,068,090)	-	-	-	-	-	-	-	-	-
Investments	-	-	-	-	-	-	-	-	-	-	-	-
Cash flow from Investing Activities	**(405,600,000)**	**-**	**(54,149,020)**	**(8,029,429)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing Activities												
Dividends Paid	-	-	-	-	-	-	-	-	-	-	-	-
Net Borrowings	202,800,000	-	-	-	-	-	-	-	-	-	-	-
Principal Repayments	-	-	-		(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)			
Cash flow from Financing Activities	**202,800,000**	**-**	**-**	**-**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**-**	**-**	**-**
Net Cash Flow	**(202,800,000)**	**(2,413,008)**	**60,556,167**	**106,675,758**	**57,046,198**	**57,046,198**	**57,046,198**	**57,046,198**	**57,046,198**	**114,705,187**	**114,705,187**	**114,705,187**

** Stalks Yield from 55 li/MT to 66 li/MT*
** Grain Yield from 375 li/MT to 450 li/MT*

Appendix 17. Income Statement Assuming High Yielding Variety (10 % increase in ethanol yield)* of a Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Income Statement

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Sales												
Ethanol		-	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000
Organic Fertilizer		-	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000
CDM credits		-	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905
CO_2 gas produced		-	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688
Total Sales		-	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593
Less: Cost of Sales												
Feedstock												
Stalks		-	58,181,818	58,181,818	58,181,818	58,181,818	58,181,818	58,181,818	58,181,818	58,181,818	58,181,818	58,181,818
Grains		-	46,545,455	46,545,455	46,545,455	46,545,455	46,545,455	46,545,455	46,545,455	46,545,455	46,545,455	46,545,455
Other Raw Materials												
Stalks Processing Mats.		-	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095
Grains Processing Mats.		-	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363
Total Cost of Raw Materials		-	132,003,731	132,003,731	132,003,731	132,003,731	132,003,731	132,003,731	132,003,731	132,003,731	132,003,731	132,003,731
Direct Labor		-	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933
Manufacturing overhead		-	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800
Total Cost of Sales		-	147,167,464	147,167,464	147,167,464	147,167,464	147,167,464	147,167,464	147,167,464	147,167,464	147,167,464	147,167,464
Less: Operating Expenses												
Management/administration		1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000
Research & Development				-	-	-	-	-	-	-	-	-
Pollution Control		-	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617
Maintenance		-	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129
Depreciation Expense		-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Realty Tax		550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000
Others		543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008
Total Operating Expense		2,413,008	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755
Income Before Interest & Tax		(2,413,008)	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374
Interest Expense		-	-	-	-	-	-	-	-	-	-	-
Income Before Tax		(2,413,008)	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374	107,159,374
Tax		-	36,434,187	36,434,187	36,434,187	36,434,187	36,434,187	36,434,187	36,434,187	36,434,187	36,434,187	36,434,187
Net Income		(2,413,008)	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187

** Stalks Yield from 55 li/MT to 60.50 li/MT*
** Grain Yield from 375 li/ MT to 412.5 li/ MT*

Appendix 18. Balance Sheet Assuming High Yielding Variety (10 % increase in ethanol yield)* of a Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Balance Sheet

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Assets												
Current Assets												
Cash & Equivalents	9,451,142	7,038,134	77,763,321	148,488,508	161,554,706	174,620,904	187,687,101	200,753,299	213,819,497	284,544,684	355,269,871	425,995,058
Short Term Investments	-	-	-	-	-	-	-	-	-	-	-	-
Account Receivables	-	-	22,080,930	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359
Inventory	5,248,858	-	37,575,534	37,575,534	37,575,534	37,575,534	37,575,534	37,575,534	37,575,534	37,575,534	37,575,534	37,575,534
Total Current Assets	14,700,000	7,038,134	137,419,785	216,174,402	229,240,599	242,306,797	255,372,995	268,439,193	281,505,390	352,230,577	422,955,764	493,680,952
Property, Plant & Equipment												
Land	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000
Plant, Equipment & Cap. Devt	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000
Less:Accumulated Depreciation	-	-	(38,220,000)	(76,440,000)	(114,660,000)	(152,880,000)	(191,100,000)	(229,320,000)	(267,540,000)	(305,760,000)	(343,980,000)	(382,200,000)
Property, Plant & Equipment	390,900,000	390,900,000	352,680,000	314,460,000	276,240,000	238,020,000	199,800,000	161,580,000	123,360,000	85,140,000	46,920,000	8,700,000
Total Assets	**405,600,000**	**397,938,134**	**490,099,785**	**530,634,402**	**505,480,599**	**480,326,797**	**455,172,995**	**430,019,193**	**404,865,390**	**437,370,577**	**469,875,764**	**502,380,952**
Liabilities												
Current Liabilities												
Accounts Payable	-	-	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292
Short/Current Long Term Debt	-	-	-	-	-	-	-	-	-	-	-	-
Other Current Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Total Current Liabilities	-	-	5,455,292	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66
Long Term Debt	202,800,000	202,800,000	202,800,000	202,800,000	171,505,011	136,141,673	96,181,101	51,025,654	(0)	(0)	(0)	(0)
Total Liabilities	**202,800,000**	**202,800,000**	**208,255,292**	**208,255,292**	**176,960,302**	**141,596,964**	**101,636,392**	**56,480,946**	**5,455,292**	**5,455,292**	**5,455,292**	**5,455,292**
Stockholder's Equity												
Common Stock	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000
Retained Earnings	-	(7,661,866)	79,044,494	119,579,110	125,720,297	135,929,833	150,736,603	170,738,247	196,610,099	229,115,286	261,620,473	294,125,660
Total Stockholder's Equity	**202,800,000**	**195,138,134**	**281,844,494**	**322,379,110**	**328,520,297**	**338,729,833**	**353,536,603**	**373,538,247**	**399,410,099**	**431,915,286**	**464,420,473**	**496,925,660**
Liabilities & Stockholder's Equity	**405,600,000**	**397,938,134**	**490,099,785**	**530,634,402**	**505,480,599**	**480,326,797**	**455,172,995**	**430,019,193**	**404,865,390**	**437,370,577**	**469,875,764**	**502,380,952**

** Stalks Yield from 55 li/MT to 60.50 li/MT*
** Grain Yield from 375 li/ MT to 412.5 li/ MT*

Appendix 19. Cash Flow Assuming High Yielding Variety (10 % increase in ethanol yield)* of a Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Cash Flows

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Operating Activities	-											
Net Income	-	(2,413,008)	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187	70,725,187
Other Operations	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation	-	-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Cash flow from Operating Activities	**-**	**(2,413,008)**	**108,945,187**	**108,945,187**	**108,945,187**	**108,945,187**	**108,945,187**	**108,945,187**	**108,945,187**	**108,945,187**	**108,945,187**	**108,945,187**
Investing Activities												
Capital Expenditures	(400,351,142)	-	-	-	-	-	-	-	-	-	-	-
Changes in Accounts Receivable	-	-	(22,080,930)	(8,029,429)	-	-	-	-	-	-	-	-
Changes in Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Changes in Inventories	(5,248,858)	-	(32,326,676)	-	-	-	-	-	-	-	-	-
Investments	-	-	-	-	-	-	-	-	-	-	-	-
Cash flow from Investing Activities	**(405,600,000)**	**-**	**(54,407,606)**	**(8,029,429)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing Activities												
Dividends Paid	-	-	-	-	-	-	-	-	-	-	-	-
Net Borrowings	202,800,000	-	-	-	-	-	-	-	-	-	-	-
Principal Repayments	-	-	-		(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)			
Cash flow from Financing Activities	**202,800,000**	**-**	**-**	**-**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**-**	**-**	**-**
Net Cash Flow	**(202,800,000)**	**(2,413,008)**	**54,537,581**	**100,915,758**	**51,286,198**	**51,286,198**	**51,286,198**	**51,286,198**	**51,286,198**	**108,945,187**	**108,945,187**	**108,945,187**

** Stalks Yield from 55 li/MT to 60.50 li/MT*
** Grain Yield from 375 li/ MT to 412.5 li/ MT*

Appendix 20. Income Statement Assuming 10% decrease in the cost of raw materials* of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Income Statement

