ENHANCING THE VIABILITY OF CASSAVA FEEDSTOCK FOR BIOETHANOL IN THE PHILIPPINES

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ABSTRACT

This paper discusses the potential of cassava as a source of feedstock for bioethanol and the major policy considerations for developing the industry. The paper provides some recommendations on enhancing the viability of cassava as source of bioethanol in the Philippines. Cassava has been identified in the Biofuels Act of 2006 as one of the possible sources of feedstock for bioethanol in the Philippines. However, as the paper explains, there are certain important concerns that need to be addressed for the project to be viable. These include the market, productivity of cassava production, cost of cassava feedstock in comparison with other feedstock sources, potential production areas, production technologies, feedstock supply arrangements between feedstock producers and processing plants, incentives for industry players, and impact on the environment.

Key words: Biofuel, market, policy

INTRODUCTION

The Biofuels Act of 2006 (RA9367) which was signed on January 12, 2007 mandates 5% and 10% bioethanol blending on February 6, 2009 and 2011, respectively. This corresponds to 269 ML and 594 ML ethanol for 2009 and 2011, respectively. The main intention of the law is to reduce the dependence of the country on imported fossil fuel and cushion it from the erratic price fluctuations as well as ensure the availability of clean energy which can lead to reductions in Greenhouse Gas (GHG) emissions. Ethanol (CH_3CH_2OH) is a flammable, colorless, slightly toxic chemical compound commonly found in alcoholic beverages. This can be produced from plant material or petroleum. Ethanol derived from crops is called bioethanol in order to distinguish it from that which is produced synthetically from petroleum. The provisions of said Biofuel law of the Philippines include incentives to investors in enterprises that will be involved with production, distribution and use of locally produced biofuel. The specific tax on local or imported biofuels component of the blend per liter of volume is zero given that the local or imported bioethanol is denatured into bioethanol fuel. The value added tax on the sale of raw material used in the production of biofuels is also zero up to 5 years Income Tax Holidays. Another incentive provided by the law is that the water effluents from the production of biofuels which was used for the purpose of reuse, e.g. distillery slops used as liquid fertilizer and other agricultural purposes, will be exempted from wastewater charges (Biofuels Act of 2006).

Among others, one of the crops mentioned in the Biofuel Act as a possible source of biofuel is cassava. Would it be feasible to tap this crop for biofuel given all these incentives? This paper discusses the potential and current constraints of utilizing cassava as a possible source of feedstock for bioethanol production and the possible approaches to relaxing these constraints. Specifically, it discusses issues related to the supply of cassava, market arrangements, energy requirement for processing, financial viability and environmental considerations.

METHODOLOGY

This paper is based on the results of a study on the feasibility of using cassava as feedstock for bioethanol in the Philippines. The first part of the study involved the determination of the best practices for the production of cassava for ethanol production followed by the determination of best processing performances adaptable in the Philippines, specifically in the identified areas of the prospective investors. Technical, manpower and cost requirements for setting up the processing plant and the cassava plantation were also determined. Finally, the financial and sensitivity analyses were undertaken to determine the economic viability of producing ethanol from cassava. The study considered three cases for the economic viability study: a) the viability of cassava tuber production both for corporate farming and joint venture business arrangements (Case 1); b) the viability of the processing cassava tubers into bioethanol (Case 2), and; c) the viability of an integrated feedstock production and bioethanol processing plant (Case 3). The potential of the project for energy recovery and utilization, and for earning carbon credits within the Clean Development Mechanism under the Kyoto protocol were also considered in the study.

The study team visited Eastern Petroleum cassava plantation in General Santos City and Bago Distillery, Incorporated in Negros Occidental for the purpose of collecting the required information and verifying data. The analysis of the data was the basis for identifying the constraints in production, processing and marketing and opportunities as well as the approaches to addressing these constraints and exploiting the opportunities.

RESULTS AND DISCUSSION

Cassava as Potential Feedstock

In the Philippines, cassava has for a long time primarily been cultivated for food and in smaller but increasing quantities, for animal feed and other industrial products. The crop is relatively typhoon and drought-resistant, and requires minimum crop maintenance. Cassava tubers can also be chipped, dried and stored for utilization during periods of lean supply. In areas with evenly distributed rainfall, cassava can be harvested all year-round. More recently, it has gained importance as a possible fuel commodity not only in the Philippines but also in China, Thailand, Indonesia, and other countries which have more advanced national biofuel programs.

