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Energy and Food

SIMULTANEOUS FOOD & BIOFUELS PRODUCTION AND ITS IMPLICATIONS ON FOOD SECURITY

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Abstract

Achieving food security while producing biofuel to power cars is one of the main challenges humanity faces in the new millennium. At present, is there enough food for all? Food reserves in storage are claimed to have declined by 22% compared to the 2005-2006 level and that food reserves shall decline further by 53 million tons (Mt) this year. In the Philippines, rice is the barometer of food security. The government claims there is no rice shortage but 2.7 Mt of rice should be imported for the lean months (July, August and September) as buffer stock. By 2015, or even earlier, rice supply will become even more precarious since a 22% supply deficit should be anticipated if the rice output of this year is simply maintained. It is hard selling that there is no rice crisis and that there is simply a price crisis. The price of rice relative to the 2007 level has indeed increased by 2.22x (P17.50 to P40.0/kg) this June 2008. Many believe that the current price of rice is already high. Using 3 different procedures in determining the true price of rice showed that 1 kg of rice is worth P66/kg (@ $1136/ton import price), P68.4/kg relative to its price in 1975(CPI) and it is P80/kg (considering price parity with the price of oil, oil-based inputs and just labor).

The world, in general, and the Philippines, in particular, is already experiencing difficulties in producing sufficient food for the growing population. Producing renewable energy through biofuel to address the declining oil supply and its almost daily escalating price and also producing adequate food require the same resources or inputs (land, water, initial energy or oil, fertilizer and machineries). In terms of land, as early as the 1980s, all the prime lands in the world are already used for agri- and – aquaculture. This occurred in the 1970s for the Philippines. Of the 1.4B ha of cultivated lands, 30% are already degraded. Erosion is occurring at 9M ha per year and soils are being destroyed at a rate 13x faster than they are being formed. If biofuels are to be produced at the intended amount, they will be grown in some 564 M ha more. This is the additional land area needed to produce the food requirements of 2 billion people by 2030. In the Philippines, we need to put into cultivation some 5M ha (or yield increase equivalent to the yield of 5Mha)for food crops production in the next 15-20 years to satisfy our food requirements which is also the area requirement if we are to produce 100% ethanol to replace gasoline.

Producing biofuels also requires more water (up to 10,000 li of water/li) than producing 1 kg of corn or rice (5000 li of water/kg) for food. The world is already suffering from varying levels of water scarcity. At present, 74% of water is used to

irrigate food crops. Biofuel crops, at the current area planted, use only 1% water but this water consumption will increase to 80% if the biofuel production plan materializes. Current data show that one out of three individuals in the world is now suffering from water scarcity. Global warming/ global climate change, droughts, more forest fires and high evaporation triggered by high temperature will further magnify the diminishing supply of fresh water both for agriculture and domestic use (household and industries).

So much land and water shall be used to produce biofuel in response to the oil crisis. The US government study conducted showed that all forms of renewable energy, including biofuels, however, will only supply 9% of energy needs or 2.25% if only the 4 (biofuel, solar, wind and wave) renewable energy sources are considered. If all the corn and soybean in the US will be processed, they will supply only 12 and 6% of their gasoline and diesel requirements, respectively. In the Philippines, fermenting all the sugarcane harvested in 390,000 ha sugar lands will only satisfy 7.5% of our gasoline requirement by 2011. Sugarcane will have to be planted in 5.3M ha to produce enough ethanol. This is the same area needed for food crops to supply the additional food requirements of 15-20 million Filipinos by 2020. Aside from sugarcane, there are other crops being considered in producing bioethanol in the Philippines. Sweet sorghum is one. It should be pointed out that sweet sorghum will be planted in lands using water which otherwise will be used for food crops. *Jatropha*, on the other hand, is being promoted as a biodiesel crop option since the food and many other uses of coconut oil have already made its price prohibitive. The main drawback of *Jatropha* is its low seed/ oil yield, thus, making its production uneconomical and low in energy balance. More detailed studies should be done.

The effect of biofuels on the environment and on biodiversity is another concern. Biofuel production produces voluminous wastes. Where will all the liquid wastes be thrown? Bio-cleaning the wastes is so cash- and energy-intensive, nullifying the energy balance or net energy yield of biofuel. Biofuel crops planted in new lands necessitates land clearing using fire as the easiest, cheapest and fastest tool. Part of the low energy return from biofuel production is that it also burns oil to prepare lands, plant, fertilize, harvest, and haul the feedstocks, thus, burning a tremendous amount of oil. Ethanol return from corn is only 6%. Furthermore, Nitrogen Oxide (NOx) emission from biofuel production increases due to the use of fertilizer and due to the burning of biomass and oil. Biofuel feedstock establishment is facilitated by burning and production thrives on monoculture. Endemic species' habitats are destroyed and biodiversity is sacrificed. This also happened when humankind burned and cultivated lands for food crops. The simple linear thought, therefore, is.....*more crops for food or biofuel = more lands and water use = more fertilizer or oil use = more erosion = more greenhouse gas emission.*

Humankind is in a difficult bind. Indeed, how could we face the millennium challenge of simultaneous food and biofuel production without sacrificing food security? Biofuel production is currently propelling further food price spikes. Last year, 100M tons of grain were processed into biofuel. It is hard to defend biofuel that they are not directly causing the current world food prices spikes. This year, the estimated deficit was 53M tons *Is is clear that without biofuel in the food equation, there is still enough food supply.* Food price increases have caused food riots in 36 countries. About 3 billion people are now affected especially those who spend 60-70% of their income on food, as they are simply priced out. The stomach of the poor are emptied by the biofuel-powered cars of the rich. Many Filipinos are hungrier and feel poorer than ever. The Millenium

Development Goal of poverty reduction is set back once again.

There many options other than biofuel—solar, wind, wave. The technology is now in place for solar- powered and battery/electric or hybrid cars for transport. In the Philippines (a tropical country), geothermal, hydro-electric, wind and solar power, are so abundant. They remain to be tapped.

Keywords: Food security, biofuel, ethanol, biodiesel, distillery slop, biodiversity, erosion, greenhous gas, global warming/climate change, food miles, globalization, cheap food, cheap oil

Abbreviations: GWP-global warming potential, Mt- million tons, Mha- million hectares, GHG-green house gas, NOx-nitrogen oxides, CPI-consumer price index, FAO-Food &Agriculture Organization, CIA- Central Intelligence Agency

Brief Background

The food crisis is real! Considering food production and consumption, the current food crisis is no surprise. On the production side, food production is carried out under an increasingly difficult production environment –global warming /global climate change - floods, typhoon, droughts, narrowing cycles of El Niño /La Niña, reduced R & D for agriculture, the continuing increase of oil price which propelled a price leap of oil-based inputs(fertilizer & pesticides), decreasing production capacity of the agro-ecosystem to meet requirements or the deteriorating resource base for production (Fig.1). The arable surface of the Earth (1.4 billion ha) is now fully utilized by agriculture and aquaculture (Buringh, 1989). In the Philippines, as early as the 1970s, all the prime agricultural lands (10 Mha) have already been cultivated. Expansion will encroach on fragile and less favorable agro-environments which are too steep, too dry, or with barren soils. Of the 1.4 billion ha cultivated lands, about 327 million ha or 34% have been degraded. An average of 9 million ha are eroded every year and soils are being destroyed 13 times faster than the natural soil formation. Some 400 million ha irrigated lands or 30% are desertified by salinization. With these diminishing lands for food production, "How Many People Could the Earth Support?" Ross McCluney (http://www.ecofuture.org / pop/rpts/mccluney_maxpop.html) revealed a wide range of values from only 2 billion (Pimentel estimates) to as high as 40 billion by eating a vegetarian diet as estimated by Revelle. In the Philippines, we made an estimate of our

