Technical Paper

Value Addition and Prospects of Bioethanol Production from Sugarcane in the Philippines

Marilyn M. ELAURIA *¹, and Jessie C. ELAURIA *²

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The overall vision of the Philippine government is the reduced dependence on imported energy through environmentally desirable options such as the use of bioethanol. Sugarcane is considered to be tested and ready for bioethanol production. This paper presents the value addition from sugarcane production to processing into bioethanol as well as the prospects of the bioethanol industry in the Philippines. The total value added for the industry is the summation of all the value added in each enterprise such as personnel remuneration or the wages paid, taxes and duties earned by the government from the enterprises, depreciation and interest on investments, and the entrepreneur's net profit.

Total value added (including the profits generated out of the by-products) of bioethanol production amounted to PhP82,716.79 (US\$1,879.93)/ha production of sugarcane processed into bioethanol. Bioethanol production showed optimistic results in terms of employment created and government income through taxes. The total number of man-days required in the whole process from sugarcane production to ethanol production summed up to 130 man-day/ha/year. Tax revenues were estimated at PhP2,277 (US\$51.76)/ha/year.

The bioethanol industry has great potential of contributing to the reduction of the country's dependence on imported fossil fuel with due regard to the protection of public health and the environment, at the same time providing opportunities for livelihood for poverty alleviation and sustainable economic development and energy security.

Key Words

Sugarcane, Bioethanol, Value addition, Energy security

1. Introduction

The overall vision of the Philippine government is the reduced dependence on imported energy and broader resource base with an indigenous, inexhaustible and environmentally desirable option such as the use of renewable energy (RE) including biomass energy such as bioethanol. In the Philippines, sugarcane is the primary feedstock for the production of bioethanol.

Sugarcane is the fourth major crop grown in the Philippines in terms of area planted. In 2009-2010 cropping period, area planted amounted to 404,034 ha producing

22,932,819 t^{†1} of cane with an equivalent raw sugar production of 1,970,784 t (Bureau of Agricultural Statistics, 2010)¹⁾. Presently, sugarcane farmers produce an average of only 65 t-cane/ha potentially yielding only 70 L or 4,550 L/(ha year) of ethanol per metric ton using sugarcane as feedstock. The sugar industry is currently producing 10% surplus sugar that could supply a portion of the country's initial needs for bioethanol (Sugar Regulatory Administration, 2008)²⁾. This surplus has to be shipped to the low-priced world market for the domestic prices to remain profitable for the producers.

With the promulgation of the Biofuels Act of 2006, which mandates up to 10% bioethanol blending, investments in the bioethanol sector are encouraged by the gov-

* 1 Department of Agricultural Economics, College of Economics and Management, University of the Philippines Los Banos, College, Laguna
lynme42@yahoo.com

* 2 Department of Engineering Science, College of Engineering and Agro-industrial Technology, University of the Philippines Los Banos, College, Laguna
jcelauria@yahoo.com

^{†1} The unit ton (t) in this manuscript is metric ton which is equivalent to 1 Mg (1 megagramme)

ernment to meet the huge domestic ethanol demand. At present, there are three sugar mills producing ethanol domestically. Commercial production of ethanol from sugarcane will boost the sugarcane industry and help reduce the country's dependence on imported fossil fuel.

This paper presents the value addition from sugarcane production to processing into bioethanol. Value addition in bioethanol production from sugarcane starts with the raw material production - sugarcane, and then processing the primary product - cane juice into the final product - bioethanol.

2. Value Addition from Bioethanol Production

Value added (VA) refers to the additional value of a commodity over the cost of commodities used to produce it from the previous stage of production. The more processes a product undergoes, the higher value addition accumulates to it. The value added generated for each conversion process for all the product forms is shared among the different stakeholders who provide the services and factors of production.

Value added measures the increase in wealth for the nation, and represents the distribution of the income among the agents of the national economy as represented by the sum of remuneration to labor, interest charges and taxes in addition to the net margin of the entrepreneur (Tallec and Bockel, 2005)³⁾. The concepts of value addition in the commodity chain analysis of Tallec and Bockel are adopted in this paper.

Value added (VA) is defined by the equation: $VA = Y - II$; where Y is the value of the output and II is the value of intermediate inputs used. The difference between value added and expenditure on labor, interest charges and taxes is termed gross profit (GP).

$$GP = VA - (\text{wages and salaries} + \text{interest charges} + \text{taxes})$$

Value added is thus composed of four elements: (1) personnel remuneration; (2) interest charges; (3) taxes; and (4) a balance, called the gross profit, representing the return (or loss) to the activity under consideration and can be re-written as follows:

$$VA = \text{personnel remuneration} + \text{interest charges} + \text{taxes} + GP$$