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Sales												
Ethanol		-	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000
Organic Fertilizer		-	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000
CDM credits		-	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905
CO_2 gas produced		-	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688
Total Sales		-	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593
Less: Cost of Sales												
Feedstock												
Stalks		-	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000
Grains		-	41,890,909	41,890,909	41,890,909	41,890,909	41,890,909	41,890,909	41,890,909	41,890,909	41,890,909	41,890,909
Other Raw Materials												
Stalks Processing Mats.		-	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095
Grains Processing Mats.		-	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363
Total Cost of Raw Materials		-	139,567,367	139,567,367	139,567,367	139,567,367	139,567,367	139,567,367	139,567,367	139,567,367	139,567,367	139,567,367
Direct Labor		-	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933
Manufacturing overhead		-	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800
Total Cost of Sales		-	154,731,101	154,731,101	154,731,101	154,731,101	154,731,101	154,731,101	154,731,101	154,731,101	154,731,101	154,731,101
Less: Operating Expenses												
Management/administration		1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000
Research & Development				-	-	-	-	-	-	-	-	-
Pollution Control		-	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617
Maintenance		-	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129
Depreciation Expense		-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Realty Tax		550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000
Others		543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008
Total Operating Expense		2,413,008	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755
Income Before Interest & Tax		(2,413,008)	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738
Interest Expense		-	-	-	-	-	-	-	-	-	-	-
Income Before Tax		(2,413,008)	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738	99,595,738
Tax		-	33,862,551	33,862,551	33,862,551	33,862,551	33,862,551	33,862,551	33,862,551	33,862,551	33,862,551	33,862,551
Net Income		(2,413,008)	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187

** Stalk Price from PhP 550/ MT to PhP 495/ MT*
** Grain Price from PhP 6/kg to PhP 5.40/ MT*

Appendix 21. Balance Sheet Assuming 10% decrease in the cost of raw materials* of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Balance Sheet	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Assets												
Current Assets												
Cash & Equivalents	9,402,657	6,989,649	72,722,836	138,456,023	146,530,221	154,604,419	162,678,617	170,752,814	178,827,012	244,560,199	310,293,386	376,026,573
Short Term Investments	-	-	-	-	-	-	-	-	-	-	-	-
Account Receivables	-	-	22,080,930	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359
Inventory	5,297,343	-	37,313,716	37,313,716	37,313,716	37,313,716	37,313,716	37,313,716	37,313,716	37,313,716	37,313,716	37,313,716
Total Current Assets	14,700,000	6,989,649	132,117,482	205,880,099	213,954,296	222,028,494	230,102,692	238,176,890	246,251,087	311,984,274	377,717,461	443,450,649
Property, Plant & Equipment												
Land	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000
Plant, Equipment & Cap. Devt	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000
Less:Accumulated Depreciation	-	-	(38,220,000)	(76,440,000)	(114,660,000)	(152,880,000)	(191,100,000)	(229,320,000)	(267,540,000)	(305,760,000)	(343,980,000)	(382,200,000)
Property, Plant & Equipment	390,900,000	390,900,000	352,680,000	314,460,000	276,240,000	238,020,000	199,800,000	161,580,000	123,360,000	85,140,000	46,920,000	8,700,000
Total Assets	**405,600,000**	**397,889,649**	**484,797,482**	**520,340,099**	**490,194,296**	**460,048,494**	**429,902,692**	**399,756,890**	**369,611,087**	**397,124,274**	**424,637,461**	**452,150,649**
Liabilities												
Current Liabilities												
Accounts Payable	-	-	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292
Short/Current Long Term Debt	-	-	-	-	-	-	-	-	-	-	-	-
Other Current Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Total Current Liabilities	-	-	5,455,292	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66
Long Term Debt	202,800,000	202,800,000	202,800,000	202,800,000	171,505,011	136,141,673	96,181,101	51,025,654	(0)	(0)	(0)	(0)
Total Liabilities	**202,800,000**	**202,800,000**	**208,255,292**	**208,255,292**	**176,960,302**	**141,596,964**	**101,636,392**	**56,480,946**	**5,455,292**	**5,455,292**	**5,455,292**	**5,455,292**
Stockholder's Equity												
Common Stock	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000
Retained Earnings	-	(7,710,351)	73,742,191	109,284,807	110,433,994	115,651,530	125,466,300	140,475,944	161,355,796	188,868,983	216,382,170	243,895,357
Total Stockholder's Equity	**202,800,000**	**195,089,649**	**276,542,191**	**312,084,807**	**313,233,994**	**318,451,530**	**328,266,300**	**343,275,944**	**364,155,796**	**391,668,983**	**419,182,170**	**446,695,357**
Liabilities & Stockholder's Equity	**405,600,000**	**397,889,649**	**484,797,482**	**520,340,099**	**490,194,296**	**460,048,494**	**429,902,692**	**399,756,890**	**369,611,087**	**397,124,274**	**424,637,461**	**452,150,649**

** Stalk Price from PhP 550/ MT to PhP 495/ MT*
** Grain Price from PhP 6/kg to PhP 5.40/ MT*

Appendix 22. Cash Flow Assuming 10% decrease in the cost of raw materials* of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Cash Flows

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Operating Activities	-											
Net Income	-	(2,413,008)	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187	65,733,187
Other Operations	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation	-	-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Cash flow from Operating Activities	**-**	**(2,413,008)**	**103,953,187**	**103,953,187**	**103,953,187**	**103,953,187**	**103,953,187**	**103,953,187**	**103,953,187**	**103,953,187**	**103,953,187**	**103,953,187**
Investing Activities												
Capital Expenditures	(400,302,657)	-	-	-	-	-	-	-	-	-	-	-
Changes in Accounts Receivable	-	-	(22,080,930)	(8,029,429)	-	-	-	-	-	-	-	-
Changes in Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Changes in Inventories	(5,297,343)	-	(32,016,373)	-	-	-	-	-	-	-	-	-
Investments	-	-	-	-	-	-	-	-	-	-	-	-
Cash flow from Investing Activities	**(405,600,000)**	**-**	**(54,097,303)**	**(8,029,429)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing Activities												
Dividends Paid	-	-	-	-	-	-	-	-	-	-	-	-
Net Borrowings	202,800,000	-	-	-	-	-	-	-	-	-	-	-
Principal Repayments	-	-	-		(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)			
Cash flow from Financing Activities	**202,800,000**	**-**	**-**		**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**-**	**-**	**-**
Net Cash Flow	**(202,800,000)**	**(2,413,008)**	**49,855,884**	**95,923,758**	**46,294,198**	**46,294,198**	**46,294,198**	**46,294,198**	**46,294,198**	**103,953,187**	**103,953,187**	**103,953,187**

** Stalk Price from PhP 550/ MT to PhP 495/ MT*
** Grain Price from PhP 6/kg to PhP 5.40/ MT*

Appendix 23. Income Statement Assuming 10% increase in the cost of raw materials* of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Income Statement

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Sales												
Ethanol		-	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000
Organic Fertilizer		-	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000
CDM credits		-	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905
CO_2 gas produced		-	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688
Total Sales		-	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593
Less: Cost of Sales												
Feedstock												
Stalks		-	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000	70,400,000
Grains		-	56,320,000	56,320,000	56,320,000	56,320,000	56,320,000	56,320,000	56,320,000	56,320,000	56,320,000	56,320,000
Other Raw Materials												
Stalks Processing Mats.		-	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095
Grains Processing Mats.		-	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363
Total Cost of Raw Materials		-	153,996,458	153,996,458	153,996,458	153,996,458	153,996,458	153,996,458	153,996,458	153,996,458	153,996,458	153,996,458
Direct Labor		-	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933
Manufacturing overhead		-	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800
Total Cost of Sales		-	169,160,192	169,160,192	169,160,192	169,160,192	169,160,192	169,160,192	169,160,192	169,160,192	169,160,192	169,160,192
Less: Operating Expenses												
Management/administration		1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000
Research & Development				-	-	-	-	-	-	-	-	-
Pollution Control		-	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617
Maintenance		-	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129
Depreciation Expense		-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Realty Tax		550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000
Others		543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008
Total Operating Expense		2,413,008	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755
Income Before Interest & Tax		(2,413,008)	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647
Interest Expense		-	-	-	-	-	-	-	-	-	-	-
Income Before Tax		(2,413,008)	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647	85,166,647
Tax		-	28,956,660	28,956,660	28,956,660	28,956,660	28,956,660	28,956,660	28,956,660	28,956,660	28,956,660	28,956,660
Net Income		(2,413,008)	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987

** Stalk Price from PhP 550/ MT to PhP 605/ MT*
** Grain Price from PhP 6/kg to PhP 6.60/ MT*

Appendix 24. Balance Sheet Assuming 10% increase in the cost of raw materials* of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Balance Sheet