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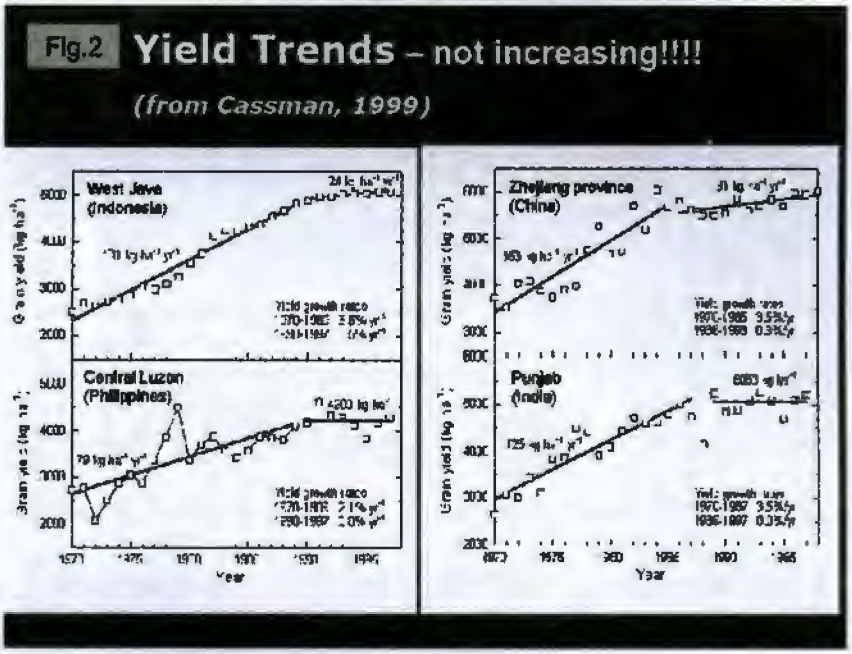
ideal carrying capacity. At 0.43 ha/ person, about 28 million Filipinos could be ideally living in the country, our population in 1960s. It means, we have exceeded our ideal population 3X! The babies who will be born in the next 15 years will need another Philippines (Mendoza,2008).

Fig.1

On the consumption side, the huge population especially among poor and food-deficient countries, the increasing affluence of fast-growing economies particularly China and India who comprised about 40% of world population, led to greater consumption of oil and meat or animal products. All together, the demand for food increased. The current trade regime or globalization has brought about the interconnected adverse effects not only on the environment but also on energy use (by increased food miles) and food insecurity especially in the poorer countries. Heavily subsidized agricultural products of developed countries and exported cheap to developing countries, like the Philippines, led to the belief that it is more practical to import foods. Why produce when it is cheaper to import? But this was short-lived as food prices in the world market had increased. The Philippines is now the largest rice importer in the world.

The Food Supply Status

Reserves of cereals (FAO records) revealed that world wheat declined 11 percent (2007), the lowest level of food reserves since 1980 as it is only good for 12 weeks of the world's total consumption - 22% less than the average 18 weeks food stored in 2000-2005. In Australia, wheat production decreased by 50% since the 2005-06 crop year because of drought while Canadian wheat fell 20.6 % in 2007 and their exports fell by 6 million tons. *US, Australia and Canada are the TOP 3 EXPORTERS OF CEREALS in the world.* Rice yields



came to a plateau or yield increases are so minimal. Rice production increased at 2.5-3.0% per year in the 1970s and 1980s. In the 1990s onward, the growth rate was only1.5 % (Fig.2).

Global stockpiles of cereals is estimated to decline by 53Mtons this year (Elisabeth Rosenthal: http://www.iht.com/articles/2007/12/17/europe/food.php).

Is there a rice shortage in the Philippines? There is no rice shortage .We have enough rice. The rice import @ 2.7 million metric tons is merely for buffer stock, the Government claims…,This year 2008 , the 1st Harvest of the year was 7.1Mt (41%) and we still need to produce 10.22 Mt (59%) the rest of the year. Our expected harvest for the year is 17. 32 Mt (Source : Dept. of Agric., PDI , June 25,2008).Our rice supply may not be that critical this year but increasing population and the other yield depressing factors cited above may put our food security in great peril starting 2015 (or even much earlier) when our rice demand will increase by 20% relative to our 2008 consumption (Table 1).

Table 1. Estimated rice requirements/paddyrice equivalent,cropped area, demand gap & % increase in yield to meet the demand up to year 2020.

YEAR	Philippine Population (M)	Projected Rice Requirement(1) (M Tons)	Projected Rice Requirement(2) (M Tons)	Paddy rice Equiv.(1) (M Tons)	Paddy Rice Equiv.(2) (M Tons)	d Area Demand Gap(1) (M Tons)	Demand Gap(2) (M Tons)
2007	88.10	10.45	11.28	16.34	17.62	1.65	2.47
2008	90.04	10.68	11.52	16.70	18.01	1.88	2.72
2009	92.02	10.92	11.78	17.06	18.40	2.11	2.97
2010	94.04	11.16	12.04	17.44	18.81	2.35	3.23
2011	96.11	11.41	12.30	17.82	19.22	2.60	3.50
2012	98.23	11.66	12.57	18.21	19.65	2.85	3.77
2013	100.39	11.91	12.85	18.61	20.08	3.11	4.04
2014	102.60	12.18	13.13	19.02	20.52	3.37	4.33
2015	104.75	12.43	13.41	19.42	20.95	3.62	4.60
2016	106.95	12.69	13.69	19.83	21.39	3.89	4.88
2017	109.20	12.96	13.98	20.25	21.84	4.15	5.17
2018	111.49	13.23	14.27	20.67	22.30	4.42	5.46
2019	113.83	13.51	14.57	21.11	22.77	4.70	5.76
2020	116.11	13.78	14.86	21.53	23.22	4.97	6.06

**2.2% Projected Average Population growth rate/year up to year 2014,.*

2.1% year 2015 to 2019 and 2.0% by year 2020.

(1) Per capita consumption 118.67 kg/person (94 + 24 buffer, NFA)

(2) Per capita consumption 128.0 kg/person (based on RDA ,65% of 2000kcal from rice , 1.0 kg rice =3,700kcal , estimated by Mendoza,2001)

64 % milling recovery , 60:40 WS : DS crop ; 3.7 mt/ha DS & 2.8 mt/ha WS= 3.2 mt/ha

Assumed Cropped Area per Year= 4.3 Mha (1.5Mha irigated x 2 + 1.3Mha rainfed), Rqd.) 100

% Rice Sufficiency= (Actual Cropped Area/Cropped Area

Sufficient Yield level = Total Paddy rice rqd./Cropped Area :

Food Price Crisis or Simple Human Denials?

The era of cheap food is over, the Asian Development Bank Chief said. The UN's food price index rose 45 percent in the past 10 months but some prices have climbed even faster. Wheat went up 108 per cent in the past 12 months; Corn, 66 per cent and rice (220% ,2007 to date), the food that feeds half of the world, went "*from being a staple to a delicacy*," (Abah Ofon,2008)
http://www.theglobeandmail.com/servlet/story/RTGAM.20080410.wfood0411/BNStory/International/home

Poor people are simply priced out ! In 2007, commercial rice can be bought as low as Php17.50/ kilogram. *A*s of this date, rice is sold at P40/kg. Is it really expensive? Is this the true market price of rice in the Philippines? How much is the true price of rice? Prices were determined in three different ways (Mendoza, 2008) and the estimated prices are shown below :

Table 2. Estimated farm gate price of paddy rice and equivalent retail price per kg at various imported price (in USD/ton).

Imported Price of Rice (1) USD/ton	Farm Gate Price of Palay/ kg (2) PhP/kg	Retail Price per kg (3) PhP/kg
700	19.50	40.60
800	22.74	46.40
900	25.06	52.20
1136	31.63	65.89
1200	33.41	69.60
1300	36.20	75.40
1400	38.98	81.20
1500	41.76	87.00
1600	44.54	92.80
1700	47.33	98.60
1800	50.18	104.40
1900	52.90	110.20
2000	55.68	116.00

Notes:

1) Imported price at USD / metric ton, $1 = P43 exchange rate , no tariff. Shipping costs are included

2) The farm gate price of palay is estimated directly from the imported price plus costs of handling (Nueva Ecija is the reference pt.)