Cassava can survive in a wide range of soil types but grows best in deep, fertile and well-aerated soils although it can give fairly good yields in poor soils provided it is not water-logged. Well-drained soil is very important when engaging in cassava production. Sandy loam or clay loam soil is ideal for cassava since this will enable better root development and ensure quality tubers. Hard soils on the other hand frequently cause tuber deformation and difficulty in harvesting. The crop may be grown in plain to rolling terrain. However, growing cassava in sandy soils of hilly topography must be provided with practices that will minimize soil erosion to maintain the soil productivity. Soil pH range of 5.5-6.5 is needed by the crop but it can tolerate acidity rather than salinity. Cassava can grow in areas with ambient temperature of 25-30 °C and in places with as high as 5000 m. The optimum annual rainfall requirement is 760 to 1,015 mm and grows very well in areas with more or less evenly distributed rainfall throughout the year. However, it can grow with as low as 500 mm annual rainfall. In areas with distinct wet and dry seasons, planting is best done at the start of the rainy season. Cassava can tolerate prolonged drought except at the early stage of development. Drought stress can cause shedding of older leaves and arrested growth. Sufficient moisture however must be available during the establishment period. Although yield may be affected, the crop can adapt in places where rainfall is low since it has the ability to utilize nutrients from the stalk and storage roots once moisture is restored.

Table 1 shows the estimates of the cost of ethanol derived from different types of feedstock (DA-BAR, 2007). Average costs of feedstock per liter of ethanol from molasses and corn are quite high, while those using sweet sorghum is comparable to that of sugarcane. In comparison, feedstock from cassava can be the most expensive among the major feedstock depending on prevailing prices of tubers or derived products, as well as in the form the cassava products are used. Cassava used for food and other related preparations are generally purchased at a higher price than those used for industrial purposes. Potentially however, cassava can be inexpensive and be the cheapest source of starch-based feedstock for bioethanol production given its very high starch-to-sugar conversion ratio.

Table 1. Feedstock cost comparison, cost/liter, Philippines, 2004-2005.

Feedstock	Price (PhP/MT)		Liter/ha	Feedstock Cost (PhP/L)	
	Min	Max	/year	Min	Max
Sugarcane	1,000	1,100	6,120	13.89	15.28
Molasses	4,500	5,400	806	19.06	22.62
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	20.9
Cassava	1,500	5,800	5,549	8.38	32.4

In 2006, the total cassava production area in the Philippines was estimated at 204,678 hectares with a production volume of 1,756,854 metric tons (BAS, 2007). The national average yield was only 8.6 mt/ha/yr. This may be attributed to the fact that the crop is traditionally grown with minimal farm inputs. Potentially, the yield can be increased since cassava is very responsive to fertilization and irrigation. Data from multi-location or regional tests of the National Seed Industry Council show for example that average yield of cassava, particularly those of improved varieties, can reach up to 20 to 40 tons/ha/yr. With such high feedstock yield levels, ethanol yield from cassava becomes comparably better than those from other feedstock such as sugarcane or sweet sorghum.

Cassava productivity can also be greatly enhanced through the adoption of appropriate cultural management practices, the utilization of high yielding, adapted crop varieties and improved harvesting and processing techniques. Improved production efficiency leads to reduced cost of production and consequently to lower feedstock cost.

Potential Areas for Growing Cassava

There are six provinces that have been identified in the study as best suited for growing cassava for feedstock production (Table 2). The topography of the target areas varies from predominantly plain to mountainous. The sites mostly fall under the Type IV climate classification with uniform rainfall distribution throughout the year. Soil types range from sandy to clay but are predominantly sandy loam.