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Assets												
Current Assets												
Cash & Equivalents	8,921,688	6,508,680	62,718,667	118,928,654	117,479,651	116,030,649	114,581,647	113,132,645	111,683,642	167,893,629	224,103,616	280,313,604
Short Term Investments	-	-	-	-	-	-	-	-	-	-	-	-
Account Receivables	-	-	22,080,930	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359
Inventory	5,778,312	-	38,756,625	38,756,625	38,756,625	38,756,625	38,756,625	38,756,625	38,756,625	38,756,625	38,756,625	38,756,625
Total Current Assets	14,700,000	6,508,680	123,556,222	187,795,638	186,346,636	184,897,634	183,448,631	181,999,629	180,550,627	236,760,614	292,970,601	349,180,588
Property, Plant & Equipment												
Land	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000
Plant, Equipment & Cap. Devt	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000
Less:Accumulated Depreciation	-	-	(38,220,000)	(76,440,000)	(114,660,000)	(152,880,000)	(191,100,000)	(229,320,000)	(267,540,000)	(305,760,000)	(343,980,000)	(382,200,000)
Property, Plant & Equipment	390,900,000	390,900,000	352,680,000	314,460,000	276,240,000	238,020,000	199,800,000	161,580,000	123,360,000	85,140,000	46,920,000	8,700,000
Total Assets	**405,600,000**	**397,408,680**	**476,236,222**	**502,255,638**	**462,586,636**	**422,917,634**	**383,248,631**	**343,579,629**	**303,910,627**	**321,900,614**	**339,890,601**	**357,880,588**
Liabilities												
Current Liabilities												
Accounts Payable	-	-	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292
Short/Current Long Term Debt	-	-	-	-	-	-	-	-	-	-	-	-
Other Current Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Total Current Liabilities	-	-	5,455,292	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66
Long Term Debt	202,800,000	202,800,000	202,800,000	202,800,000	171,505,011	136,141,673	96,181,101	51,025,654	(0)	(0)	(0)	(0)
Total Liabilities	**202,800,000**	**202,800,000**	**208,255,292**	**208,255,292**	**176,960,302**	**141,596,964**	**101,636,392**	**56,480,946**	**5,455,292**	**5,455,292**	**5,455,292**	**5,455,292**
Stockholder's Equity												
Common Stock	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000
Retained Earnings	-	(8,191,320)	65,180,930	91,200,346	82,826,334	78,520,669	78,812,239	84,298,683	95,655,335	113,645,322	131,635,309	149,625,296
Total Stockholder's Equity	**202,800,000**	**194,608,680**	**267,980,930**	**294,000,346**	**285,626,334**	**281,320,669**	**281,612,239**	**287,098,683**	**298,455,335**	**316,445,322**	**334,435,309**	**352,425,296**
Liabilities & Stockholder's Equity	**405,600,000**	**397,408,680**	**476,236,222**	**502,255,638**	**462,586,636**	**422,917,634**	**383,248,631**	**343,579,629**	**303,910,627**	**321,900,614**	**339,890,601**	**357,880,588**

** Stalk Price from PhP 550/ MT to PhP 605/ MT*
** Grain Price from PhP 6/kg to PhP 6.60/ MT*

Appendix 25. Cash Flow Assuming 10% increase in the cost of raw materials* of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Cash Flows	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Operating Activities	-											
Net Income	-	(2,413,008)	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987	56,209,987
Other Operations	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation	-	-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Cash flow from Operating Activities	**-**	**(2,413,008)**	**94,429,987**	**94,429,987**	**94,429,987**	**94,429,987**	**94,429,987**	**94,429,987**	**94,429,987**	**94,429,987**	**94,429,987**	**94,429,987**
Investing Activities												
Capital Expenditures	(399,821,688)	-	-	-	-	-	-	-	-	-	-	-
Changes in Accounts Receivable	-	-	(22,080,930)	(8,029,429)	-	-	-	-	-	-	-	-
Changes in Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Changes in Inventories	(5,778,312)	-	(32,978,312)	-	-	-	-	-	-	-	-	-
Investments	-	-	-	-	-	-	-	-	-	-	-	-
Cash flow from Investing Activities	**(405,600,000)**	**-**	**(55,059,243)**	**(8,029,429)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing Activities												
Dividends Paid	-	-	-	-	-	-	-	-	-	-	-	-
Net Borrowings	202,800,000	-	-	-	-	-	-	-	-	-	-	-
Principal Repayments	-	-	-		(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)			
Cash flow from Financing Activities	**202,800,000**	**-**	**-**		**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**-**	**-**	**-**
Net Cash Flow	**(202,800,000)**	**(2,413,008)**	**39,370,744**	**86,400,558**	**36,770,998**	**36,770,998**	**36,770,998**	**36,770,998**	**36,770,998**	**94,429,987**	**94,429,987**	**94,429,987**

** Stalk Price from PhP 550/ MT to PhP 605/ MT*
** Grain Price from PhP 6/kg to PhP 6.60/ MT*

Appendix 26. Income Statement Assuming 10% decrease in the days of operation* of Distillery Plant with 40 kld, 80% Utilization Rate, Philippines, 2006.

Income Statement

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Sales												
Ethanol		-	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000
Organic Fertilizer		-	28,080,000	28,080,000	28,080,000	28,080,000	28,080,000	28,080,000	28,080,000	28,080,000	28,080,000	28,080,000
CDM credits		-	3,795,215	3,795,215	3,795,215	3,795,215	3,795,215	3,795,215	3,795,215	3,795,215	3,795,215	3,795,215
CO_2 gas produced		-	654,019	654,019	654,019	654,019	654,019	654,019	654,019	654,019	654,019	654,019
Total Sales		-	270,993,234	270,993,234	270,993,234	270,993,234	270,993,234	270,993,234	270,993,234	270,993,234	270,993,234	270,993,234
Less: Cost of Sales												
Feedstock												
Stalks		-	57,600,000	57,600,000	57,600,000	57,600,000	57,600,000	57,600,000	57,600,000	57,600,000	57,600,000	57,600,000
Grains		-	46,080,000	46,080,000	46,080,000	46,080,000	46,080,000	46,080,000	46,080,000	46,080,000	46,080,000	46,080,000
Other Raw Materials												
Stalks Processing Mats.		-	23,321,786	23,321,786	23,321,786	23,321,786	23,321,786	23,321,786	23,321,786	23,321,786	23,321,786	23,321,786
Grains Processing Mats.		-	1,227,027	1,227,027	1,227,027	1,227,027	1,227,027	1,227,027	1,227,027	1,227,027	1,227,027	1,227,027
Total Cost of Raw Materials		-	128,228,812	128,228,812	128,228,812	128,228,812	128,228,812	128,228,812	128,228,812	128,228,812	128,228,812	128,228,812
Direct Labor		-	3,411,840	3,411,840	3,411,840	3,411,840	3,411,840	3,411,840	3,411,840	3,411,840	3,411,840	3,411,840
Manufacturing overhead		-	10,235,520	10,235,520	10,235,520	10,235,520	10,235,520	10,235,520	10,235,520	10,235,520	10,235,520	10,235,520
Total Cost of Sales		-	141,876,172	141,876,172	141,876,172	141,876,172	141,876,172	141,876,172	141,876,172	141,876,172	141,876,172	141,876,172
Less: Operating Expenses												
Management/administration		1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000
Research & Development				-	-	-	-	-	-	-	-	-
Pollution Control		-	1,075,156	1,075,156	1,075,156	1,075,156	1,075,156	1,075,156	1,075,156	1,075,156	1,075,156	1,075,156
Maintenance		-	4,454,216	4,454,216	4,454,216	4,454,216	4,454,216	4,454,216	4,454,216	4,454,216	4,454,216	4,454,216
Depreciation Expense		-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Realty Tax		550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000
Others		543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008
Total Operating Expense		2,413,008	46,162,380	46,162,380	46,162,380	46,162,380	46,162,380	46,162,380	46,162,380	46,162,380	46,162,380	46,162,380
Income Before Interest & Tax		(2,413,008)	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682
Interest Expense		-	-	-	-	-	-	-	-	-	-	-
Income Before Tax		(2,413,008)	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682	82,954,682
Tax		-	28,204,592	28,204,592	28,204,592	28,204,592	28,204,592	28,204,592	28,204,592	28,204,592	28,204,592	28,204,592
Net Income		(2,413,008)	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090

** From 300 days operation to 270 days operation*

Appendix 27. Balance Sheet Assuming 10% decrease in the days of operation* of Distillery Plant with 40 kld, 80% Utilization Rate, Philippines, 2006.

