

## Food security implications of biofuel production

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### ABSTRACT

Producing liquid biofuel for cars to address the declining oil supply requires the same resources or inputs (land, water, initial energy or oil, fertilizer and machineries) as in producing food for humans. As early as the 1980s, all the prime lands in the world are already used for agri- and - aquaculture (1970s for the Philippines. Biofuel production consumed water (up to 10,000 L of water/L ethanol). At present, 74% of water is used to irrigate food crops. Only 1% water is now used for biofuel but this water consumption will increase to 80% if the biofuel production plan materializes. 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).

The simple linear thought is.....*more crops for food or biofuel = more lands and water use = more fertilizer or oil use = more erosion = more greenhouse gas emission.*

Biofuels have forced global food prices up by 75% , a World Bank study showed. In 2007, 100 metric tons (Mt) of grains were processed into biofuel . This precipitated to food price spikes in the following year. It is clear that without biofuel in the food equation, there will be enough food. As more money is spent for food, food price spikes have caused 100 million people to be below poverty line and food riots in 36 countries. About 3 billion people are now affected especially those who spend 60-70% of their income on food. There are many options other than biofuel such as solar, wind, and 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.

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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

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).

Human beings directly manage 27 % of the Earth's surface area and harvest more than 40 % of the planet's biological productivity (Vitousek *et al.*, 1986 ; Cox *et al.*,2002;2006). Yet food production per person is on the decline, and agriculture worldwide is worsening the global ecological crisis (Tillman *et al.*, 2001;Vidal,2007; Magdoff, 2008 ; Cox, 2008).The arable surface of the Earth (1.4 billion ha) is now fully utilized by agriculture and aquaculture (Buringh, 1989 ; Kindell and Pimentel, 1994). In the Philippines, as early as the 1970s, all the prime agricultural lands (10 million ha) (Mendoza, 2008) have already been cultivated. Expansion will encroach on fragile and less favorable agro-environments which are too steep, too dry, or with barren soils (Buringh, 1989 ). Of the 1.4

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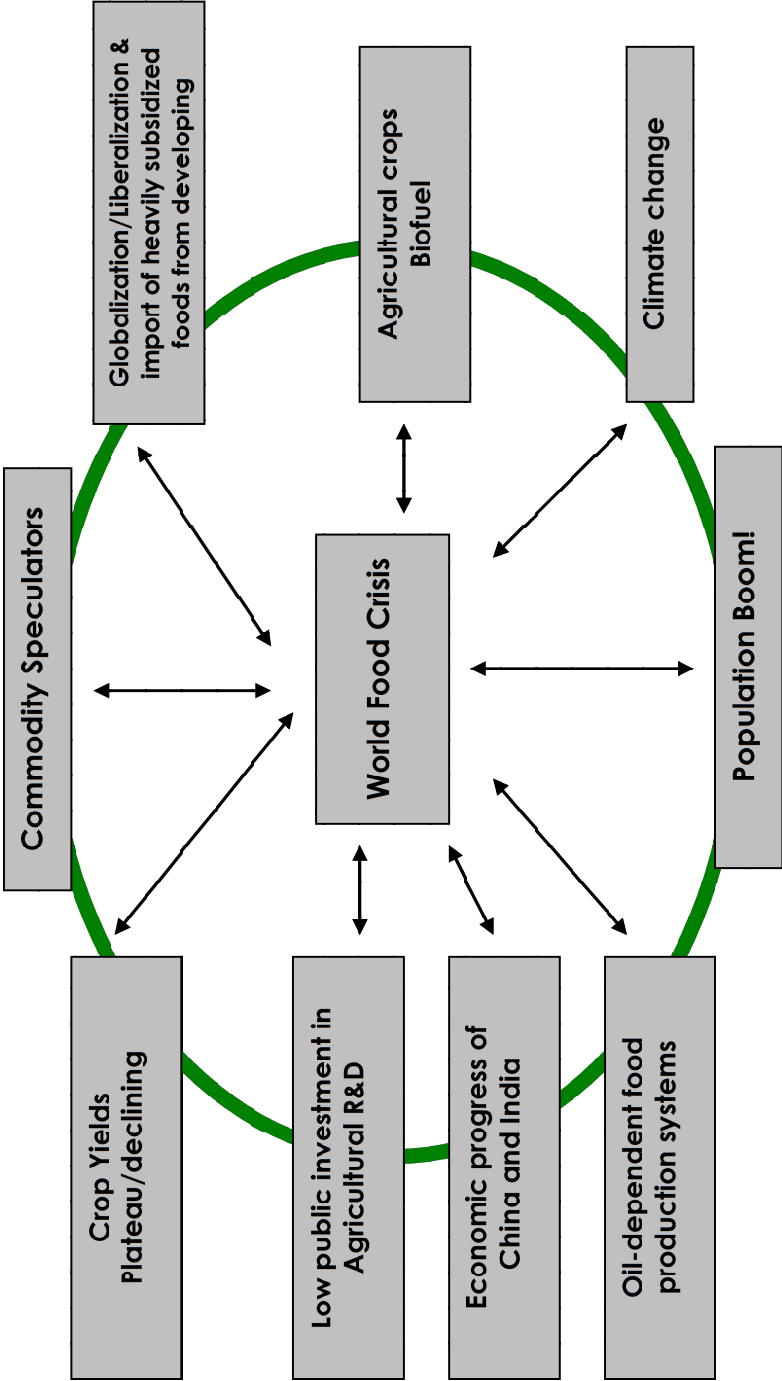