3) The retail price per kg is estimated at zero tarrif, $1 = P43 exchange rate, plus handling costs (Nueva Ecija is the reference pt.), 64% milling recovery

Imported rice (@$1136/t)
= P 66/kg (Table 2)
CPI corrected (1975 to 2008)
= P68/kg (Table 3)
Adjusted to current price inputs & just wage
= P86/kg (Table 4)

If the price of rice is Php 2.50/kg in 1975 and it is indexed to 2008, it should fetch Php 68.48/kg (Table 3). The 2008 rice price spike (P50/kg in Davao) was not a spike after all but reflective only of the true market price of rice in the domestic market (Mendoza , 2008). In the Philippines, the price of basic food is not allowed to freely move up or down based on the market forces. It is the policy of the state to make food available and affordable (food security) through direct and indirect interventions. In the case of rice, the National Food Authority (NFA) always ensures that enough supply is available (achieved mainly through importation) so that rice prices in the domestic market is stabilized. Viewed from the perspective of the low wage earners, this strategy of the government is highly laudable. If the government cannot force employers to increase wages, it can at least maintain food prices at affordable levels. But this is disincentive to the farmers because they could hardly make a living out

Table 3. Consumer price index of food, beverages, and tobacco.

Year (A)	FBT (*B)	1978=100 ©	1973=100 (D)	E
1973	55.40	55.40	100.00	1.00
1978	100.00	100.00	180.51	1.81
1988	380.40	380.40	686.64	6.87
1990	429.50			
1988	100.00	380.40	686.64	6.87
1992	157.30			
1994	180.70	687.38	1,240.76	12.41
1996	217.40			
1994	100.00	687.38	1,240.76	12.41
2000	145.50	1,000.14	1,805.31	18.05
1992	66.10			
1996	84.30			
2000	100.00	1,000.14	1,805.31	18.05
2007	134.90	1,349.19	2,435.36	24.35
2008* May	151.60	1,516.22	2,736.85	27.37

* (http://www.census.gov.ph/data/sectordata/2008/cp080501r.htm)

A = Representative years, B = CPIs for Food, Beverages, & Tobacco *Phil Stat Yearbooks (1987 – 2007)*

C = Adjusted CPI consistent with 1978 base price (1978=100) , D = Adjusted CPI using data in C to make 1973 as the base year (1973 = 100)

E = CPI or price ratio at 1973 base price ,

ex. How much is a kilo of rice in 1973 priced at Php 2.50 for May of 2008? , of farming. Subsidizing rice, a form of cash transfer to the poor, will mean huge costs. It was estimated that the National Food Authority will incur up to P37 Billion loss this year alone (PDI, June 13,2007).

Rice farming is associated to poverty. It is no surprise that poverty is a rural phenomenon in the Philippines since 9 out of 10 farmers are rice farmers.

Table 4 .Rice price adjustments as the price of oil increases

Oil Price per barrel (USD)	Price of Urea per bag (50kg)	Palay price per cavan (50kg) ; 1	Price of palay per Kg 2	Price of rice per Kg 3
100	1050	1050	21.0	**57.00**
110	1230	1230	24.6	**70.62**
120	1410	1410	28.2	**78.54**
130	1590	1590	31.8	**86.46**
140	1770	1770	35.4	**94.38**
150	1950	1950	39.0	**102.30**

1- Price of Urea = Price of Palay

2- Farm gate price of palay =palay price per cavan/50 kg

3- Price of rice (retail) = 2 x price of palay/kg + post-production costs

Post-prodn. = Drying/hauling, milling, warehousing, sack, profit(approx.P15/kg)

Oil Dependent Food Systems

Humanity is overconsuming oil. Over 1.5 trillion barrels of oil equivalent had been consumed since Edwin Drake drilled the first oil well in 1859 (www.energyandcapital.com) and in 40 years, the remaining1.5 trillon will be consumed at the current rate of utilization of 85 million barrels a day, or about 31 billion barrels/year (BP Global Statistical Review of World Energy, 2007). What Earth stored in 9 million years (Rodolfo,2007), humanity consumes in one years . In less than 2 years, the oil price might increase to $200/barrel. *The era of cheap oil is gone!* Hopefully, the conflict in Iran will be solved diplomatically. Otherwise, oil price might increase further to an unaffordable level although this event will accelerate further the shift to alternative energy sources and it will decrease considerably oil consumption which in turn will reduce significantly greenhouse gas emission, thus, saving humanity by not reaching the predicted tipping point - 2 degrees centigrade increase in temperature (Hansen, 2008).

Why is oil so important in our food systems ? Simple ! Our food systems use so much oil to cultivate, fertilize, harvest, process, store, and distribute food. From production – to- post production, rice utilizes an oil equivalent of 830 li or 42 li oil @ 128kg/rice per person. Sugarcane uses 1120 li oil equivalent or 2.4 li oil @ 20kg sugar/capita. Prices of food are inevitably affected with oil price increases. ***As the era of cheap oil is gone, so is the era of cheap food in view of the excessive dependence of our food systems on oil.*** In the United States, 1514 li of oil equivalents are expended annually to feed each American. Agricultural energy consumption is broken down as follows:· 31% for the manufacture of inorganic fertilizer, 19% for the operation of field machinery, 16% for transportation, 13% for irrigation, 8% for raising livestock (not including livestock feed), 5% for crop drying, 5% for pesticide production, 8% miscellaneous (Pimentel, David and Giampietro, Mario. 1994, McLaughlin, N.B., et al.2000; as cited by Pfeiffer, DA. 2003). The first International Agriculture Assessment on Science and Technology Development (IAASTD) approved by 54 governments scored industrial agriculture as a causal factor in increasing food prices, hunger, social inequities, and environmental disasters (http://www.agassessment-watch.organdhttp://www.panna.org/).

The Biofuel Mania

The over utilization of oil has brought about complex situations. The fast dwindling supply and the ensuing oil price spikes led to a breathtaking speed of biofuel production. Food crops (corn, soybean etc.) being processed into biofuel increased the demand of crops used as feedstocks which intensely compete with the same resources – land ,water, financial & human capital- being used for food production. The current thinking is that biofuel production is good for our economy as summarized in Fig.3.

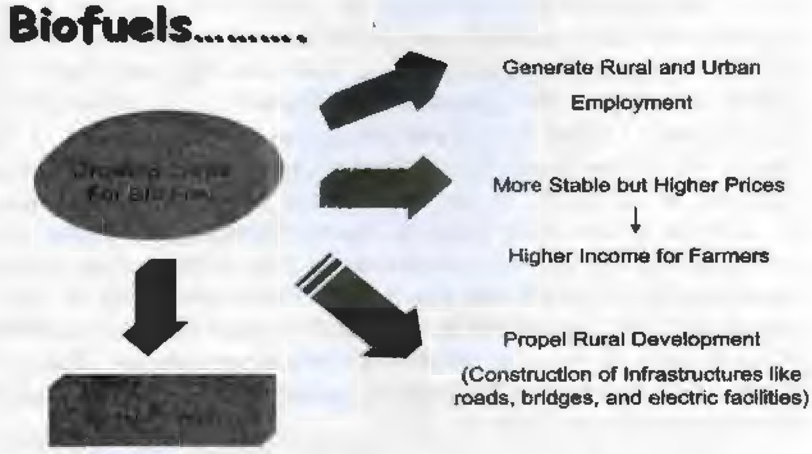


Fig.3

Let us assess biofuels if they are really advantageous .

Biofuels and Net Energy Yields

There are 2 considerations:

(1) Crops as Feedstocks- For bioethanol --- sugarcane, corn, sorghum, root crops; For biodiesel----- palm oil, soybean, rapeseed, canola, castor oil, *Jatropha,* and

(2) (2) Net Energy yields from a given crop source. *Net Energy Yield = Gross Energy yield less Cost of energy*. This can be simply derived by estimating the Energy efficiency(Ee)= Energy output / Energy input (Energy balance) and the Energy Intensity (Ei) = amount of energy used to produce 1.0 li of energy (ethanol) = 1/ Ee (Mendoza, 2008).