Table 2. General topography, climatic and soil characteristics of cassava target sites, 2008**.**

Target Area	Topography	Soil Type	Climate
Saranggani	Plain to Rolling	Sandy Loam to Clay Loam	Type IV
South Cotabato	Mostly Rolling	Loam to Sandy Loam	Type IV
Sultan Kudarat	Mostly Rolling to Plain	Sandy Loam to Loam	Type IV
Misamis Oriental	Undulating to Hilly	Clay to Sandy Loam	Type II & III
General Santos	Mostly Plain	Sandy Loam to Silty Loam	Type IV
Zambales	Plain to Rolling	Mainly Sandy	Type I

The common characteristics of these areas that make them ideal for producing cassava include low propensity for typhoons, mostly plain to undulating topography, well drained soils, well distributed rainfall, the large enough area for growing cassava and high productivity. The yield per hectare of these target areas range from 11.8 to 22.2 MT/Ha, which is higher than the national average productivity of 8 MT/Ha. Zambales, however, has a low yield of 5.8 MT/Ha. Other potential production areas for cassava production include the provinces of Bukidnon, Negros, North Cotabato and Davao. Many of these provinces have comparable physical characteristics as the target sites described above and have been traditional growing areas for cassava. Production hectarage of cassava in Bukidnon is around 6,460 hectares with an annual production volume of 131,048 MT. Average yield is one of the highest at 20.3 MT/Ha. Negros Occidental and Negros Oriental are planted to 3,065 hectares and 2,750 hectares of cassava, producing 26,191 and 10,048 MT per year, respectively. Average yields however are quite low at 3.6 to 8.8 MT/Ha. North Cotabato is planted to around 910 hectares producing around 8,863MT annually; yield levels average 9.7 MT/Ha. Cassava plantations in the Davao Region provinces of Davao Oriental, Davao Sur and Davao Norte are around 356, 772 and 444 hectares, respectively, contributing 2,185 MT/yr, 884 MT/yr and 3,110 MT/yr, respectively. Average yields range from 6 to 7 MT/Ha.

A good number of the potential cassava growing areas mentioned above are also planted to large sugarcane fields making them all the more suitable for cassava growing. Moreover, most of these provinces have Agrarian Reform Communities (ARC's) covering numerous municipalities. Establishing plantations in ARC's particularly under the joint venture or contract growing agreements is advantageous due to the existence of beneficiary organizations supervised by the provincial offices of the Department of Agrarian Reform. In Region XII, there are around 72 ARC's covering 202 barangays in the main target production site for cassava feedstock production.

A key factor to consider in the selection of plantation areas is proximity to where the produce will be conveyed for processing. The production sites to be developed should as much as possible be contiguous and located near the processing plant. The location of primary processing centers should allow the chipping and drying of harvested tubers without delay. Primary processing and storage sites should also be located such that the cost of inbound transport to the distillery site is minimized. The road infrastructure connecting the plantation sites to the primary processing facilities and the distillery plant should be adequate enough to facilitate the delivery of the feedstock.

Production of Cassava

There are three major considerations in the production of cassava, namely, the production arrangements, plantation area requirements and establishment and cassava varieties and cultural management technologies.

Contract arrangements for producing cassava and cassava chips are very important to ensure the continued supply of feedstock for the processing plant. There are two possible contract arrangements between the distillery company and the farmer-landholder that may be considered, the corporate farming system and the joint venture agreement. These production agreements allow the distillery plant to manage the supply chain and minimize risks of their investments. These arrangements were determined through plantation visit to Eastern Petroleum in General Santos City.

Under a corporate farming setup, the company arranges for a long term lease of 10 to 25 years with the landholder. Increase in lease rates of 1 to 2% per year are reasonable standard provisions. In almost all cases, the corporation also provides priority employment to the farmer landholders and their immediate relatives. This corporate farming arrangement is advantageous to the company as it allows full control of the management and operation of the collective landholdings ensuring continued farm production. However under this arrangement, the wages are fixed and do not provide incentives for increase in productivity. In addition, appropriate measures to prevent or minimize incidences of pilferage can be a major consideration in large plantation areas.

In the Joint Venture scheme, farmer cooperatives or clusters provide land and labor for the production of cassava. The company operating the processing plant provides the technical support, planting materials, agro-chemicals and other production inputs. Upon harvest of the produce, farmers get 30 to 40% of the profit and the rest retained by the company. This scheme provides a less rigid corporate structure and might prove more acceptable to small farmer-landholders. Also, farmers are encouraged to improve productivity since their income is based on the partnership's profit. Disadvantages of such a business arrangement are the increased possibility of diverting harvest (pole-vaulting) and pilferage when the current market price of the produce is very high. There is also no assurance of continued supply of feedstock, as the company has no long-term control over landholding.