Figure 1. Determining factors of the world food crisis

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](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 (at 2,500 kcal, Revelle, 1976 as cited by Cohen, 1995). In the Philippines, the estimated ideal agricultural area is 0.43 ha/ person. This translates to about 28 million Filipinos who could be ideally living in the country (the Philippine population in 1960s). It means, we have exceeded our ideal population three times! The babies who will be born in the next 15 years will need another Philippines (Mendoza, 2008).

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 comprise about 40% of world population, is leading 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 (Altieri & Bravo, 2007; Magdoff, 2008) but also on energy use (by increased food miles, McKei, 2008; Defra, 2005) 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 food (which also increased food miles, McKei, 2008). Why produce when it is cheaper to import? But this was short-lived as food prices in the world market had increased.

### *The food supply status*

Reserves of cereals (FAO, 2008) revealed that world wheat declined 11% in 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 (Mt). 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 only 1.5 % (Cassman, 1999 as cited by Mendoza, 2008). Global stockpiles of cereals is estimated to decline by 53 mt this year (Elisabeth Rosenthal: <http://www.iht.com/articles/2007/12/17/europe/food.php>).

In the Philippines, in particular, enough rice is guaranteed through rice import at 2.7 million metric tons for buffer stock, the Government claimed and this year 2008, the first harvest of the year was 7.1Mt (41%) (Dept. of Agric., Philippine Daily Inquirer (PDI), June 25, 2008). The expected harvest of about 10.22 Mt (59%) for the rest of the year could not be achieved and so with the expected harvest for the year (17.32 Mt). Altogether, this was attributed to typhoons, floods and lower applications of fertilizer input by the farmers which in turn is due to its high price. 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).

### *Food price crisis or simple human denials?*

The era of cheap food is over, the chief of the Asian Development Bank 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% in the past 12 months; corn, 66 % and rice 220% , (2007 to date), the food that feeds half of the world, went "from being a staple to a delicacy," (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/kg. As of this date (October 2008), rice is sold at

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

Year	Philippine population (M)	Projected rice Requirement (1) (M tons)	Projected rice Requirement (20) (M tons)	Paddy rice Equivalent (1) (M tons)	Paddy rice Equivalent (2) (M tons)	Area Demand Gap (1) (M tons)	Area Demand Gap (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 2000 kcal from rice, 1.0 kg rice = 3,700 kcal, estimated by Mendoza, 2001) 64% milling recovery, 60:40 WS : DS crop; 3.7 m t/ha DS & 2.8 m t/ha WS = 3.2 m t/ha Assumed cropped Area per Year = 4.3 Mha (1.5 Mha irrigated x 2 +1.3 Mha rainfed), Rqrd.) 100 Sufficient yield level = Total Paddy Rice rad./ Cropped Area

Table 2. Estimated farm gate price of paddy rice and equivalent retail price per kg at various imported price (in US D/metric 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
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	104.20
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 tariff, \$1 = P43 exchange rate, plus handling costs (Nueva Ecija is the reference pt.), 64% milling recovery.