Since one more factor of production has contributed to production: investment or capital good, is used over a period of time, the cost of using the investment called depreciation must be accounted for. When depreciation is subtracted from the Gross Profit, the balance is termed as the Net Profit (NP):

$$\text{Net Profit} = \text{Gross Profit} - \text{Depreciation}$$

Value added was computed using the formula:

$$VA = \text{personnel remuneration} + \text{taxes} + \text{interest charges} + \text{net profit} + \text{depreciation}$$

2.1 Net Profit

To determine the net profit, total production and processing costs were deducted from the returns gained from the enterprise. Returns in the enterprise include revenue from sales of the primary output and sales from by-products. Total costs, on the other hand, include value of material inputs or materials and supplies used in the production process, such as costs of feedstock and materials for processing. In addition to the value of intermediate inputs, labor costs including wages and salaries are also included, as well as the various taxes and duties charged in the production and processing processes, and depreciation costs.

2.1.1 Net Profit in Sugarcane Production

Table 1 shows the costs and returns in sugarcane production on a per hectare basis. Total production cost is PhP57,600/ha. Seeds and fertilizer costs amounted to PhP272.66/t-cane. Labor comprises the major cost item, PhP457.28 or 52% of the total production cost. At the average yield of 65 t-cane/ha, the cost per ton cane is PhP886.15. Using the selling price of sugarcane of PhP1,400/t-cane, net profit amounts to PhP33,400/ha.

2.1.2 Net Profit in Bioethanol Production

In the use of cane juice as feedstock in bioethanol production, the entire sugar content of the cane is processed for bioethanol production, while the fibrous residue (bagasse) is assumed to be utilized in a combined heat and

Table 1 Costs and returns of sugarcane production per hectare and per ton cane, Philippines, 2010

Item	Cost per toncane (in PhP)	Cost per hectare (in PhP)
Materials		
Seeds and fertilizer	272.66	17,723.08
Labor		
Planting, weeding, fertilizing	215.86	14,030.77
Harvesting and loading	241.42	15,692.31
Overheat cost (maintenance, interest, and rent)	156.21	10,153.85
Total	886.15	57,600.00
Total cost of production	886.15	57,600.00
Selling price of sugarcane	1,400.00	91,000.00
Net profit	513.85	33,400.00

Reference: Andal, S. (2006)⁸⁾ and used the producer's price index for 2005 and 2010.

Table 2 Costs and returns of ethanol production per liter and per hectare of sugarcane production processed into bioethanol, Philippines, 2010

Items		Per liter (PhP)	Per hectare (PhP)
Material	Feedstock at PhP1400/TC	20.00	91,000.00
	Chemical	2.19	9,964.50
Operating Cost	Utilities	3.65	16,607.50
	Labor	0.73	3,321.50
Capital	Plant overhead cost *	2.00	9,100.00
Total cost		28.57	129,993.50
Bioethanol yield, L (@70 L/T)			4,550L
Selling price of bioethanol, PhP		30	136,500
Net profit from bioethanol, PhP		1.43	6,506.50

* Overhead cost includes depreciation and interest

Reference: Ledesma, J. (2007)⁴⁾

power facility to supply energy requirements of the bioethanol plant. Sugarcane can provide an ethanol yield of 70L/t-cane or 4,550 L/(ha year) (Ledesma, 2007)⁴⁾.

The costs and returns in bioethanol production from cane juice are shown in **Table 2**. The feedstock cost accounts for 70 percent of the total cost. The processing cost (which includes the chemicals, utilities and direct labor cost) for large bioethanol plant with 100,000 L/d capacity is PhP6.57/L. At the selling price of PhP30/L-ethanol, net profit is PhP1.43/L and PhP6,506.50/ha of sugarcane production processed into bioethanol.

However, with smaller mill capacity, the processing cost will increase to PhP7.56 for medium bioethanol plants (50,000 L/d capacity) and PhP8.54 for small bioethanol plants (20,000 L/d capacity) resulting to lower net profit. Net profit will also be affected by the change in the feedstock cost and selling price of bioethanol.

2.2 Employment and Personnel Remuneration

Employment refers to the number of jobs that can be generated with the presence of the biomass project starting from the production of the raw material up to the final product which is bioethanol while personnel remuneration is the value of total salaries and wages paid to the employees in the different firms or activities involved in the ethanol production. Using the information generated in Tables 1 and 2, **Table 3** shows the labor requirement on a per hectare sugarcane production up to processing into bioethanol. Total number of laborers employed amounts to 130 man-day/(ha year) valued at PhP33,044.58.

2.3 Tax Revenue

Tax revenue is the income generated by the government from the entities involved in each production process. However, sugarcane farmers are exempted from paying

Table 3 Annual labor requirement per hectare and wages paid by product form in sugarcane and bioethanol production, Philippines, 2010

Product form	Labor requirement (in m-day)	Wage rate (PhP/m-day)	Wages paid (PhP)
Sugarcane	119 ¹	250	29,723.08
Bioethanol	11.07 ²	300	3,321.50
Total	130.07		33,044.58

¹ Labor requirement for planting weeding, fertilizing, harvesting and loading

² Labor requirement for processing sugarcane into ethanol

taxes thus, no taxes are generated from the farming sector. From the net profit of PhP6,506.50/ha of cane processed into bioethanol as presented in Table 2, tax revenue amounts to PhP2,277.28/ year (at 35% tax rate).