Balance Sheet

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Assets												
Current Assets												
Cash & Equivalents	9,199,021	6,786,013	61,536,103	116,286,193	113,377,293	110,468,394	107,559,494	104,650,595	101,741,695	156,491,785	211,241,875	265,991,965
Short Term Investments	-	-	-	-	-	-	-	-	-	-	-	-
Account Receivables	-	-	22,080,930	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359
Inventory	5,500,979	-	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958
Total Current Assets	14,700,000	6,786,013	121,754,991	184,534,510	181,625,611	178,716,711	175,807,812	172,898,912	169,990,013	224,740,103	279,490,192	334,240,282
Property, Plant & Equipment												
Land	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000
Plant, Equipment & Cap. Devt	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000
Less:Accumulated Depreciation	-	-	(38,220,000)	(76,440,000)	(114,660,000)	(152,880,000)	(191,100,000)	(229,320,000)	(267,540,000)	(305,760,000)	(343,980,000)	(382,200,000)
Property, Plant & Equipment	390,900,000	390,900,000	352,680,000	314,460,000	276,240,000	238,020,000	199,800,000	161,580,000	123,360,000	85,140,000	46,920,000	8,700,000
Total Assets	**405,600,000**	**397,686,013**	**474,434,991**	**498,994,510**	**457,865,611**	**416,736,711**	**375,607,812**	**334,478,912**	**293,350,013**	**309,880,103**	**326,410,192**	**342,940,282**
Liabilities												
Current Liabilities												
Accounts Payable	-	-	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292
Short/Current Long Term Debt	-	-	-	-	-	-	-	-	-	-	-	-
Other Current Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Total Current Liabilities	-	-	5,455,292	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66
Long Term Debt	202,800,000	202,800,000	202,800,000	202,800,000	171,505,011	136,141,673	96,181,101	51,025,654	(0)	(0)	(0)	(0)
Total Liabilities	**202,800,000**	**202,800,000**	**208,255,292**	**208,255,292**	**176,960,302**	**141,596,964**	**101,636,392**	**56,480,946**	**5,455,292**	**5,455,292**	**5,455,292**	**5,455,292**
Stockholder's Equity												
Common Stock	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000
Retained Earnings	-	(7,913,987)	63,379,700	87,939,219	78,105,309	72,339,747	71,171,419	75,197,966	85,094,721	101,624,811	118,154,901	134,684,991
Total Stockholder's Equity	**202,800,000**	**194,886,013**	**266,179,700**	**290,739,219**	**280,905,309**	**275,139,747**	**273,971,419**	**277,997,966**	**287,894,721**	**304,424,811**	**320,954,901**	**337,484,991**
Liabilities & Stockholder's Equity	**405,600,000**	**397,686,013**	**474,434,991**	**498,994,510**	**457,865,611**	**416,736,711**	**375,607,812**	**334,478,912**	**293,350,013**	**309,880,103**	**326,410,192**	**342,940,282**

** From 300 days operation to 270 days operation*

Appendix 28. Cash Flow Assuming 10% decrease in the days of operation* of Distillery Plant with 40 kld, 80% Utilization Rate, Philippines, 2006.

Cash Flows

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Operating Activities	-											
Net Income	-	(2,413,008)	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090	54,750,090
Other Operations	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation	-	-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Cash flow from Operating Activities	**-**	**(2,413,008)**	**92,970,090**	**92,970,090**	**92,970,090**	**92,970,090**	**92,970,090**	**92,970,090**	**92,970,090**	**92,970,090**	**92,970,090**	**92,970,090**
Investing Activities												
Capital Expenditures	(400,099,021)	-	-	-	-	-	-	-	-	-	-	-
Changes in Accounts Receivable	-	-	(22,080,930)	(8,029,429)	-	-	-	-	-	-	-	-
Changes in Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Changes in Inventories	(5,500,979)	-	(32,636,979)	-	-	-	-	-	-	-	-	-
Investments	-	-	-	-	-	-	-	-	-	-	-	-
Cash flow from Investing Activities	**(405,600,000)**	**-**	**(54,717,909)**	**(8,029,429)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing Activities												
Dividends Paid	-	-	-	-	-	-	-	-	-	-	-	-
Net Borrowings	202,800,000	-	-	-	-	-	-	-	-	-	-	-
Principal Repayments	-	-	-		(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)			
Cash flow from Financing Activities	**202,800,000**	**-**	**-**	**-**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**-**	**-**	**-**
Net Cash Flow	**(202,800,000)**	**(2,413,008)**	**38,252,181**	**84,940,661**	**35,311,100**	**35,311,100**	**35,311,100**	**35,311,100**	**35,311,100**	**92,970,090**	**92,970,090**	**92,970,090**

** From 300 days operation to 270 days operation*

Appendix 29. Income Statement Assuming Low Ethanol Price* of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Income Statement

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Sales												
Ethanol		-	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000	238,464,000
Organic Fertilizer		-	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000
CDM credits		-	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905
CO_2 gas produced		-	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688
Total Sales		-	274,607,593	274,607,593	274,607,593	274,607,593	274,607,593	274,607,593	274,607,593	274,607,593	274,607,593	274,607,593
Less: Cost of Sales												
Feedstock												
Stalks		-	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000
Grains		-	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000
Other Raw Materials												
Stalks Processing Mats.		-	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095
Grains Processing Mats.		-	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363
Total Cost of Raw Materials		-	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458
Direct Labor		-	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933
Manufacturing overhead		-	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800
Total Cost of Sales		-	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192
Less: Operating Expenses												
Management/administration		1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000
Research & Development				-	-	-	-	-	-	-	-	-
Pollution Control		-	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617
Maintenance		-	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129
Depreciation Expense		-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Realty Tax		550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000
Others		543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008
Total Operating Expense		2,413,008	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755
Income Before Interest & Tax		(2,413,008)	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647
Interest Expense		-	-	-	-	-	-	-	-	-	-	-
Income Before Tax		(2,413,008)	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647	70,190,647
Tax		-	23,864,820	23,864,820	23,864,820	23,864,820	23,864,820	23,864,820	23,864,820	23,864,820	23,864,820	23,864,820
Net Income		(2,413,008)	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827

* *From PhP 27.60/li to PhP 24.84/li*

Appendix 30. Balance Sheet Assuming Low Ethanol Price* of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Balance Sheet	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Assets												
Current Assets												
Cash & Equivalents	9,199,021	6,786,013	53,111,840	99,437,667	88,104,505	76,771,343	65,438,180	54,105,018	42,771,856	89,097,683	135,423,510	181,749,337
Short Term Investments	-	-	-	-	-	-	-	-	-	-	-	-
Account Receivables	-	-	20,137,890	27,460,759	27,460,759	27,460,759	27,460,759	27,460,759	27,460,759	27,460,759	27,460,759	27,460,759
Inventory	5,500,979	-	35,488,358	35,488,358	35,488,358	35,488,358	35,488,358	35,488,358	35,488,358	35,488,358	35,488,358	35,488,358
Total Current Assets	14,700,000	6,786,013	108,738,089	162,386,785	151,053,622	139,720,460	128,387,298	117,054,136	105,720,973	152,046,800	198,372,627	244,698,455
Property, Plant & Equipment												
Land	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000
Plant, Equipment & Cap. Devt	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000
Less:Accumulated Depreciation	-	-	(38,220,000)	(76,440,000)	(114,660,000)	(152,880,000)	(191,100,000)	(229,320,000)	(267,540,000)	(305,760,000)	(343,980,000)	(382,200,000)
Property, Plant & Equipment	390,900,000	390,900,000	352,680,000	314,460,000	276,240,000	238,020,000	199,800,000	161,580,000	123,360,000	85,140,000	46,920,000	8,700,000
Total Assets	**405,600,000**	**397,686,013**	**461,418,089**	**476,846,785**	**427,293,622**	**377,740,460**	**328,187,298**	**278,634,136**	**229,080,973**	**237,186,800**	**245,292,627**	**253,398,455**
Liabilities												
Current Liabilities												
Accounts Payable	-	-	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292
Short/Current Long Term Debt	-	-	-	-	-	-	-	-	-	-	-	-
Other Current Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Total Current Liabilities	-	-	5,455,292	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66
Long Term Debt	202,800,000	202,800,000	202,800,000	202,800,000	171,505,011	136,141,673	96,181,101	51,025,654	(0)	(0)	(0)	(0)
Total Liabilities	**202,800,000**	**202,800,000**	**208,255,292**	**208,255,292**	**176,960,302**	**141,596,964**	**101,636,392**	**56,480,946**	**5,455,292**	**5,455,292**	**5,455,292**	**5,455,292**
Stockholder's Equity												
Common Stock	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000
Retained Earnings	-	(7,913,987)	50,362,797	65,791,493	47,533,320	33,343,496	23,750,906	19,353,190	20,825,682	28,931,509	37,037,336	45,143,163
Total Stockholder's Equity	**202,800,000**	**194,886,013**	**253,162,797**	**268,591,493**	**250,333,320**	**236,143,496**	**226,550,906**	**222,153,190**	**223,625,682**	**231,731,509**	**239,837,336**	**247,943,163**
Liabilities & Stockholder's Equity	**405,600,000**	**397,686,013**	**461,418,089**	**476,846,785**	**427,293,622**	**377,740,460**	**328,187,298**	**278,634,136**	**229,080,973**	**237,186,800**	**245,292,627**	**253,398,455**