(A more detailed discussion of issues re: biofuel crops under Philippine conditions is included in Annex A). As shown on Table 5, only 1 crop-sugarcane - is showing a positive energy balance. In Table 6, the energy accounting for *Jatropha*, the most popular crop for biodiesel as it is not edible and it is known to grow in marginal soils , showed a dismal note. The energy balance ranges from 0.53 to 1.03 , for low and high yield, respectively at the field level production stage. It means that the energy consumed in processing is not yet included.

Table 5. Energy efficiency (Ee) of the various feedstock sources of ethanol production (Mendoza,2008).

FEEDSTOCK	YIELD LEVEL	ENERGY EFFICIENCY	ENERGY INTENSITY*	REFERENCE
Sugarcane[2]	Average	2.80	0.357	Mendoza et al 2007
	High	3.05	0.327	Mendoza et al 2007
Corn[3]	Low	1.06	0.94	Moriss 1994
	Average	1.25	0.800	Shappouri et al 1995
	High	1.38	0.724	Lorenz & Moriss, 1995
Cassava[4]	Average	1.00	1.000	Hill et al 2006
	High	1.32	0.757	Hill et al 2006
Sweet Sorghum	Average	0.91	1.090	Worley et al 1992
	High	1.09	0.910	Worley et al 1992

[1] Energy intensity = 1 , Energy Efficiency

[2] For Sugarcane, Ee as high as 8.0 was obtained in Brazil (Macedo et al 2004, Smeets et al 2006) which simply indicates the high potential of sugarcane for ethanol. But Ee=8.0 was not used and the Ee that was earlier estimated by Mendoza et al 2007 was used.

[3] For Corn, Ee as low as 0.75 was reported by Pimentel (2004)

[4] For Cassava, Hill et al (2006) reported only 1 Ee value

Table 6 . Energy (LDOE/ha) accounting of jatropha production on a ten year period(Ratilla,2008)

	Year 1		Year 5		Year 10		otal (5 year	otal (10year
	LDOE	%	LDOE	%	LDOE	%		
1.Fossil Fuel Based Energy Input (FFEI)								
Fuel (li)			45	9.67	45	9.67	90.000	315.000
Fertilizer								
Total	226.47	82.72	383.954	82.50	383.954	82.50		
2. Indirectly Fossil Fuel Oil Based Energy Input								
A. Labor								
B. Seeds (g)	0.89	0.33					0.890	0.890
C.Bolo	2.775	1.01					5.550	5.550
Total (IFFEI)	47.315	17.28	81.43	17.50	81.43	17.50		
Total Energy Input	**273.785**	100.00	**465.384**	100.00	**465.384**	100.00	1560.747	3887.667
Energy use/kg								
Seed Yield (kg/ha) (low)= 1700 kg/ha			**0.91809**		**0.38114**		**0.91809**	**0.38114**
Seed Yield (kg/ha)(high)= 2850kg/ha			**0.54763**		**0.22735**		**0.54763**	**0.22735**
Energy use/li oil yield								
Oil yield (low) (30%) = 251 li ton^{-1} seed			**1.83805**		**1.30344**		**1.8381**	**1.3034**
Oil yield (high)(35%)=292 li ton^{-1} seed			**0.94243**		**0.66832**		**0.9422**	**0.6683**
Energy balance (low yield)							**0.435**	**0.527**
Energy balance (high yield)							**0.849**	**1.027**

Biofuels and Energy Supply

The US government study showed that by 2030, all renewable energy including biofuels will only supply 9% of global energy needs. If divided equally among the 4 main sources, biofuel will only provide 2.25 % of the energy supply. The entire US corn harvest will only provide 12% of their gasoline needs and their entire soybean harvest, only 6% of their diesel fuels requirements. In Europe, 60 % of their arable lands could only replace 20 % of the fossil fuels used in transport. A 5.75% target would require ¼ of the EU's arable land (Goldman, 2006). In the Philippines, if all the sugarcane planted in the 390,000 ha are harvested & fermented into ethanol, it will only provide 7.3% of our gasoline requirements and sugarcane must be planted in 5.2 million ha to satisfy 100% of the country's gas requirements by 2011 . The 10% ethanol mix with gasoline needs 200,000 ha of new sugarlands (Mendoza et al.,2007). All over the world, biofuels production shall use lands over and above the existing lands for food crops as follows: Brazil.....120 Mha, Africa... ..400Mha , Indonesia...20 to 30Mha and in USA...all their corn lands and 14 % more...Approximately, the new land requirements for biofuels would be 564 Mha. Where shall we get all these lands without affecting food supply ?

Biofuels and Water

About 2,000-10,000 li of water is needed to produce a li of biofuel. In Brazil, they use 2,200 li of water/ 1 li of ethanol from sugarcane, Phil = 3,000- 4,200, India = 3,500 li. 1 li corn ethanol consumes 4,000- 10,000 li of water in the US. Table 7 shows the water bill for ethanol production for various crops in the Philippines. The International Water Management Institute (IWMI) 5 year study on global water scenario showed that biofuel crops currently consume just 1 percent of the total water used globally .If biofuel usage rises as projected, it would be using 80 per cent more water by 2030. Currently, 74% of all water is used for irrigation. There shall be 3 billion extra people by 2050 and this will result in an 80 percent increase in water use for agriculture". "If people are growing biofuels and food at the same time, more water will be needed!"*Where shall we get all the water we need* ?, David Molden asked (Sri Lanka-based IWMI). Production of biofuels could worsen water shortages (Alister Doyle,2006. http://today.reuters.com/News/CrisesArticle.aspx?storyId=L18850725 8/24/2006). At present,"One in three people in the world is enduring in one form or another, water scarcity".

Biofuels and the Environment

That biofuels are renewable and environment-friendly and they can help reduce global warming are the common perception . There are 2 main points for biofuels:(1) They are 'carbon-neutral.' When burned, the CO_2 released is re-absorbed by the crops for photosynthesis - so there is no net increase in CO_2; (2) Biofuels are renewable energy sources with a 1-year cycling time, while fossil fuel oils take several million years to be formed (Rodolfo, 2007). On the other hand, producing biofuel shows the following negative environmental features: In Brazil, more sugarcane and soybean for biofuel are grown by burning and clearing large forested areas of the Amazon jungle. Tropical forests cleared for sugarcane ethanol emit 50% more greenhouse gases than the production and use of the same amount of gasoline (David Tilman and Jason Hill, 2007). More oil palms are planted in Indonesia by clearing the forest and drying/burning their peat soils, making it the 3rd highest emitter of greenhouse gases (GHG). Every ton of palm oil produced results in 33 tons of carbon dioxide emissions—10 times more than petroleum (George Monbiot, 2007). As revealed by Friends of the Earth, production of palm oil is the biggest cause of rainforest devastation.

Massive production of biofuels in these areas will reduce the carbon content of soils and carbon stocks in forests and peat lands (UN-Energy 2007). Doug Parr, chief British scientist at Greenpeace, says 'producing 5% of biofuels may end up wiping out our existing ancient forests and all the carbon gains are lost' (Holt-Gimenez 2007).