P40/kg and the cheapest is P26/kg which is 48.6% more expensive than it was a year ago. 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 were as follows: Imported rice ( at \$1136/t)= P 66/kg (Table 2), CPI corrected (1975 to 2008) = P68/kg (Table 3) , and adjusted price of rice with oil price at \$100/barrel = P70/kg (Table 4)

If the price of rice was 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

Table 3. Consumer price index (CPI) for selected commodities used to adjust the price of rice (1973 base year)

A	B	C	D	E
Year	FBT	1978=100	1973=100	
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 Philippine Statistics Yearbooks (1987 - 2007).

C = Adjusted CPI consistent with 1978 base price (1978=100).

D = adjusted CPI using data in C to make 1993 the base year.

E = CPI as price ratio at 1973 base year. 2008 Adjusted price of rice (1973 base year)

$$= 27.36 \times 2.5 = \text{P}68.40/\text{kg}$$

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



Table 4 . Estimated rice price adjustments as the price of oil increases

Oil Price Per Barrel (US\$)	Price Of Urea Per Bag (50 kg)	Price of Palay/Rice		
		Palay/Cavan (50 kg) 1	Palay/kg 2	Rice/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-production =Drying hauling, milling, warehousing, sack, profit (approximately ₱15/kg) Source :Mendoza 2008)

affordable levels. But this is disincentive to the farmers because they could hardly make a living out of farming. Subsidizing rice, a form of cash transfer to the poor, will mean huge costs. It was estimated that the National Food Authority had incurred losses up to P37 billion in 2007 (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 (Mendoza, 2001).

### *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](http://www.energyandcapital.com)) and in 40 years, the remaining 1.5 trillion 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, 2008), humanity consumes in one year. The era of cheap oil is gone! Oil price increasing to an unaffordable level also has positive effect as it will accelerate the shift to alternative energy sources and it will decrease considerably oil consumption. This in turn will reduce significantly greenhouse gas emission, thus, saving humanity by not reaching the predicted tipping point of 2 degrees centigrade increase in

temperature (Hansen, 2003).

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 L oil at 128kg/rice per person. Sugarcane uses 1120 L oil equivalent or 2.4 L oil at 20kg sugar/capita (Mendoza, 2008). Prices of food are inevitably affected with oil price increases. As the era of cheap oil is gone, so with 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 (Pfeiffer, 2003). Agricultural energy consumption is broken down as follows: 31% for the manufacture of inorganic fertilizer, 9% 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 and Giampietro, 1994 ; McLaughlin *et al.*, 2000 as cited by Pfeiffer, 2003). The first International Agriculture Assessment on Science and Technology Development (IAASTD, 2008) 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.org> and <http://www.panna.org/>).

### *The biofuel option*

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. Harrabin (2008) had called for a delay in biofuel production until proper safeguards and policies are crafted. 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.2.

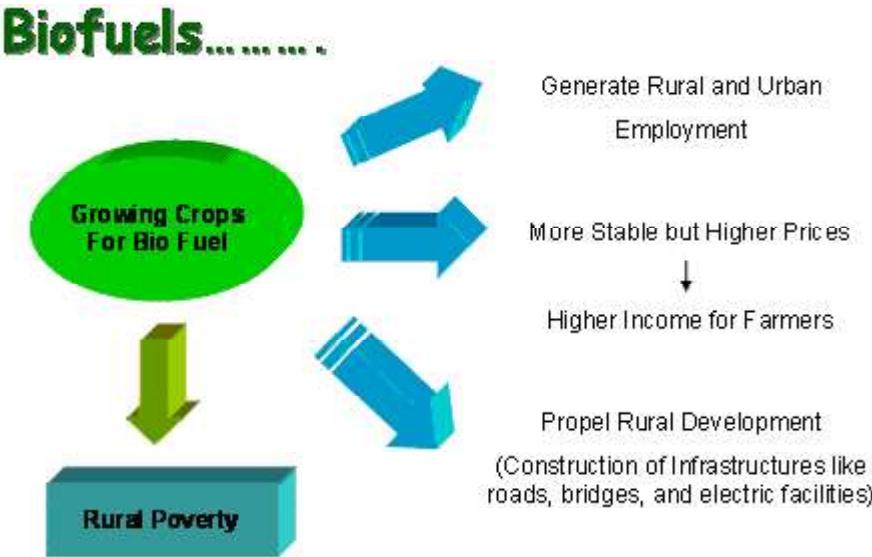


Figure 2. Perceived benefits of biofuel production.