* *From PhP 27.60/li to PhP 24.84/li*

Appendix 31. Cash Flow Assuming Low Ethanol Price* of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Cash Flows

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Operating Activities	-											
Net Income	-	(2,413,008)	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827	46,325,827
Other Operations	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation	-	-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Cash flow from Operating Activities	**-**	**(2,413,008)**	**84,545,827**	**84,545,827**	**84,545,827**	**84,545,827**	**84,545,827**	**84,545,827**	**84,545,827**	**84,545,827**	**84,545,827**	**84,545,827**
Investing Activities												
Capital Expenditures	(400,099,021)	-	-	-	-	-	-	-	-	-	-	-
Changes in Accounts Receivable	-	-	(20,137,890)	(7,322,869)	-	-	-	-	-	-	-	-
Changes in Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Changes in Inventories	(5,500,979)	-	(29,987,379)	-	-	-	-	-	-	-	-	-
Investments	-	-	-	-	-	-	-	-	-	-	-	-
Cash flow from Investing Activities	**(405,600,000)**	**-**	**(50,125,269)**	**(7,322,869)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing Activities												
Dividends Paid	-	-	-	-	-	-	-	-	-	-	-	-
Net Borrowings	202,800,000	-	-	-	-	-	-	-	-	-	-	-
Principal Repayments	-	-	-		(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)			
Cash flow from Financing Activities	**202,800,000**	**-**	**-**	**-**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**-**	**-**	**-**
Net Cash Flow	**(202,800,000)**	**(2,413,008)**	**34,420,558**	**77,222,958**	**26,886,838**	**26,886,838**	**26,886,838**	**26,886,838**	**26,886,838**	**84,545,827**	**84,545,827**	**84,545,827**

* *From PhP 27.60/li to PhP 24.84/li*

Appendix 32. Income Statement of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Income Statement

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Sales												
Ethanol		-	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000	264,960,000
Organic Fertilizer		-	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000	31,200,000
CDM credits		-	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905	4,216,905
CO_2 gas produced		-	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688	726,688
Total Sales		-	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593	301,103,593
Less: Cost of Sales												
Feedstock												
Stalks		-	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000	64,000,000
Grains		-	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000	51,200,000
Other Raw Materials												
Stalks Processing Mats.		-	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095	25,913,095
Grains Processing Mats.		-	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363	1,363,363
Total Cost of Raw Materials		-	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458	142,476,458
Direct Labor		-	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933	3,790,933
Manufacturing overhead		-	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800	11,372,800
Total Cost of Sales		-	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192	157,640,192
Less: Operating Expenses												
Management/administration		1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000	1,320,000
Research & Development				-	-	-	-	-	-	-	-	-
Pollution Control		-	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617	1,194,617
Maintenance		-	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129	4,949,129
Depreciation Expense		-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Realty Tax		550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000
Others		543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008	543,008
Total Operating Expense		2,413,008	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755	46,776,755
Income Before Interest & Tax		(2,413,008)	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647
Interest Expense		-	-	-	-	-	-	-	-	-	-	-
Income Before Tax		(2,413,008)	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647	96,686,647
Tax		-	32,873,460	32,873,460	32,873,460	32,873,460	32,873,460	32,873,460	32,873,460	32,873,460	32,873,460	32,873,460
Net Income		(2,413,008)	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187

Appendix 33. Balance Sheet of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Balance Sheet	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Assets												
Current Assets												
Cash & Equivalents	9,199,021	6,786,013	70,599,200	134,412,387	140,566,585	146,720,783	152,874,980	159,029,178	165,183,376	228,996,563	292,809,750	356,622,937
Short Term Investments	-	-	-	-	-	-	-	-	-	-	-	-
Account Receivables	-	-	22,080,930	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359	30,110,359
Inventory	5,500,979	-	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958	38,137,958
Total Current Assets	14,700,000	6,786,013	130,818,089	202,660,705	208,814,902	214,969,100	221,123,298	227,277,496	233,431,693	297,244,880	361,058,067	424,871,255
Property, Plant & Equipment												
Land	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000
Plant, Equipment & Cap. Devt	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000	382,200,000
Less:Accumulated Depreciation	-	-	(38,220,000)	(76,440,000)	(114,660,000)	(152,880,000)	(191,100,000)	(229,320,000)	(267,540,000)	(305,760,000)	(343,980,000)	(382,200,000)
Property, Plant & Equipment	390,900,000	390,900,000	352,680,000	314,460,000	276,240,000	238,020,000	199,800,000	161,580,000	123,360,000	85,140,000	46,920,000	8,700,000
Total Assets	**405,600,000**	**397,686,013**	**483,498,089**	**517,120,705**	**485,054,902**	**452,989,100**	**420,923,298**	**388,857,496**	**356,791,693**	**382,384,880**	**407,978,067**	**433,571,255**
Liabilities												
Current Liabilities												
Accounts Payable	-	-	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292	5,455,292
Short/Current Long Term Debt	-	-	-	-	-	-	-	-	-	-	-	-
Other Current Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Total Current Liabilities	-	-	5,455,292	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66	5,455,291.66
Long Term Debt	202,800,000	202,800,000	202,800,000	202,800,000	171,505,011	136,141,673	96,181,101	51,025,654	(0)	(0)	(0)	(0)
Total Liabilities	**202,800,000**	**202,800,000**	**208,255,292**	**208,255,292**	**176,960,302**	**141,596,964**	**101,636,392**	**56,480,946**	**5,455,292**	**5,455,292**	**5,455,292**	**5,455,292**
Stockholder's Equity												
Common Stock	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000	202,800,000
Retained Earnings	-	(7,913,987)	72,442,797	106,065,413	105,294,600	108,592,136	116,486,906	129,576,550	148,536,402	174,129,589	199,722,776	225,315,963
Total Stockholder's Equity	**202,800,000**	**194,886,013**	**275,242,797**	**308,865,413**	**308,094,600**	**311,392,136**	**319,286,906**	**332,376,550**	**351,336,402**	**376,929,589**	**402,522,776**	**428,115,963**
Liabilities & Stockholder's Equity	**405,600,000**	**397,686,013**	**483,498,089**	**517,120,705**	**485,054,902**	**452,989,100**	**420,923,298**	**388,857,496**	**356,791,693**	**382,384,880**	**407,978,067**	**433,571,255**

Appendix 34. Cash Flow of Distillery Plant with 40 kld, 80% Utilization Rate, 300 Days Operation, Philippines, 2006.

Cash Flows

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Operating Activities	-											
Net Income	-	(2,413,008)	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187	63,813,187
Other Operations	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation	-	-	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000	38,220,000
Cash flow from Operating Activities	**-**	**(2,413,008)**	**102,033,187**	**102,033,187**	**102,033,187**	**102,033,187**	**102,033,187**	**102,033,187**	**102,033,187**	**102,033,187**	**102,033,187**	**102,033,187**
Investing Activities												
Capital Expenditures	(400,099,021)	-	-	-	-	-	-	-	-	-	-	-
Changes in Accounts Receivable	-	-	(22,080,930)	(8,029,429)	-	-	-	-	-	-	-	-
Changes in Liabilities	-	-	-	-	-	-	-	-	-	-	-	-
Changes in Inventories	(5,500,979)	-	(32,636,979)	-	-	-	-	-	-	-	-	-
Investments	-	-	-	-	-	-	-	-	-	-	-	-
Cash flow from Investing Activities	**(405,600,000)**	**-**	**(54,717,909)**	**(8,029,429)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing Activities												
Dividends Paid	-	-	-	-	-	-	-	-	-	-	-	-
Net Borrowings	202,800,000	-	-	-	-	-	-	-	-	-	-	-
Principal Repayments	-	-	-		(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)	(57,658,989)			
Cash flow from Financing Activities	**202,800,000**	**-**	**-**	**-**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**(57,658,989)**	**-**	**-**	**-**
Net Cash Flow	**(202,800,000)**	**(2,413,008)**	**47,315,278**	**94,003,758**	**44,374,198**	**44,374,198**	**44,374,198**	**44,374,198**	**44,374,198**	**102,033,187**	**102,033,187**	**102,033,187**

Appendix 35. Fuel Properties of Ethanol.