The ethanol processing plant may also explore other production arrangements other than the ones described above to augment its requirement for feedstock. These involve purchasing cassava under a Contract Growing or Direct Purchase agreement. With this arrangement, the company agrees to pay a fixed price per kg of fresh cassava roots produced by the farmers. Under these schemes, the grower rather than the company will have a direct hand in the production of feedstock. A major disadvantage of these agreements however is that there is no assurance of a continued supply of the feedstock for the operation of the processing plant.

An assortment of contract arrangements may be explored and modified to suit the interests of both the company and landholder. Any agreement made however should assure the distillery company of sufficient raw materials so its processing plant can maintain a certain minimum level of operation. It is also essential that concerned government agencies make certain that the terms and conditions of the agreements between the farmer-landholders and corporation are justly implemented.

The plantation establishment should be given utmost priority considering that they will be the source of planting materials for the cassava plantations and at the same time feedstock for the ethanol plant. Planting should start in areas nearest to the processing plant and progress towards the farthest area. Due to the scale of the production area, it would be practicable to divide the area into two or three sub-areas depending on the contiguity and number of production farms in each contiguous site.

The other consideration is the choice of cassava varieties to grow that determines to a large extent the potential yield of harvested produce. Presently, cassava varieties are generally classified according to their use namely: (1) for food, (2) for animal feed and (3) for starch production. Varieties for food and feed must be low in HCN while those used for starch or ethanol production must be high in starch content. Recommended varieties of cassava approved by the National Seed Industry Council (NSIC) are ideal for various industrial uses because of their potentially high root yield and high root dry matter and starch contents. Factors usually considered when selecting varieties include: (1) high adaptability to the locality (2) high fresh yield (3) early maturity and (4) good storability.

The National Seed Industry Council (formerly Philippine Seed board) has recommended more than forty varieties of cassava for commercial production (DA-BPI 2003, 2004 and 2005). Majority of these varieties have high yield and produce roots with high dry matter and starch contents. However, the planting materials of most of these varieties are very limited in availability with only very few popular varieties multiplied for use in existing industries.

Established and proven technologies for cassava production for food and industrial uses have been developed by various government agencies, research institutions, private corporations and other industry stakeholders. Information and communication materials in various forms have been published to disseminate these technologies to target end-users (PCARRD 1983a and 1983b; PRCRTC, 2007; NOMIARC, 2007 and IPB-CSC, 2008). These technologies generally promote the use of good quality planting materials of high yielding varieties, optimum farm input and integrated pest management (IPM) under monoculture cropping and various intercropping systems. The production technology to be used in the feedstock production venture should take into account the above recommendations while also considering current production schemes specifically suited to the target sites.

Processing Schemes

There are two schemes considered for the primary processing of cassava into chips. The first scheme assumes a corporate farming system arrangement where the land is leased or owned by the company. This is characterized by the integration of all operations under a processing plant manager in close collaboration with the production manager. One main advantage of this scheme is the total control of the operation, and avoids dealing with individual farmers. The quality of the product is also expected to improve as all the operations are being handled in the plant. The major constraint of this scheme, however, is the selection and availability of the required 10,000 hectares for the project.

The second scheme, joint venture agreement, utilizes a middleman to undertake the washing, peeling, chipping and drying of cassava. The consolidator is in direct contact with the farmers. He may be required to support the farmers in terms of production inputs in exchange for the guarantee of selling their harvest to him. The consolidator sells the dried chips to the plant. The plant stores the dried chips and mills it into cassava flour as required by the secondary processing section. The main advantage of this scheme is the close collaboration between the consolidator and farmers. It is assumed that each consolidator will deal with about 50 farmers with about 5 hectares of land holdings each for a total of 250 hectares. The whole project will manage 40 consolidators for a total of 10,000 hectares. The consolidator will benefit from the business with the value addition from processing freshly harvested cassava into dried cassava chips. Financing the equipment capitalization might be shouldered by the project or by financing institutions such as DBP and/or Landbank of the Philippines.