Table 7.Water Consumed per ll Ethanol Produced*

Feedstock	ll Water Use/ ll of Ethanol**
• Sugarcane	3,000 – 4,200
• Corn	3,670 – 6,060
• Cassava	3,000 – 9,700
• Sweet sorghum	3,100 – 5,200

** Ll water/ll ethanol = total water consumed ÷ total ethanol produced
*Data collected from various sources : Mendoza (2008)

Growing crops for biofuel now is following the industrial plantation agricultural technology. Industrial agriculture is so oil energy-intensive that it contributes an enormous amount of greenhouse gases. For instance, ethanol production from corn uses oil at every stage. The largest source of green house gases are the chemical fertilizers (nitrogen is often the limiting factor in crop production). *First,* a huge amount of oil is consumed in the manufacture of nitrogen fertilizer. Including transport and storage, the energy use ranges from 1.8-2.04 L of oil per kg nitrogen. 'Fertilizer energy' is 28% of the energy used in agriculture (Heller 2000). *Second,* once applied in the soil, 3-5% of it escapes as [nitrogen oxides] NOx. NOx has 296x global warming potential (GWP). For every 1 kg nitrogen, more than 10 kg CO_2 equivalent is emitted in the atmosphere. Above all, growing maize erodes soils, pollutes both surface and ground waters from fertilizer run-off and deep percolation. Also, industrial plantation thrives on large scale monocropping leading to significant biodiversity loss, soil erosion and nutrient leaching (UN-Energy, 2007). Because of these, more hydrocarbon-based fertilizers must be applied to offset soil fertility decline, along with more pesticides application; more irrigation water, requiring more energy to pump; and more fossil fuels to process polluted waters (Pfeiffer, 2003). Loss of topsoil has been a major factor in the fall of civilizations
(Carter & Dale, 1981, Ponting, 1993). Iraq, formerly Mesopotamia, is where 75% of the farm land has become a salty desert. It takes 500 years to replace 1 inch of topsoil. In soil made susceptible by agriculture, erosion is reducing productivity up to 65% each year. The soil is eroding 30 times faster than the natural formation rate (Pimentel & Pimentel, 1991). Biofuel production from corn (i.e., butanol, ethanol) is especially harmful because corn causes 50 times more soil erosion than hay crops (Sullivan, 2004). The US government has studied the effect of growing continuous corn and found it increases eutrophication by 189%, global warming by 71%, and acidification

by 6% (Powers, 2005). The greenhouse gas contribution of agriculture and land use change has been summed up to 32% (IPCC, 2006). Primary agriculture contributes 14%, land use change/deforestation,18%. As more biofuel crops will be grown, large land clearings/deforestation will be done. About 564M ha will be needed to grow biofuel crops. This huge land requirements will inevitably lead to more deforestation, further reducing biodiversity, decreasing water supply and water quality, and increasing further soil erosion (Tegtmeier, 2004). Orangutans, rhinos, tigers and thousands of other species may be driven extinct (Monbiot, 2005). In turn, this will lead to more GHG emission. The FAO World Food Summit (2006) Report revealed that conventional agriculture, together with deforestation and rangeland burning, are responsible for 30% CO2 and 90% of nitrous oxide emissions worldwide. The Amazon is being destroyed by farmers growing soybeans for food (National Geographic, Jan 2007) and fuel (Olmstead, 2006).

To reduce the cost of processing, coal is used in ethanol production, replacing petroleum (Farrell, 2006, Yacobucci, 2006 & Clayton, 2006). Using coal for burning/heating biomass factories increases global warming (Farrell, 2006).

Many people believe that sourcing biofuel from human inedible crop sources like cellulosic biomass will correct its ugly features. But biofuels from biomass are also not sustainable, are ecologically destructive (Tegtmeier, 2004), have a net energy loss, and there are insufficient biomass to make significant amounts of energy because essential inputs like water, land, fossil fuels, and phosphate ores are limited. Biomass yields will also decline when residues are removed from the soil (Johnson, 2006). Farmers will not sell their residues as prices of fertilizers rise due to oil and natural gas depletion. It will be cheaper to return residues to the soil than to buy fertilizer. Fertile soil will be destroyed if crops and other 'wastes'are removed to make cellulosic ethanol (Friedemann, 2007).

(Kumar & Goh, 2000; Nelson, 2002; Sheehan, 2003). Removing crop residues would rob organic matter that is vital to the maintenance of soil fertility and tilth, leading to disastrous soil erosion levels (Magdoff & Van Es, 2000). The most prudent course is to continue to recycle most crop residues back into the soil, where they are vital in keeping organic matter levels high enough to make the soil more open to air and water, more resistant to soil erosion, and more productive (Sampson, 1981). Intensive agriculture of the last 5 to 6 decades has already removed 20 to 50% of the original soil carbon, and some areas have lost 70%. To maintain soil C levels, no crop residues should be removed under any tillage systems or on highly erodible lands (Johnson, 2006).

Furthermore, producing biofuels like ethanol in sugarcane is accompanied by the generation of huge liquid wastes called distillery slops. Corn ethanol plants generate 13 L of wastewater for every L of ethanol produced (Pimentel, 2005). While ethanol contains considerable amount of potash and many other nutrients and has fertilizer value, it is highly acidic, is high in biological oxygen demand (BOD), chemical oxygen demand (COD), and is foul-smelling. It is a highly pollutive waste if not properly treated and disposed. The production target of 120 billion L of ethanol and about 12 billion L of biodiesel by 2030 will produce about 3 trillion L of liquid wastes (Mendoza et al.,2007;Demafelis, 2007).Where will all these liquid wastes be thrown out? Avid proponents of biofuel will argue that the liquid wastes could be treated for re-use. The treatment costs will be enormous, will increase health costs, kill fish with insecticides that work their way up the food chain (Troeh, 2005).

Biofuels and Food Prices

Production of biofuels consumed almost 100 M tons of grains last year. It is hard to defend biofuels as not directly causing the current world food price spikes. This year, the estimated deficit was 53M tons *(16April,2008Monbiot. com). It is clear that without biofuel in the food equation, there is still enough food supply. If fermenting corn will be stopped, its price will decrease by 20 to 30 %.* In the US, ethanol production from corn (2008) is estimated at 11.4 billion gallons . This is equivalent to the food caloric requirements of 450 M people (@3000Kcal/person). By 2017, about 35 billion gallons will be produced which translates to the food caloric requirements of 1.4 B people (@3000Kcal/person). We cannot dictate to the US what to do with their corn. But the US produces 40 % of the world's total corn and supplies 70 % of all corn exports. Their ethanol production from corn not only propelled the increase in corn price but also in all food commodities including meat and dairy. Corn constitutes 50 % or more of livestock feed.

There are about 2.7 billion people in the world who are living on the equivalent of less than $2 a day (World Bank , 2001) and 85 % of Filipinos live on less than $2 a day! (CIA, 2006). Food crisis happens in many poor and food-deficient countries and

it is true even in rich countries :37 million poor in the U.S (observer.guardian. co.uk); 80 million in China (Paromita Shastri, livemint.com); 37 million poor in Indonesia (Indonesia-pretoria.org.za); 24 million in the Philippines (ifad. org) and 250 million in India (ews.bbc.co.uk). Caloric consumption typically declines as price rises by a ratio of 1:2.or for every 1% rise in the food price, 16 million people are made food-insecure. Some 1.2 billion people could be chronically hungry by 2025—600 million more than previously predicted (Runge & Sennauer, 2007)

What Renowned People & Institutions Say about Biofuels !

"Biofuels policy in the EU and the UK may have run ahead of the science". Professor Robert Watson *Jacques Diouf, head of the UN Food and Agriculture Organization said that* "a very serious risk that fewer people will be able to get food," particularly in the developing world,

http://www.iht.com/articles/2007/12/17/europe/food.php .

The International Monetary Fund noted that " The use of food as source of fuel may have serious implications on the supply of food if the expansion of biofuels continues." "The stomachs of the poor are losing out to the cars of the wealthy."

Jean Zeigler, a UN special rapporteur, calls the biofuel trade *"a crime against humanity."*

" Biofuels could end up damaging the natural world rather than saving it from global warming", Jeffrey A McNeely, chief scientist of IUCN .

We must avoid falling into the trap of having a *"cure worse than the disease!"*, the biofuel malady, according to Dr.Paul Crutzen.

Do we have Options other than Biofuels?