Items	Ethanol
1. Formula	C2H5OH
2. Molecular Weight	46.07
3. Carbon/Hydrogen (W)	4.0
4.% Carbon (W)	52.17
5.% Hydrogen (W)	13.4
6. % Oxygen (W)	34.78
7. Boiling point @ 1 atm °C	78.40
8. Freezing point @ 1 atm °C	-80.00
9. Density @ 15.5 °C lb/gal	6.63
10. Viscosity @ 20°C/1 atm, Centipoise	1.20
11. Specific heat @ 25°C/1 atm BTU/lb	0.6
12. Heat of vaporization,® boiling point/1 atm, BTU/lb	
13. Heat of vaporization, @ 25°C/1 atm, BTU/lb	361.0
14. Heat of combustion @ 25°C, BTU/lb	
a) Higher heating value	12,780
b) Lower heating value	11,550
15. Stoichiometric, lb air/lb fuel	9.0
16. Research octane number	105
17. Flash point temp. °C	12.778
18. Auto-ignition temp. °C	422.778
19. Flammability limits	
a).Lower	4.3
b).Higher	19.0
20. Latent heat of vaporization @ 20°C, KJ/Kg	921.36
21. Cetane number	8

Source: FAO, Integrated Energy Systems in China – The Cold Northeastern Experience, 1989.

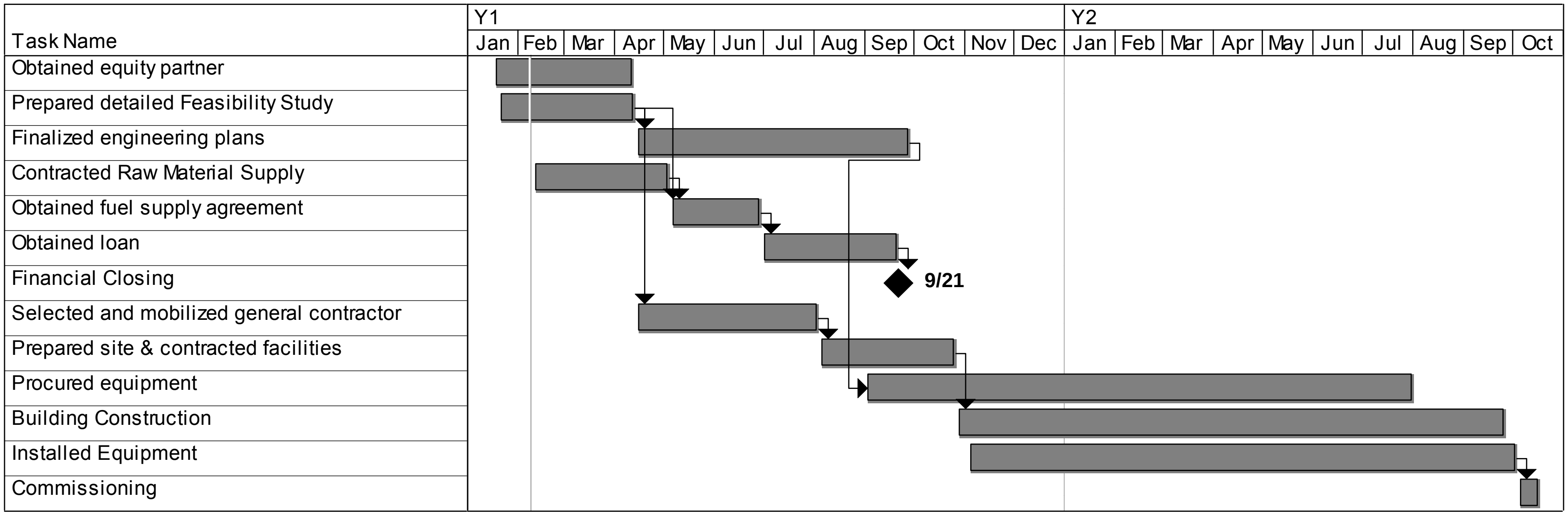
Appendix 36. Philippine Government Support and Incentives for Bioethanol Production

1.0 Technical Support	**1.1 Department of Science and Technology- Philippine Council for Industry and Energy Research and Development:** The Philippine Council for Industry and Energy Research and Development (PCIERD) is one of the sectoral planning councils of the Department of Science and Technology (DOST). It is mandated to serve as the central agency in the planning, monitoring and promotion of scientific and technological research for applications in the industry, energy, utilities and infrastructure sectors. It has the authority to set and specify research and development (R&D) goals and priorities and rationalize the allocation of available resources for its delineated sectors. (www.dost.gov.ph). To date, PCIERD is considered as the leader in policy formulation, planning and programming of national S&T activities for the industry, energy particularly in alternative energy sources, utilities, and infrastructure sectors.
	1.2 The Department of Agriculture-Bureau of Agricultural Research (DA-BAR): The Bureau of Agricultural Research (BAR) was created by virtue of Executive Order 116 signed in 1987. It is mandated to ensure that agricultural research are coordinated and undertaken for maximum utility to agriculture. The EO requires the Bureau to tap farmers, farmers' organizations and research institutions especially state colleges and universities (SCUs) in the conduct of research for use by the Department of Agriculture (DA) and its clientele (www.bar.gov.ph). The main function of DA-BAR is to coordinate and provide funds for research and development activities with in connection with agriculture. In addition, it is also involved in developing partnerships with local and international research organizations, strengthens institutional capabilities, and manages knowledge and advocate policies towards improved governance and progressive agricultural and fishery sector.
	1.3 The Department of Energy (DOE): The Department Energy is mandated by RA 7638 (Department of Energy Act of 1992) to prepare, integrate, coordinate, supervise and control all plans, programs, projects and activities of the Government relative to energy exploration, development, utilization, distribution and conservation (www.doe.gov.ph). In addition, the department is tasked to improve the quality of life of the Filipino by

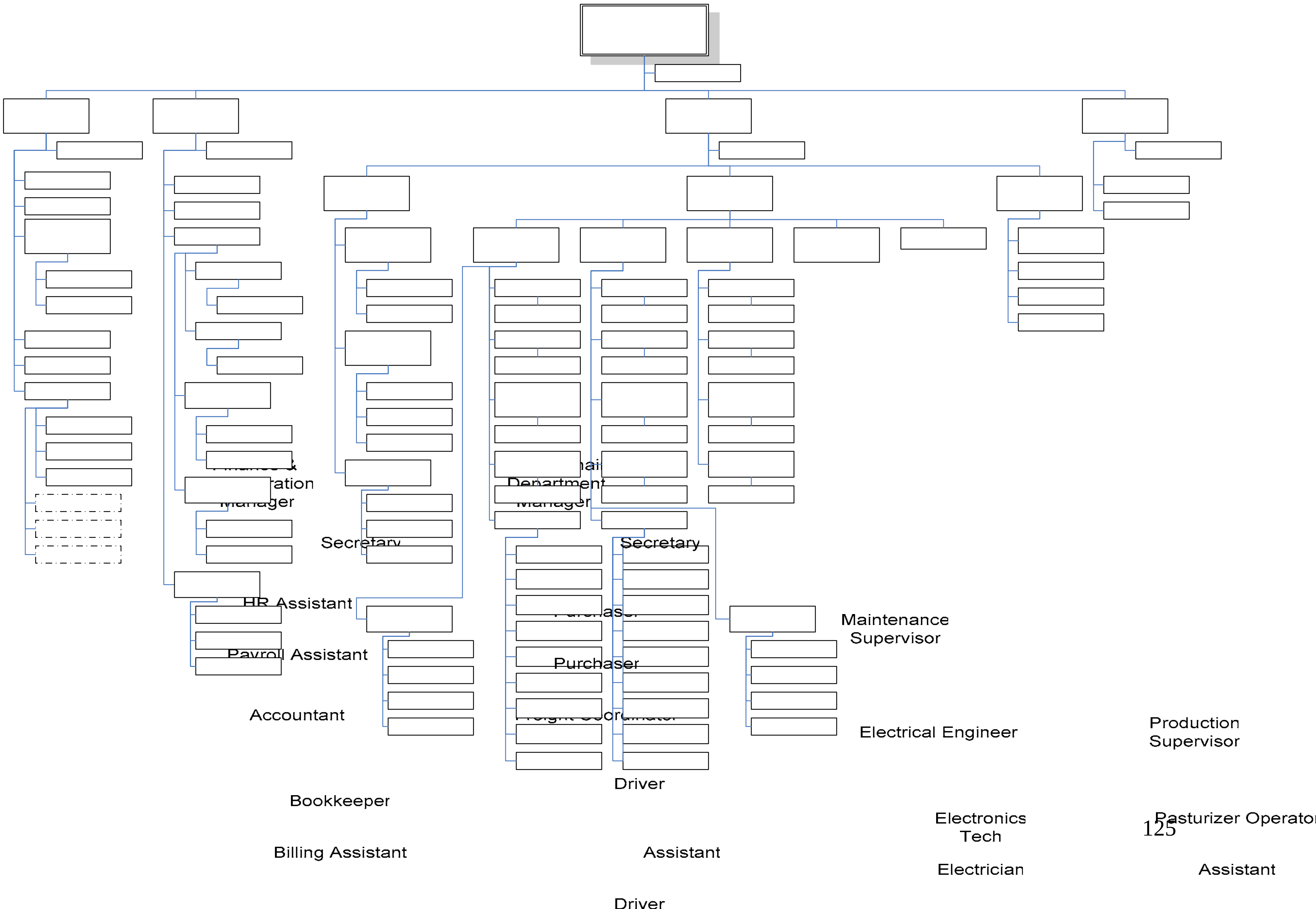
	formulating and implementing policies and programs regarding petroleum, power, oil etc. Currently, DOE is concentrating its efforts to implement the alternative fuel program which includes the development of fuel from renewable sources which will act as a substitute for traditional fuel. The program is being implemented to reduce our dependence on imported oil and to provide cheaper and safer alternatives to fossil fuels. In addition, locally-sourced products will be used as feedstock for the production of alternative fuels (bioethanol, biodiesel etc.). With the development of alternative fuels, the Philippines will be secure of its energy needs in the long run leading to sustainable development of the country.
2.0 Seed Supply	**2.1 Quarantine:** The Philippines has not yet developed a sweet sorghum seeds laboratory that can provide farmers with quality seeds at the commercial scale. Currently, the country is still importing sweet sorghum seed particularly from India since the Philippines is in the process of developing and testing a number of sweet sorghum seed varieties through several State Universities and Colleges (SCUs), Plant quarantine is considered a process which provides a legal and safeguard activity to ward off exotic and undesirable pest and diseases. Plants and seeds to be imported or exported are subjected to quarantine. The plant quarantine service was mandated by government, with the Bureau of Plant Industry as the enforcement agency (Plant Quarantine Law of 1978), to prevent the introduction of foreign pest and diseases into the country as well as to regulate the importation of seed.
	2.1.1 The Plant Quarantine Services The BPI's plant quarantine services include inspection, laboratory examination, post entry monitoring and clearance at seaports, airports, mail exchanges, quarantine stations and authorized premises. Plant quarantine is also a response to the introduction of exotic pest and diseases. And it helps by providing information to exporters on agricultural crops and products about the kinds of pests or diseases in the crops to be exported. And lastly, quarantine is considered the frontline defense against the entry of pest and diseases.
	2.2 Seed Certification Seed certification is a process in which seeds of superior varieties are grown under supervision and quality testing to