Based on the results of the financial analyses of the alternative production and processing schemes, the corporate farming scheme seems to be a better business arrangement than the joint venture scheme. This is possibly so because of the efficiencies associated with larger scale production. (Table 3). The minimum viable price for the cassava chips processing by consolidators, bioethanol processing from cassava chips, and bioethanol processing from an integrated feedstock production and bioethanol processing from cassava are also presented in Table 4. The financial analysis of the different production arrangements were used as basis for determining the prices.

Table 3. Comparison of corporate farming and joint venture business arrangements.

Case 1. Cassava Plantation	Corporate Farming	Joint Venture
Area Requirement for full production (Ha)	10,000	10,000
Tubers Yield (kg/Ha)	20,000	20,000
Land Rental (Php)	4,000	-
Farmer's Share (%)	-	20
Tubers Minimum Viable Price (Php)	2.83609	2.85926
Percent Mark-up	55.25	75.76
Cost of Goods Sold per Unit (Php/kg tubers)		
Direct Material	0.31	0.31
Direct Labor	0.98	0.98
Overhead Cost	0.55	0.35
Total Cost of Sales	1.83	1.63
Selling and Administrative Expenses	0.03	0.03
Interest on Loan	0.20	0.32
Total Cost	2.07	1.98
Fixed Capital Investment (Php)	85,339,936	85,339,936
Working Capital (Php)	455,652,896	406,052,896
Total Project Cost (Php)	540,992,832	491,392,832
Financial Indicators		
Average Net Income (Php)	104,050,093	93,788,939
Return on Investment (%)	19.23	19.09
Internal Rate of Return (%)	12.00	12.00
Payback Period (yrs)	6.23	6.25
Net Present Value (Php)	5,290	1,844

Table 4. Minimum viable price of cassava chips and bioethanol from cassava, 2009.

	Price	Unit
Cassava chip processing by consolidators	12.9121	Php/kg
Bioethanol processing from cassava chips	50.9058	Php/L
Integrated bioethanol processing*	51.9471	Php/L

*Bioethanol Production from Corporate-run Cassava Feedstock Production and Bioethanol Processing
Source: DA-BAR, 2008.

The Market

The signing of Republic Act 9367 that mandates the phasing out of the use of harmful gasoline additives and/or oxygenates and that all liquid fuels for motors and engines sold in the Philippines must contain locally sourced biofuels components has provided a very good market opportunity for the Philippines. In addition, the rising prices as well as the uncertainty of supply of oil and the increasing greenhouse gas emissions has made timely the shift in the energy mix towards the use of cleaner indigenous renewable energy. The rising oil prices shall continue not only because of depletion of reserves but also because of the continuing political instability in the Middle East. The domestic as well as foreign markets such as Japan, Taiwan, and South Korea are the possible markets for Philippine bioethanol. With the enactment of the Biofuels Law, there is already a captive domestic market for bioethanol as a transport fuel.

Given the Biofuel Law, the Department of Energy (DOE) projects that the country will need in 2009 about 223 million liters of bioethanol for the transport sector alone to comply with the 5% blending of bioethanol. By 2011, this ethanol requirement will increase to 482 million liters to 537 million liters by 2014 (Table 5).

The Philippines has a huge potential for producing different crops such as sugarcane, corn, sweet sorghum, and cassava that are suitable sources of feedstock for bioethanol production. Only sugarcane however can be a locally sustainable source of ethanol for motor fuel. Ethanol produced from sugarcane feedstock is the major competitor of the ethanol produced by the proposed project utilizing cassava feedstock. The bagasse from sugarcane can be utilized as renewable source of fuel for the distillery's boilers, thus minimizing the use of bunker oil. Ethanol coming from distilleries with excess capacities and cheaper ethanol coming from other countries are potential competitors to ethanol produced from cassava feedstock.

At present, at least four companies have signified their intention to use cassava as feedstock for bioethanol production. The target areas for cassava production include the provinces of: Saranggani, Zambales, South Cotabato, Sultan Kudarat and Misamis Oriental, and the City of General Santos.

Table 5. Bioethanol demand projections for the year 2006 –2014.