For the Philippines, there are many options in pursuing energy security other than biofuels and they are as follows : improve energy use efficiency - minimize the use of cars – walk, bike ride, shift to more renewable and environment-friendly sources of energy- solar, wave, and wind energy (Mendoza,2007, Rodolfo,2007 and 2008).

The food crisis is a wake-up call. There are several OPTIONS that can be done both on the production and consumption side.

On the food supply or food production , there are many possibilities (Mendoza, 2008) : 1) Growing food the whole year round is possible where sunlight is available. All the rest can be provided (soil, composts, water). If one so desires, land availability is not the issue. It is the willingness and interest of the individual. Sustainable food advocates claim that family farms and gardens not only can feed the world, they are the only food production approach that can sustain food in the long run (Bradley et al, 1992). A sunshine-rich country like the Philippines, whose climate is so accommodating for the whole year round growth of crops provided water is available, need not fear hunger. We have no freezing winter that requires expensive heated glasshouses to grow crops.

Oil-based agriculture is unsustainable agriculture (Ho, 2008). This old paradigm of industrial, energy-intensive, and toxic agriculture is a concept of the past (IAASTD,2008). Small-scale farming and agro-ecological methods provide the way forward to avert the current food crisis and meet the needs of local communities. For the first time an independent, global assessment acknowledges that farming has a diversity of environmental and social functions and that nations and peoples have the right to democratically determine their best food and agricultural policies (http://www.agassessment-watch.organdhttp://www.panna.org/). There is a need to pursue a biodiverse, integrated, and organic/sustainable (BIOS) agriculture as the core strategy to sustainable food security. Organic agriculture can feed the world (Winter 2007, Badgley et al., 2007). Organic farming requires lesser energy in growing crops and it is consistent with the declining fossil fuel oil supply; and diversified and integrated farming gives higher production compared with the conventional monocrop farming. A case study comparing a monocrop and a diverse farm showed that the estimated food caloric value produced in the diverse farm is 61.7% higher than the conventional monocrop rice farm (Mendoza, 2001). Sufficient food calories (65% of 2000 kcal/day) for 48 persons in one year could be harvested in this farm. BIO-farm has 2 important requirements, namely :

(1) bio-farming is decision-intensive, hence, the farmers should own the land to enable them to make independent decisions and motivate them to rebuild and restore soil fertility @ impoverished soil >>> low yield>>> impoverished farmers >>> malnourished farm families ...... Smaller, more diverse farming systems require a level of husbandry that is simply uneconomical at any other scale. Organic crops and livestock demand specialist knowledge and regular monitoring (http://www.theecologist.org/archive_detail.asp?content_id=1184).

(2) The farmers need seed support as they have lost their indigenous/traditional seeds through long years of monoculture farming practices. The UN FAO estimates that 75 per cent of the genetic diversity of agricultural crops has been lost over the past 100 years (FAO, 1997).

On the consumption or demand side, the changing climatic pattern and the diminishing resource requirements to grow sufficient rice call for a *change* in the thinking that if we have not eaten rice, our meal is not complete or we have not eaten yet. Three options were earlier forwarded (Mendoza, 2008):

Option 1. Diversify our food caloric sources. We can supplement rice with corn, camote, or any other carbohydrate yielding crops. Simple estimates show that reducing the 65% caloric energy supplied by rice (translates to 124 kg /capita) to only 50% (translates to 95 kg/capita) makes us immediately self-sufficient in rice.

Option 2. Food wastage must be minimized or avoided. The current world food shortage is not simply the result of a production shortfall. It is how the food we produce are utilized or wasted. Why do we need to polish rice? Unpolished rice is more nutritious (rich in vitamins), and it gives higher milling recovery (from 64% to 72 % milling recovery of unpolished rice; bran is about 8%). This translates to about 1.2M tons of rice savings. About 10 to 15% more rice will be saved if we eat unpolished rice. Add together, this sums up to about 2.4 million tons of rice. We become more than self-sufficient in rice.

Option 3. In the Philippines, about 7.0 million tons of corn are fed to our poultry and livestock (We produce 6.0 tons, we import the rests). We just divert 2.5 million tons of corn, mill them and mix the milled corn grains with rice at 10 to 15 %, we automatically become food caloric self- sufficient. In the developed world, particularly the US, about 2/3 of their small grains (cereals of soybean) are fed to livestock. Everybody in the world wants to adopt the American diet. And we want to eat like the average Americans. We would need 5 more Earths, or only about 1 billion would live if all people eat like the Americans. Of the 2.13 B tons of grains produced this year, only 1.01 B ton, according to the United Nation's Food and

Agriculture Organization, will be directly consumed by the people. The production of biofuels will consume almost 100 M tonnes (16April, 2008Monbiot.com) to fuel cars, but 760 M tons will be fed to animals – an amount equivalent to 14 times the global food deficit of 56 Mtons(FAO, 2006)

The growing affluence of China and India leads to booming meat consumption, and is now the single dominant factor pushing up food and energy usage. As the Chinese become more affluent, they can now afford to buy more meat, beef and chevon. They now raise billions of sheep, and grow lots of corn and soybean just to feed their livestock{(1 kg pork = 5.6 kg corn equivalent, 1 kg broiler chicken = 4.8 kg corn equivalent, 1 kg corn equivalent = 0.7 kg corn + 0.3 kg soybean, 1 kg soybean = 3.2 kg corn) (Mendoza, 2001)}. This is called the thermodynamic loss of food via food type conversion. As feed Grain g animals g man, we lose 90% protein, 96% calories, 99% carbohydrates, 100% fiber. The 50 gram meat-dietary intake per day translates to 2 days of food if eaten as corn or soybean. It is a choice then of eating meat today and forgoing food for 2 days. It is not that we should abandon eating meat. The logic is to raise animals but not feeding them food that directly competes with human food. The ruminants feed on grasses or fibrous crop residues, in turn, producing manure for composts to fertilize our crops. For the Philippines, we are simply lucky as we are endowed with large coastal and marine waters (220 M ha) and fresh water (1.0 M ha) where fish can grow and multiply for the protein part of our nutrition. But again, good governance and people's cooperation in protecting the sea (preserve the remaining mangroves and plant more as they serve as fish breeding grounds) is the key to the revival of our seas teeming with fish. Bringing back the watersheds that supply free-flowing fresh water to the river during summer months favors the breeding and fingerling production of many fish species in the resulting brackish water of river banks.

References

Altieri,M and Elizabeth Bravo. 2007. "The ecological and social tragedy of biofuels," 5/1/07, www.foodfirst.org

BP Global Statistical Review of World Energy. June 2007. http://www.bp.com/statisticalreview

Badgely, C. Moghtader, J., Quintero, E., Zahem, E., Chappel, M.J., Aviles-Vasquez, K., Samulona,A. and Perfecto, I. 2006. Organic agriculture and the global food supply. Renewable Agric and Food Systems: 22(2):86-108.

BAS (Bureau of Agriculture Statistics); Average per capita of the Phils. 2007.

Bradley, Fern Marshall and Barbara W. Ellis, eds. Rodale's All-New Encyclopedia of Organic Gar Brar, D. S. and G. S. Khush. 1997. Wide hybridization for riceimprovements: Alien gene transfer and molecular characterization of introgression. pp 21-29 In M. P. Jones, M. Dingkhun, D. E. Johnson and S.O. Fagade eds. Interspecific hybridization: Progress and prospect WARDA, 01BP2551, Bouake, Cote d' voire.dening. Emmaus, Pennyslvania: Rodale, 1992.

Buringh, P. 1989. Availability of agricultural land for crop and livestock production. In *Food and Natural Resources*, eds. D. Pimentel and C.W. Hall. 69-83. San Diego: Academic PressBadgley et al .2007.Organic agriculture and the global food supply. Renewable Agriculture and Food Systems: 22(2); 86–108.