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) 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 ).Others defined this as EROI ( Energy Returned/ Energy Input) (Cleveland *et al.*,1999; EROEI.com: [? eroei.com/articles/the\\_chain/what\\_is\\_ero](http://eroei.com/articles/the_chain/what_is_ero)

$$EROI_t^* = \frac{\sum_{i=1}^n \lambda_{i,t} E_{i,t}^o}{\sum_{i=1}^n \lambda_{i,t} E_{i,t}^c}$$

where  $\lambda_{i,t}$  is the quality factor for fuel type i at time t and Eo and Ec are the thermal equivalents of energy outputs and energy inputs, respectively.

The other is Energy Intensity (Ei) or the amount of energy used to produce 1.0 li of energy (ethanol) or  $E_i = 1/ E_e$  (Mendoza, 2008). As shown on Table 5, only 1 crop-sugarcane - is showing a positive energy balance. While sugarcane showed  $E_e = 2.8-3.05$ , the optimum energy efficiency as estimated by Hall (2003) is  $E_e = 5$ . The energy balance of ethanol production from sugarcane in Brazil  $E_e = 8$  (Macedo *et al.*,2004). 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

Table 5. Energy efficiency (Ee) and energy intensity (Ei) of the various feedstock sources for ethanol production (Source: Mendoza,2008).

Feedstock	Yield Level	Energy Efficiency	Energy Intensity*	Reference
Sugarcane <sup>2</sup>	Average	2.80	0.357	Mendoza <i>et al</i> 2007
	High	3.05	0.327	Mendoza <i>et al</i> 2007
Corn <sup>3</sup>	Low	1.06	0.940	Moriss 1994
	Average	1.25	.800	Shappouri <i>et al</i> 1995
	High	1.38	0.724	Lorenz & Moriss, 1995
Cassava <sup>4</sup>	Average	1.00	1.000	Hill <i>et al</i> 2006
	High	1.32	0.757	Hill <i>et al</i> 2006
Sweet Sorghum	Average	0.91	1.090	Worley <i>et al</i> 1992
	High	1.09	0.910	Worley <i>et al</i> 1992

means that the energy consumed in processing are not yet included (Ratilla & Mendoza, 2008).

#### *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 fuel 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 (Mendoza, 2008). Where shall we get all

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

	Year 1		Year 5		Year 10		Total	
	LDOE	%	LDOE	%	LDOE	%	in 5 years	in 10 years
<b>1. Fossil fuel based energy input (FFEI)</b>								
Fuel			45	9.67	45	9.67	90.00	315.00
Fertilizer								
Total	226.47	82.72	383.954	82.50	383.954	82.50		
<b>2. Indirect fossilfuel oil based energy input</b>								
A. Labor								
B. Seeds (g)	0.89	0.33					0.890	0.890
C. Bolo	2.775	1.01					5.550	5.550
<b>Total (IFFEI)</b>	<b>47.315</b>	<b>17.28</b>	<b>81.43</b>	<b>17.50</b>	<b>81.43</b>	<b>17.50</b>		
<b>Total Energy input</b>	<b>273.785</b>	<b>100.00</b>	<b>465.384</b>	<b>100.00</b>	<b>465.384</b>	<b>100.00</b>	<b>1560.47</b>	<b>3887.667</b>
<b>Energy use/kg</b>								
Seed yield (kg/ha)								
(low) = 1700 kg/ha			0.91809	0.38114			0.91809	0.38114
Seed yield (kg/ha)								
(high) = 2850 kg/ha			0.54763	0.22735			0.54763	0.22735
<b>Energy use/li oil yield</b>								
Oil yield (low) (30%)								
= 251 ton <sup>-1</sup> seed			1.83805	1.30344			1.8381	1.3034
Oil yield (low) (35%)								
= 292 ton <sup>-1</sup> seed			0.94243	0.66832			0.9422	0.6683
<b>Energy balance (low yield)</b>							<b>0.435</b>	<b>0.527</b>
<b>Energy balance (high yield)</b>							<b>0.849</b>	<b>1.027</b>

Table 7. Water consumed per liter ethanol produced\*

Feedstock	Liter Water Use/Liter of Ethanol++
Sugarcane	3,000-4,200
Corn	3,670-6,080
Cassava	3,000-9,700
Sweet sorghum	3,100-5,200

these lands without affecting food supply? About the same land area should be cultivated to provide the food requirements of the increasing population by 2030 at the current productivity levels.