	ensure its genetic identity, maintain varietals purity and meet certain quality standards before being distributed to farmers. It is considered a tool for producing genetically pure, good quality seed of improved variety. It means that certain quality standards / requirements are fulfilled (Douglas, 1980). This process is approved as part of system for quality control of seed multiplication and production and consists of field and bin inspection, pre and post control tests and seed quality tests (FAO, 1969, Delonche and Potts, 1971). Seed certification is done after the seeds are subjected to laboratory inspection, examination and treatment. Generally, the main purpose of seed certification is to uphold the superior quality of seeds e.g. presence of weed seeds, other crop seeds, seed borne diseases, viability, mechanical purity and to make it available to the farmers by ensuring seed supply. Issuance of a phytosanitary certificate is an indication that the seeds have been certified by the certifying organization. There are several known Seed Certifying Organizations in the Philippines but the primary organization is the BPI-NSQCS. This agency implements seed quality control procedures for the certification of government seed farms and private seed growers. BPI-NSQCS adheres to seed testing and other seed quality standards determination through its Regional and Satellite seed Testing Laboratory. The agency has certified seed inspectors who conduct field and seed inspection and SQCS personnel who are in charge of the seed lot verification sampling. In addition, there are private seed certifying agencies such as private seed producers.

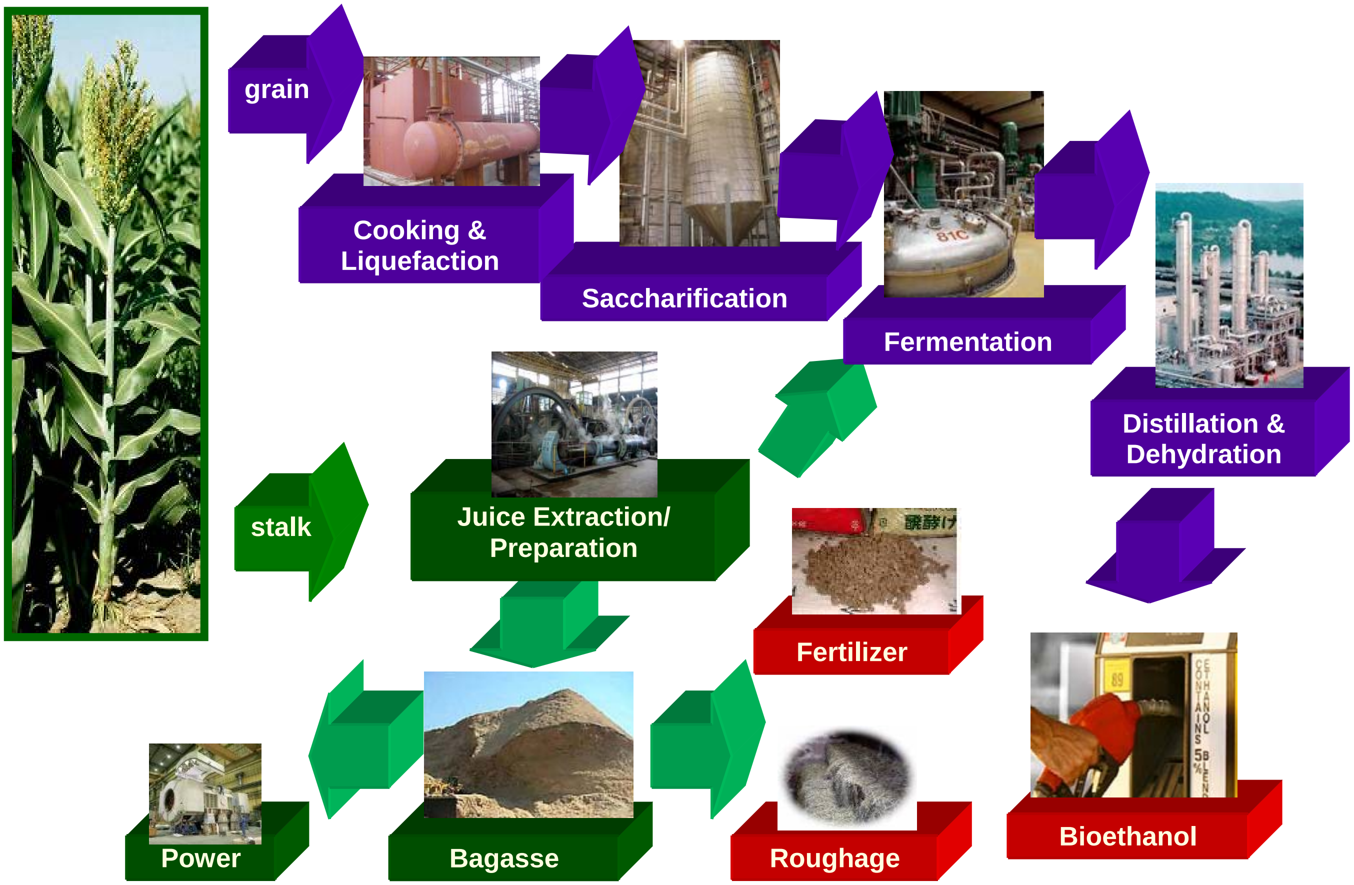
Appendix 37. Projected Implementation Schedule



Appendix 38. Sample Table of Organization for Sweet Sorghum Distillery



Appendix 39. General Process Flow. Production of Ethanol from Sweet Sorghum



Appendix 40. Listings of the different kinds of support provided in selected countries.

Thailand	Thailand relies on 90% import of oil for its fuel requirement. It created the National Ethanol Development Committee to oversee the implementation of its bioethanol production program. Promotes the use of cassava, sugarcane and rice as feedstock. Ethanol is to replace methyl-tertirary-butyl-ether (MTBE) as octane booster of gasoline. The government mandates the blending of 10% bioethanol to gasoline. Government incentives include zero excise tax on gasoline blended fuel, exemption from paying the State Oil Fund and Energy Conservation Fund, promotion incentives from its Bureau of Investment (BOI), zero tariff on imported equip0ment and machineries related to bioethanol feedstock production and processing, and a corporate tax holiday of 8 years. The estimated cost of bioethanol-gasoline blend is lower by 0.70 – 1.0 baht/li (US$0.01 to US$0.02) than gasoline.
India	Its transport sector accounts for more than 50% of its fuel oil consumption. In 2002, the Indian government mandated nine states and four federally ruled areas to sell E5 by January 2003. The main source of feedstock will come from sugarcane because production glut of sugar and molasses. Other type of feedstock considered is sweet sorghum Rusni distillery plant at Hyderabad, India the only distillery plant using sweet sorghum as feedstock started operating on October 2006. Bioethanol producers are exempted from paying excise tax and sales tax. However, this varies from state to state.
China	The State Planning and Trade Commission and the State Development and Manning Commission promote the use of use of ethanol in China. The country has the largest fuel ethanol plant in the world, the Jilin Tianhe Ethanol Distillery win an initial capacity of 2.5 mMli/day. In 2002, a 300,00 ton/year bioethanol plant was constructed in Nanyang, Henan province with a total investment cost of US$155 M. The capacity of the plant could expand to 500,000 tons/year in the future. Blending of bioethanol to gasoline is not mandated.
Australia	In 2002, government channeled some production of sugarcane production to bioethanol because of declining price of sugar in the world market. Provided excise tax exemption to bioethanol manufacturers in 2000 but was later replaced by an ethanol production subsidy which raises the cost of importing ethanol. The government mandated an E10 blending for transport fuel. The government also extended an AUD$50 M support package to the transport fuel industry for developmental works in bioethanol promotion.