CIA. 2006. Philippines. *World Factbook.* 11 July 2006, Accessed 27 September 2006. http://sportsforum.ws/sd/factbook/geos/rp.html#Econ. Caroline Lucas Mep, et al "Fuelling a Food Crisis: The impact of peak oil on food security", The Greens/European Free Alliance, European Parliament, 12/06

Defra, 2005. The Validity of Food Miles as an Indicator of Sustainable Development: Final report, Department of Environment Food and Rural Affairs.

Doiron. 2008. http://www.alternet.org/story/81769/

Doyle, A. 2007.Food, biofuels could worsen water shortages. http://today.reuters.com/News/CrisesArticle.aspx?storyId=L18850725

Dufey Annie, "International trade in biofuels: Good for development? And good for environment?" International Institute for Environment and Development, 2006.

Delft Hydraulics in George Monbiot, "If we want to save the planet, we need a five-year freeze on biofuels" The Guardian, 3/27/2007

David Tilman and Jason Hill, Washington Post, 3/25/07

EIA. 2000. US-EIA Presentation : Long Term World Oil Supply,

(http://www.eia.doe.gov/pub/oil_gas/petroleum/presentations/2000/long_term_supplyindex.htm)

FAO (1997) .The State of the Worlds Plant Genetic Resources for Food and Agriculture, Food Agriculture Organisation of the United Nations, Rome.

FAO. 2006. Livestock's Long Shadow. ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e.pdf

Ford Runge and Benjamin Senauer, "How Biofuels Could Starve the Poor",Foreign Affairs, May/June 2007

Goodchild, Peter, 2007. petergoodchild@interhop.net

Hamer, Ed & Mark Anslow. 2008. 10 reasons why organic can feed the world. http://www.theecologist.org/archive_detail.asp?content_id=1184

Hansen, James .2003. Twenty Years Later: Tipping Points Near on Global Warming http://www.huffingtonpost.com/dr-james-hansen/twenty-years-later-tippin_b_108766.html .June 23, 2008 | 05:57 PM (EST)

Harrabin, Roger. 2008 Call for delay to biofuels policy .BBC Environment Analyst http://news.bbc.co.uk/2/hi/science/nature/7309099.stm

Holt-Giménez, E. 2007. Exploding the Biofuel Myths Food First/Institute for Food and Development Policy (http://www.foodfirst.org/, published in http://www.foodfirst.org/node/1715>

Leu, Andre. 2007. Organic Agriculture Can Feed the World in Organic Farming, Winter 2007, citing Jules Pretty, 2006. http://www.rimisp.org/getdoc.php?docid=6440 Pretty, 1999, The Living Land.

Mae-Wan Ho. 2008. Organic Cuba without Fossil Fuels. http://www.i-sis.org.uk/full/OrganicCubawithoutFossilFuelsFull.php. SIS Press Release 21/01/08

McLaughlin, N.B., et al.2000. Comparison of energy inputs for inorganic fertilizer and manure based corn productionCanadian Agricultural Engineering, Vol. 42, No. 1, 2000.

Mendoza, TC. 2001. Pursuing Debates in Food Security in the New Millenium. SEARCA Professorial Chair lecture. Dept. of Agronomy, College of Agriculture, UP Los Banos, Phil. June 2001

MENDOZA, T. C. 2007. The Energetics of Ethanol Production and its Implications. *Asia Life Sciences* 16(2):115-138.

Mendoza T C.2007.ARE BIOFUELS REALLY BENEFICIAL FOR HUMANITY? Philippine Journal of Crop Science (PJCS) 32(3): 83-98.

Mendoza, T.C. 2008. Agronomic features, Ethanol Yields, Resource Use of Four Feedstocks for Ethanol Production Under Phil. Condition. *The Phil. J of Crop Science 3(1):*

Mendoza, T.C., E.T. Castillo and R. Demafilis. 2007. The Costs of Ethanol Production from Sugarcane under Eastern Batangas Conditions. *The Phil. J of Crop Science 32(3):25-48*

Mendoza, TC. 2008. Food security challenges. What must be done ? Power pt. presentation. "Peoples Forum on Hunger", held at PRRM Bldg., 56 Mother Ignacia, Quezon City, on March 28, 2008,

Mendoza TC.2008.Why food prices increase & what can be done. Philippine Journal of Crop Science 2008, 33(2): In Press

Ofon, Abah 2008. Globe and Mail, Canada. http://www.theglobeandmail.com/servlet/story/RTGAM.20080410.wfood0411/BNStory/International/home

Pfeiffer, DA. 2003. Eating Fossil Fuels. http://www.fromthewilderness.com/free/ww3/100303_eating_oil.html

Pimentel, David and Giampietro, Mario. 1994. Food, Land, Population and the U.S. Economy, Carrying Capacity Network, 11/21/1994. http://www.dieoff.com/page55.htm

Raya Widenoja and Brian Halweil .2008.Analysis: Banning "Bad" Biofuels, Becoming Better Consumers http://www.worldwatch.org/node/5587– January 23, 2008 – 12:05am

Rosenthal, Elisabeth. http://www.iht.com/articles/2007/12/17/europe/food.php)

UNPF (United Nations Population Fund). World Population to 2300. New York: United Nations. http://www.unfpa.org/swp/ US EPA, 1998, Ruminant Livestock and the Global Environment

Vitousek, P.M. et al. 1986. Bioscience 36. http://www.science.duq.edu/esm/unit2-3

Ziegler, Jean. 2008. Philippine Daily Inquirer, April 15, 2008

Annex A. Technical Issues and Concerns for Some Crops Intended for Biofuel under Philippines Conditions*

There is a legal mandate to produce biofuel. Unless the law is repealed or amended, then, we are bound to comply with it. Out of necessity, the law was enacted to provide guidelines in biofuel production at the macro-level. The detailed production aspects (micro level) need to be addressed at the farm level. Summarized in this paper are basic information for the much talk-about biofuel feedstock sources under Philippine conditions. For ethanol they are sugarcane, sweet sorghum and corn and for bio-diesel, it is jatropha. Production of coconut oil for biodiesel (coconut methyl esther)or CME is a complex issue as the price of cooking oil had increased considerably.

1. Sugar Cane

(a) The energy balance for sugarcane is positive. As of to date, it is the only crop under Philippine condition that shows positive prospects for biofuel production. It has an energy balance (Ee) ranging from 2.8-3.0.If the fuel used in distillery slop waste application are included , then the Ee decreases.

(b) Distillery slop waste disposal must be put in place especially during the rainy season where re-use or application in sugarcane fields could not be done anymore. Submarine sea discharge of distillery slop waste, must not be done. Moreover, throwing away slop wastes in creeks or rivers and finally to the sea without adequate treatment and clean up should be avoided.

(c) While it needs improvement overtime, the technology from sugarcane is already in place in the country. Despite this, there is slow progress in the building ethanol plants for biofuel. During the last NAST meeting where sugarcane ethanol production was discussed, it was suggested that a Feasibility study (including Policy recommendations) must be conducted to compare the autonomous versus adjunct distilleries to existing sugar mills. One-and-half years to go, about 600 million li of ethanol is needed to satisfy the 10% the blend to gasoline as per Biofuels Act.

2. Corn

(a) Not only corn is used as animal feed, it is also the food staple for some 20M Filipinos.

(b) Yearly, we are importing about 1M tons of corn or more to satisfy our requirements.

(c) Earlier pre-feasibility study conducted under Cagayan condition showed negative IRR even at P8/kg corn. At present, the farm gate price of corn ranges from P12-15/kg.

(d) The net ethanol yield for corn is so low since the energy balance in near 0 or slightly higher than 1. Much oil-based energy is used in planting to processing corn for ethanol.

It is good that using corn as feedstock for ethanol is already shelved .

3. Sweet Sorghum

(a) The agronomy of sweet sorghum production is not yet optimized under Philippine conditions.There are no locally bred variety for sweet sorghum (G x E principle, a variety which is good in India may not necessarily be good here). While breeding is in-progress, it requires time to hybridize, select progenies, tests the agronomic and yield performance of the selections across locations (adaptability) and years (stability). Likewise, crops cultural management practices – spacing, time of planting, fertilizer rates – are being optimized.Pest reactions, and agronomic performance of imported varieties are not fully known yet.