#### *Biofuel and water*

About 2,000-10,000 L of water is needed to produce a L of biofuel. In Brazil, they use 2,200 L of water/ 1 L of ethanol from sugarcane, Phil = 3,000- 4,200, India = 3,500 L. 1 L 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 (Mendoza,2008 ). 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, 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".

#### *Biofuel 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<sub>2</sub> released is re-absorbed by the crops for photosynthesis - so there is no net increase in CO<sub>2</sub>; (2) Biofuels are renewable energy sources with a 1-year cycling time, while fossil fuel oils take several million years to be formed (Rodolfo, 2008; Magdoff, 2008). 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 (Hill *et al.*, 2006). 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 (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).

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(2.15 LDOE/kg once nitrogen fertilizer reaches the fields in the Philippines, Mendoza, 2008). 'Fertilizer energy' is 28% of the energy used in agriculture (Heller and Keoleian, 2003). Second, once applied in the soil, 3-5% of it escapes as [nitrogen oxides] NO<sub>x</sub>. NO<sub>x</sub> has 296x global warming potential (GWP). For every 1 kg nitrogen, more than 12 kg CO<sub>2</sub> 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 and Dale, 1981). 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 *et al.*,1995). 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% (Pimentel *et al.*,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% CO<sub>2</sub> and 90% of nitrous oxide emissions worldwide. The Amazon is being destroyed by farmers growing soybeans for food and fuel (Olmstead, 2006 ).

To reduce the cost of processing, coal is used in ethanol production, replacing petroleum (Farrell, 2006; Yacobucci, 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 (Andrews, 2006; Blanco-Canqui *et al.*, 2006). 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 and Weil, 2004; Lal, 1998.). 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. 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 ; Magdoff and Weil, 2004; Lal, 1998).

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 and Patzek, 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 in 2007. 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, 2008 Monbiot.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 %. It is now certain that Biofuels have forced global food prices up by 75% (Chakraborty, 2008). 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 (at 3000 Kcal/person ). By 2017, about 35 billion gallons will be produced which translates to the food caloric requirements of 1.4 B people (Mendoza, 2008). 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 (Carter & Miller, 2007).

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 and Sennauer, 2007 ). It is in this context that the a biofuel production should be delayed (Harrabin, 2008)

### *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, 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 (Pretty, 1996; Jeavons, 2001). 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 (Mendoza, 2008). We have no freezing winter that requires expensive heated glasshouses to grow crops.

Oil-based agriculture is unsustainable agriculture (Mae-Wan 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 had acknowledged 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.org> and <http://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 (Mendoza, 2008). Organic agriculture can feed the world (Pretty, 1996; Leu, 2007; Badgley *et al.*, 2007; Scialabba and Hattam, 2002). Organic farming requires lesser energy in growing crops (Niggli *et al.*, 2009) 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 (Stanhill, 1990; Pimentel *et al.*, 2005; Pretty, 2001, 2003). 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. Organic crops and livestock demand specialist knowledge and regular monitoring([http://www.theecologist.org/archive\\_detail.asp?content\\_id=1184](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 produced 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 since we can not eat the same amount of rice compared to well-polished 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. Many people in the world want to adopt the American diet. 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. This is called the thermodynamic loss of food via food type conversion. As feed, grain → animals → 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. Furthermore, the livestock sector is a major player, responsible for 18% of green house gas emissions in CO<sub>2</sub> equivalent (Steinfeld *et al.*, 2006). 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.

## SUMMARY AND CONCLUSIONS

Achieving food security and producing biofuel to power cars are challenges humanity faces in the new millennium. Food reserves in storage are claimed to have declined by 22% compared to the 2005-2006 level and that food reserves shall decline further this year 2008. In the Philippines, rice is the barometer of food security. The government claims there is no rice shortage. At present, the price of rice is again low if the cost of production is to be considered. 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 (2008) 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 increased by 2.22x (P17.50 to P40.0/kg, June 2008). Many believed 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 (at \$1136/ton import price), P68.4/kg relative to its price in 1975(CPI) and it is P86/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, requires 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 were already used for agri- and -aquaculture(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, the additional land area needed to produce the food requirements of 2 billion people by 2030.

So much land 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.

Producing biofuels also requires more water (up to 10,000 L of water/li) than producing 1 kg of corn or rice (5000 L 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).

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 (NO<sub>x</sub>) 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. 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 Millennium Development Goal of poverty reduction is set back once again.

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