Year	**Projected Gasoline Demand* (In Million Liters)**	**Mandated Blend**	**Bioethanol Requirement (In Million Liters)**	**Forex Savings** (Php Million)**	**Value of Ethanol Production (Millions of Pesos)*****
A	B	C	D = B x C		
2006	3,892	0			
2007	4,091	0			
2008	4,274	0			
2009	4,457	5%	223	9,361	6,018
2010	4,639	5%	232	9,742	6,264
2011	4,823	10%	482	20,255	13,022
2012	5,006	10%	501	21,026	13,516
2013	5,188	10%	519	21,788	14,008
2014	5,371	10%	537	22,559	14,502

Source: Philippine DOE
Notes: * Based on 2006 Philippine Energy Plan (PEP) Update
** Based on current pump price for gasoline, Php 42/liter (September 2007
*** At a distillery price of Php 27.00 per liter of ethanol

A number of bioethanol companies are still in the process of planning and land acquisition and expected to start operations in 2011. New entrants in the market mean additional ethanol production capacities and represent new competitors in the industry. Competition is expected to become intense when the national ethanol requirement shall have been exceeded.

POLICY RECOMMENDATIONS FOR ENHANCING VIABILITY

There are three major factors affecting the viability of producing bioethanol from cassava feedstock in the Philippines. These include the size of the market for bioethanol, the productivity of cassava and impacts on the environment.

The size of the market for bioethanol and the competitiveness of cassava feedstock with other sources of feedstock are major consideration for tapping cassava as a possible source of bioethanol. The market is well defined and in fact with the passage of the biofuels law, this market can be considered as a captive market which eventually will be a protected market come February 7, 2011. This is expected to expand over time given the provisions of the law that mandates that the blending proportions should be increased over time from 5% in the first two years during the implementation of the law and 10% within the first four years. Subject to availability of bioethanol, production blends may be increased. The law also mandates that this should be sourced locally. In addition to the captive local markets, the foreign markets are quite sizable and it would take time before their requirements are met. It is expected that over time, the competition will be more intense as the supply increases and the local and foreign requirements for biofuel are met.

The second consideration is the potential of cassava as a source of biofuel feedstock. This refers specifically to the sufficiency and sustainability of the supply of feedstock for the processing plant. The factors influencing these are as follows: (1) the potential yield of the varieties used for different biophysical conditions; (2) production scheme which should consider vertical integration to ensure the sustainability of feedstock supply for the processing plants; (3) the presence and condition of the access roads which has a significant effect on the eventual cost of the feedstock; (4) the cost of power generation; and (5) processing.

The viability of the ethanol distillery plant is dependent on increased net income that may be realized by increasing productivity and at the same time reducing per-unit production costs.

One of the key determinants of viability is the sustainability of the feedstock supply. To ensure continued supply of the feedstock, production should provide satisfactory income and economic incentives for the feedstock producer. The incentives can come in the form of increasing cassava productivity, getting a good price for their farm produce and a share in other potential income streams. Income sharing arrangement on the potential income streams such as derived from CDM, liquid fertilizer, and the like, should for example be established with feedstock suppliers in a binding legal instrument. Considering that bioethanol fuel in the Philippines is a captured and eventually a protected market by Feb. 7, 2011, purchase price formula for cassava has to be formulated to protect and maximize profitability of the feedstock suppliers.

Another major determinant is the improvement in the cassava production system which would enhance efficiency and profitability for both landholder-farmers and the processing plant. Well-established technologies are currently available to improve the productivity of cassava for food and industrial uses. These technologies generally promote the use of superior varieties, optimum cultural management practices and integrated pest management. The production technologies to be used in the proposed feedstock production project should take into account the above strategies while also considering traditional production schemes specifically suited to the target sites. Development of protocol for rapid propagation of cassava should be supported for mass participation of small farmers in the production of cassava for bioethanol. An estimated 50 million pesos is needed to start this program.

Different growing regions and production sites however may face different problems and limitations in the production of feedstock. As more marginal areas are utilized in an effort to expand production, there may be a decline in fertility levels. This however may be addressed by the application of higher levels of fertilization inputs and the use of suitable varieties adapted to the particular growing conditions. Bulk negotiated government purchase of fertilizer should be pursued as this will reduce fertilizer price to Php800.