(b) Agro-processing interphases are yet to be done. The time of planting/ ratooning and harvesting to processing is yet to be optimized across locations. Ethanol yield that can be obtained from the stems are still low due to low brix and % Pol (low Apparent Purity= %Pol/Brix), low sucrose content. Our stoicheometric estimates indicates that ethanol yields per ton sweet sorghum stems could only yield 18-25li of ethanol or an average of 20 li (Mendoza, 2008).

Sweet sorghum is contemplated to be planted and harvested when there is no sugarcane harvesting ie. Moths of June,July, , August & September .Consider the 2 planting schedules:

<u>Schedule 1</u> July, August to September harvest . This means sweet sorghum should be planted in March, April , May or early June to harvest in July, August to September . Planting in March and April needs irrigation while harvesting in July, August to September coincides with the rainy months . Too much rain will present difficulties in harvesting, besides the sucrose yields will be low.

- Sweet Sorghum grows tall (>2m), may easily lodge due to typhoons
- Cutting/loading/hauling presents too much difficulties
- Moisture has dilution effects on the juice à reduce sugar content in the juice
- Moisture simply adds weight, making harvesting & hauling expensive since these items are paid by the weight
- Ratoon establishment will be impaired if it is too wet.
- Bud germination will be low
- Weeding/cultivation will be difficult
- Poor growth of ratoons leading to poor ratoon yield

<u>Schedule 2: December to January planting</u>

- Very optimum planting time if irrigation facilities are in place. Without irrigation, crops will be subjected to drought near harvest time when water is so

critically needed due to grain filling and sugar storage in the stem
- Harvested sorghum will have good ratoons if irrigated immediately
- Late planted sorghum may be affected by the early onset of rains. Difficulties will be encountered at harvest.

Risks are higher in using sweet sorghum as feedstock for ethanol production.

(1) ITCZ location of the country (>22 typhoons yearly); harvesting months for August to September are the peak rainfall and typhoon months; global warming/ global climate change has made production environment so risky.

(2) Biological risk factors as pests and adaptability since we do not have locally bred cultivars.

(3) Cultural factors – it's a new crop in the many areas where it is planned to be grown.

Recommendation:

(1) More R & D is yet to be done as in breeding locally adapted variety, optimizing its cultural management practices, and in assessing how the crop adapts in varying soil, rainfall or climatic variations in the country. It is still premature to promote sweet sorghum as feedstock for ethanol production on a commercial scale.

(2) Village-level or small scale of production must be tested first to determine the following:

a. Agronomic aspects of the crop
b. Agro-processing interphase

(3) Sweet sorghum is a new crop in the many areas where it will be planted. Farmers will take sometime to familiarize themselves to its culture. To compete with other crops , it must provide higher income if farmers are to grow Sweet sorghum. Using current varieties, unfortunately, do not show positive economic return on the part of the farmers.

(4) The logistics side of sweet sorghum if used as feedstocks for ethanol must be studied. Deleafing the stems is so laborious. A self-deleafing cultivar must be developed as in sugarcane .

4. Jatropha

(a) There are no existing plantations yet from where the yield levels claimed @ 5-7 tons/ha could be validated. There are doubts that 5 tons yield level could be obtained (Mendoza et al , 2007) as shown in the following estimates :
@ (30% oil x 5 tons) x 3.03 gram glucose equivalence of oil in seed = 4.54 tons
@ 2.42 gram glucose equivalence of seedcoat and the presscake = 8.48 tons
Total = 13.02 tons/ha

(b) The D1-oil pricing formula: Seed price = 15% x diesel oil price , is too low for farmers to make profit from Jatropha (ie. Diesel oil price @

P60/li = .15 x P60= P 9/kg seed ; 1kg seed = 10kg fresh fruits, P=0.60/ kg-fresh fruits). The sharing practice between the coffee harvester and the owner in Batangas is 50: 50 (Sandoval, personal communication ,2007; pjsandoval@yahoo.com). If this will be adopted, nobody will harvest Jatropha fruits at P=0.45/kg-fresh fruits. At P.45/kg or P4.50/ seed , the gross income for the farmer will only be P7,650/ha @ 1,700 kg-see/ha or even at the high yield level of 2,800kg/ha , the gross income will only be P12,600/ha.(The yield data were extracted from the UPLB data)

(c) Extracting Jatropha oil mechanically is also inefficient. The coconut mechanical oil expeller if used in Jatropha seeds to extract oil is giving very low oil yield at 20-27% only. Mechanical extraction needs to be optimized. Although enzymatic extraction gives higher oil yield but the enzymes are expensive (Demafelis,2008). Extraction data were obtained under laboratory scale . They are yet to be done under pilot plant or commercial scale. The enzymes should be locally produced to reduce their costs if ever that is possible.

(d) Just like the extraction process, the experiences on Jatropha trans esterification processes are limited. Studies are still under way.

(e) Jatropha oil is suggested to be for the industry and not for transport fuel. The quality of JME (Jatropha Methyl Ester) for transport fuel is still untested (AIPSI Managing Director Rafael Diaz , PDI B9, Feb. 18, 2008)). This concern of AIPSI must be addressed.

(f) Jatropha massively planted in hillsides or watershed should be studied further to determine the following:

   i. The effects on water supply downstream: Jatropha is drought tolerant, fine. But it also means that it absorbs limited moisture very well. This will lessen the moisture available to its companion plants and water supply downstream will also be depleted especially during El Nino years.

   ii. Jatropha has 2 toxins: Cursin and Phorbol ester . What will happen to these toxins if there are huge leaf fall and branches in the soil? How will it affect water quality that flows downstream?

(1) Unlike studies on the reuse of distillery slops from potable ethanol plants, so far there is no similar study on biodiesel wastewater reuse in the Philippines *Jatropha* biodiesel industry.

(2). Energetics is the study on the energy input and generation for certain activity or process. Energy requirements for biofuel production cover all energy inputs from feedstock from production, harvesting, hauling to the factory, primary and secondary processing and waste treatment/ disposal. For policy direction on prioritization of feedstock and process, study of energetics should be given top priority .

Our initial study on the energetics of Jatropha showed very low energy balance at 0.5 to 1.05 for low and high yield ,respectively. It should be emphasized that our analysis is at the production level only . It does not include yet processing and waste disposal.

Recommendation: Slow down in plantation establishment for Jatropha until the above issues are settled. It goes without saying also that the publicized LBP funding window @ PhP 4.3 billion for large-scale production of Jatropha should be frozen. Loan takers (farmers) are not assured if they could payback their loans due to the very low seed yield & seed price. What will happen to their lands if they are used as collateral?

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References

Mendoza, T C , Oscar Zamora, Joven Lales. Jatropha : What the Public should know. (Published in PDI Sept.9,2007 Faculty of Crop Science, College of Agriculture, University of the Philippines at Los Banos tcm_uplb77@yahoo.com

Mendoza, T.C. 2008. Agronomic features, Ethanol Yields, Resource Use of Four Feedstocks for Ethanol Production Under Phil. Condition. *The Phil. J of Crop Science 3(1):*

Mendoza, T.C. 2007. Energetics of Ethanol Production from Sugarcane and its Implications. Asian Life Science Journal 16(2):115-136

Mendoza, T.C., E.T. Castillo and R. Demafilis. 2007. The Costs of Ethanol Production from Sugarcane under Eastern Batangas Conditions. *The Phil. J of Crop Science 32(3):25-48*

Mendoza T C, Eulogio Castillo & Annalissa L Aquino. 2007. Towards Making *Jatropha curcas* (*Tubang Bakod*) a Viable Source of Biodiesel Oil in the Philippines. Philippine Journal of Crop Science 32(1): 29-44

Mendoza T C.2007.ARE BIOFUELS REALLY BENEFICIAL FOR HUMANITY? Philippine Journal of Crop Science (PJCS) 32(3): 83-98.