Brazil	The price of fuel bioethanol has become competitive with gasoline due to economies of scale in operation, improvement of processing technology and productivity increases in the production of sugarcane using new developed hybrids and farm production technology. The government provided price support as an incentive for businessmen to invest in the industry. In 1999, assured that the industry has attained stability government liberalized the prices of alcohol. Bioethanol fuel gained a price advantage over gasoline of at least 33% since the liberalization of prices. By 1988, it had a larger market share than gasoline in the transportation sector. From a span of 9 years that is from 1972 go 2002, fuel bioethanol displaced 210 billion liters of gasoline valued at US$52 billion. Aside from providing the requirement of the domestic market, the industry also generated export earnings from excess production. The export of bioethanol in 2003 peaked at 770 million liters in mostly in the form of beverage and industrial alcohol. With the removal of the price subsidy, government concentrated on the regulation of anhydrous-gasoline blend rates. Blend rates range from E10 to E30 for standard transport vehicles. With the development of bioethanol fuel dedicated designed cars, E100 which an outright substitution of gasoline with bioethanol was introduced.
Other South American Countries	Peru, Colombia, Costa Rica, Jamaica and El Salvador are just some of the South American countries that have entered the global industry of bioethanol. Peru has its Mega-project aimed at transforming 240,000 hectares of the central jungle in the north of Peru into a sugarcane producing center to supply the feedstock requirement 20 bioethanol distilleries. A pipe will connect the jungle to the port of Bajovar to facilitate the transport of export of the product to the US through California. It expects to achieve a 1.2 billion liters export by 2010. Colombia has mandated its transport sector to use E10 blend since 2001. While Costa Rica, Jamaica and El Salvador export bioethanol to the US under the Caribbean Basin Economic Recovery Act.
United States	It is the second largest producer of bioethanol in the world. The feedstock is mainly corn. It is working on the commercialization of cellulosic derived alcohol which it regards as the future of bioethanol production. The Clean Air Act and the Renewable Fuel Standards (RFS) triggered the adoption of bioethanol as gasoline blends. The

	Clean Air Act created a captive market by banning the use of MTBE as oxygenate of gasoline. As of 2004, California, New York and Connecticut are some of the states that banned the use of MTBE. The RFS legislation required renewable fuel to grow to 20 billion liters by 2012. This target could be surpassed with the recent announcement of the Bush administration to reduce the US's dependence on oil by 20%. Aside from a captive market, the US government provides a credit and trading program to refineries to meet the targeted production requirement. Moreover, it gives special promotion programs for biomass fuel.
Canada	Some provinces have started implementing the Canadian bioethanol production development program. The government mandates an E10 to achieve a 35% market penetration by 2010. Saskatchewan and Manitoba were the first to implement this program. As an incentive to manufacturers tax breaks of CAD$0.15 per liter and CAD$0.25 are extended by Saskatchewan and Manitoba, respectively to bioethanol manufacturers.
European Union	The EU in 2003 directed its member states to achieve a 2% share in bioethanol related researches by the end of 2005 and a 5.75% share by the end of 1020. This directive was followed by the declaration of exemption of ethanol from the tax on mineral and oil products. Spain, Sweden and France are the leading producers of bioethanol in the region. Industry experts project the EU to be a net importer of bioethanol.

Appendix 41. Sugarcane Production Costs.

Particular	Amount (PhP)
1. Land preparation	5,960.00
2. Planting	10,130.00
3. Replanting	2,650.00
4. Fertilization (1st and 2nd dose)	6,990.00
5. Cultivation and weed control	6,800.00
6. Pest control	1,360.00
7. Drainage	960.00
8. Harvesting	7,800.00
9. Miscellaneous, 10 man-days	1,200.00
TOTAL	**43,760.00**

Appendix 42. Listing of Useful Contacts.

1. A. R. Palaniswamy, Managing Director
   Rusni Distilleries Pvt. Ltd.
   Office: 383 HIG, BHEL, R.C. Puram, Hyderabad – 502032 Andrah Pradesh, India
   Plant: Mohammed Shapur(V), Sanaga Reddy, Medak, Andrah Pradesh, India
   Tel: +91 40 23026800/23025310
   Cell: +91 98663 16124
   E-mail: rusnispirit@rediffmail.com
   Service: Distillery design and general contracting

2. Gerry Tee, Vice President for Operations
   Center for Alcohol Research & Development Foundation
   7th Floor, Allied Bank Center
   6754 Ayala Avenue, Makati City
   Tel: +63 2 893-3555
   E-mail: gerrytee@tanduay.com
   Service: assistance on ethanol production and distillery waste management

3. Buddy Arinzol
   Alfa Laval Philippines Inc.
   3rd floor, Molave Bldg,
   2231 Pasong Tamo Makati City
   Philippines
   Tel: +63 2 812 7596
   Fax: +63 918 913 7553
   E-mail:. buddy.arinzol@alfalaval.com
   Service: Distillery design and general contracting

4. Mark Taylor
   Ethanol Product Manager

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Norman House Friar Gate Derby DE1 1NU England
Tel: +44 (0)1332 636000 ext 6031
Fax: +44 (0)1332 636020
E-mail: marktaylor@fletchersmith.co.uk
Service: Cane/stalk handling and juice extraction mills

5. BIOTECH
   University of the Philippines - Los Baños
   College, Laguna, Philippines
   Tel. +63 49 536-2721/536-1620
   http://www.uplb.edu.ph/admin/ovcre/biotech
   Service: yeast research and development, pure strains supply

6. Prof. Rex Demafelis, Department Chairman
   Department of Chemical Engineering
   College of Engineering and Agro-Industrial Technology
   University of the Philippines - Los Baños
   College, Laguna, Philippines
   Tel. +63 49 536-2315 (telefax)
   E-mail: rbdema@yahoo.com
   Service: distillery design, research and development

7. Dr. Arsenio N. Resurreccion, Director
   Institute of Agricultural Engineering
   College of Engineering and Agro-Industrial Technology
   University of the Philippines - Los Baños
   College, Laguna, Philippines
   Tel. +63 49 536-3606 (telefax)
   Service: Comprehensive agricultural engineering services

8. Simon Qian
   ZHANGJIAGANG PIOTECH CO., LTD
   1007, SHIYOU BUILDING, ZHANGJIAGANG CITY,
   JIANGSU, CHINA
   FAX: 86 512 58979062
   E-mail: qld21@pub.sz.jsinfo.net
   Service: Gluco and alpha amylase supply

9. Armand Fernandel
   Unioil Philippines
   Sta. Ana, Manila
   Tel. (02) 564-1991
   Fax: (02) 564-4486

10. Ito Cabaero, Depot Manager
Caltex Philippines
6750 Ayala Avenue, Ayala Centre, Brgy. San Lorenzo, Makati City
Tel.: (02) 813-6013/ (02) 830-8301

10. Carl Posadas, Fuels Brand Manager
Shell Philippines
156 Valero St., Salcedo Village, Makati City
Trunkline: (02) 816-6501
Fax: (02) 816-6565
Toll free number: 1-800-10000-1111

11. Andrew Tan, Petron Corplan
Petron Philippines
368 Senator Gil Puyat Avenue, Salcedo Village, Petron Mega Plaza, Belair, Quezon City
Tel.: (02) 886-3888

12. Tanya Samillano
Flying-V Philippines
Columbia Tower Unit 96, 9th flr., Ortigas Avenue, Mandaluyong City
Tel.: (02) 721-0175; (02) 726-7640;
Fax: (02) 723-3379; (02) 727-6044

13. Rey Jimenez
Seaoil Philippines
Ground Flr., Meridien Bldg., #29 Annapolis St., Greenhills, San Juan, Manila
Tel.: (02) 723-5272