The efficiency and profitability of cassava and feedstock production will be greatly enhanced by continuing research on cassava production and processing. Increased government funding for cassava R and D along with the support of private end-users should provide mutual benefits to growers and industry stakeholders. Government research investment on crop technology development should focus on interventions that would lower the high labor and input requirements of cassava production. Higher budget allocation for research on farm mechanization, cultural management and varietal development should be provided by government to increase yield, increase starch content and consequently increase ethanol productivity of cassava as feedstock. More directly, subsidies or tax exemptions for such high cost inputs as fertilizers and agro-chemicals as well as fuel for farm machineries would significantly help reduce farm production costs.

The expansion of areas for cassava production would be expected to result to certain positive and negative externalities arising from the effects on existing industries that may be affected by the newly introduced business enterprises. The generation of a large number of jobs is expected for populations along the target production sites and adjacent localities. However, this may also increase pressure on food demand and supply. Likewise, the increase in demand for utilities may increase the pressure on the use of common local resources such as water, labor and transportation facilities.

While there is a positive impact on labor employment, the availability of labor may be a foreseeable problem with more progressive growing regions. Much labor may be drawn from farm communities to the cities since more job opportunities and higher wages are available in areas near urban centers and industrial sites. To prevent acute shortages of labor, the feedstock producer or ethanol plant should provide enough incentives for agricultural workers to stay and work in the farm.

The increase in cassava production for bioethanol would lead to an increase in pressure on existing road and transport facilities, especially those far from urban areas which would most likely have less-developed road network. This would mean higher transport costs for feedstock from the farms to the processing centers, and in conveying field supplies to the production farms. Under such circumstances, additional investments should be allocated for land clearing and road development. Investors to the proposed project may also seek government assistance to support road development efforts in the proposed growing areas, Corporate action may also be needed in order to construct vital roads and bridges in selected ethanol production areas, assuming there is no government assistance in these areas.

In most of the target or potential production sites in the country, there is enough area for growing cassava for feedstock. However, the use of these areas for growing cassava for bioethanol processing may have an adverse impact on food supply, i.e. indirect consumption in the form of meat and other derived products. Also, production areas for cassava for bioethanol feedstock production should be consistent with Philippine government policy and FAO–led intergovernmental declaration on sustainable and food security compliant biofuels production in Rome last June 3-5, 2008.

The source of energy is another consideration. An auxiliary energy source is recommended because of the large energy requirements for the cassava-into-ethanol process, especially for drying fresh cassava tubers during the rainy season. This is advisably an energy farm wherein a fast growing tree or grass crop shall be grown specifically to provide steam for the boiler or generator. The said energy farm should be a corporate-run operation and the harvested biomass shall be processed, e.g. bailing, chipping in order to provide ready boiler fuel. This means that the scale of the energy farm shall be limited in land area in order to produce biofuel energy equivalent to 160 MT of coal/day or

0.33 Million BTU/day. A fast-growing tree crop may be grown, such as eucalyptus, or a suitable grass. A detailed sub-study is needed in order to determine detailed logistic requirements and costing for the energy farm.

To meet the energy requirements, co-generation should be considered a must in all ethanol plants given the significant amount of biomass production. To further reduce power generation cost, coal maybe used to supplement biogas only if complete environmental safeguards are in place especially on the coal storage and gaseous emissions. The cost of electricity generated by a multi-fired boiler using coal as fuel is estimated at 1 to 1.5 pesos per kwh. This production cost is only about 1/6 of the production cost when bunker is used as fuel.

The third major consideration is impact on the environment given the potential residues from processing. In this respect, the use of compost can be promoted for better energetics, improved environmental effects (GHG) and possibly reduction in cost of production. Loading application of anaerobically treated distillery slops such as liquid fertilizer to specific cassava plantation should be validated. Slops application as liquid fertilizer could be as much as 200 cubic meter per hectare per year as in sugarcane plantation. With this, an estimated savings of as much as 50% could be realized on both capital investment and operating cost of wastewater treatment facility of the ethanol plants.

On the whole, a cassava feedstock and bioethanol industry in the country should develop efficient production and processing capabilities to contend with the low cost of importing ethanol as well as to compete with other nations aiming to export bioethanol to the international market.

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