2.4 Total Value Addition

Table 4 shows the summary of the total value added per product form generated from the per hectare production of sugarcane up to processing into bioethanol. The total value added for all the value adding activities amounted to PhP82,716.79 (US\$1,879.93)/(ha year) with sugarcane production contributing 82.45% in the total value added.

Considering that around 404,034 ha in the Philippines are planted to sugarcane in 2009-2010 (BAS, 2010) and if at least 10 % of the cane production will be processed into bioethanol, the total value addition from the bioethanol industry would be PhP3.342 billion (US\$75.95 million)/year.

In addition to the total value addition, dollar savings arise from bioethanol usage in lieu of imported gasoline or ethanol imports. It is expected that some of the imported fuel would be offset with the adoption of sugar ethanol as a gasoline fuel blend. As a result, reduced imports of fuel translate to dollar savings for the country. The dollar sav-

Table 4 Summary of value added per hectare of sugarcane production processed into bioethanol production, Philippines, 2010

Product form	Net profit (PhP/ha)	Wages (PhP/ha)	Taxes (PhP/ha)	Interest & depreciation (PhP/ha)	Value added (PhP/ha)	Percent %
Sugarcane	33,400.00	29,723.08	Exempted	5,076.93	68,200.01	82.45
Bioethanol	6,506.50	3,321.50	2,277.28	2,411.50	14,516.78	17.55
Total	39,906.50	33,044.58	2,277.28	7,488.43	82,716.79	100.00
	US\$906.97	US\$751.01	US\$51.76	US\$170.19	US\$1,879.93	

ings is estimated using the Philippine Department of Energy (DOE) computed dollar savings for every liter of displaced imported fuel of US\$0.64/L. From a one-hectare production of sugarcane, the total volume of gasoline that would be displaced will be 4,550 L using bioethanol. The displaced gasoline translates to an equivalent dollar savings of around US\$2,912/ha. If at least 10 % of the total sugarcane production will be processed into bioethanol, the total foreign exchange savings in the Philippines would be US\$117.65 million/year.

3. Prospects of Bioethanol Industry in the Philippines

The sugarcane crop is a versatile crop for ethanol production. It offers a number of available substrates or materials containing substances fermentable into alcohol. These cane-based substrates can be produced intermediately by a sugar mill and can be stored and hauled to an autonomous distillery without considerable change in the substrate quality. It can be also pumped out directly to an existing adjunct facility.

The Biofuels Act of 2006 (RA 9367) mandates the blending of 5% and 10% bioethanol into gasoline in February 2009 and 2011, respectively⁵⁾. This corresponds to 222.89 ML ethanol for 2009 and 482.3 ML for 2011. A promising domestic market exists for ethanol. The estimated ethanol requirement for motor fuel over the period 2011-2017 is 2,780 ML equivalent to 39.176 Mt of sugarcane (DOE-PEP 2007-2014)⁶⁾.

On the first year of the proposed mandated blend, only 36% can be supplied by the projected surplus production. The rest will have to be supplied through increase in sugarcane area. If the projected increase in productivity as projected by the sugar master plan is sustained, the production of ethanol for motor fuel in the first year will require 21,300 ha only (Sugar Regulatory Administration, 2007)⁷⁾. In the succeeding years, the US quota will be terminated. Hence the bigger surplus will be attained that will cover the ethanol requirement.

4. Conclusion

Total value added (including the profits generated out of the by-products) of bioethanol production amounted to

PhP82,716.79 (or US\$1,879.93)/ha production of sugarcane processed into bioethanol. Bioethanol production showed optimistic results in terms of employment created and government income through taxes. The total number of man-days required in the whole process from sugarcane production to ethanol production summed up to 130 man-day/(ha year). Tax revenues per hectare were estimated at PhP2,277/(ha year) (at 35% tax rate).

In general, the over-all value addition of the bioethanol industry is very significant. The industry does not only generate employment opportunities, but they also augment the income of the stakeholders. Moreover, the tax revenues and foreign exchange savings are significant contribution of the bioethanol industries, not only to the province and the region but to the national economy as a whole.

With the increasing oil prices in the world market, the transport sector's high dependence on imported oil would result to higher cost of transportation. Philippines has been actively promoting the development and utilization of bioethanol from sugarcane as an alternative fuel for the transport sector. The bioethanol industry has great potential of contributing to the reduction of the country's dependence on imported fuels with due regard to the protection of public health and the environment, at the same time providing opportunities for livelihood for sustainable economic development.

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