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GLOBAL DEBATE ON USE OF BIOFUELS CONTINUES

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There are various social, economic, environmental and technical issues with biofuel production and use, which have been discussed in the popular media and scientific journals. These include: the effect of moderating oil prices, the "food vs fuel" debate, poverty reduction potential, carbon emissions levels, sustainable biofuel production, deforestation and soil erosion, loss of biodiversity, impact on water resources, etc.

The International Resource Panel, which provides independent scientific assessments and expert advice on a variety of resource-related themes, assessed the issues relating to biofuel use in its first report *Towards sustainable production and use of resources: Assessing Biofuels*. In it, it outlined the wider and interrelated factors that need to be considered when deciding on the relative merits of pursuing one biofuel over another. It concluded that not all biofuels perform equally in terms of their impact on climate, energy security and ecosystems, and suggested that environmental and social impacts need to be assessed throughout the entire life-cycle.

Social and economic impact

The International Energy Agency's *World Energy Outlook*, concludes that rising oil demand, if left unchecked, would accentuate the consuming countries' vulnerability to a severe supply disruption and resulting price shock. The report suggested that biofuels may one day offer a viable alternative, but also that "the implications of the use of biofuels for global security as well as for economic, environmental, and public health need to be further evaluated".

According to Francisco Blanch, a commodity strategist for Merrill Lynch, crude oil would be trading 15 per cent higher and gasoline would be as much as 25 per cent more expensive, if it were not for biofuels. Gordon Quaiattini, president of the Canadian Renewable Fuels Association, argued that a healthy supply of alternative energy sources will help to combat gasoline price spikes

"Food vs. fuel" debate

Food vs fuel is the debate regarding the risk of diverting farmland or crops for biofuels production in detriment of the food supply on a global scale. Essentially the debate refers to the possibility that by farmers increasing their production of these crops, often through government subsidy incentives, their time and land is shifted away from other types of non-biofuel crops driving up the price of non-biofuel crops due to the decrease in production. Therefore, it is not only that there is an increase in demand for the food staples, like corn and cassava, that sustain the majority of the world's poor but this also has the

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potential to increase the price of the remaining crops that these individuals would otherwise need to utilize to supplement their diets.

A recent study for the International Centre for Trade and Sustainable Development shows that market-driven expansion of ethanol in the US increased maize prices by 21 percent in 2010, in comparison with what prices would have been had ethanol production been frozen at 2004 levels. A November 2011 study states that biofuels, their production, and their subsidies as leading causes of agricultural price shocks.

The counter-argument includes considerations of the type of corn that is utilized in biofuels, often field corn not suitable for human consumption; the portion of the corn that is used in ethanol, the starch portion; and the negative effect higher prices for corn and grains have on government welfare for these products. The "food vs. fuel" or "food or fuel" debate is internationally controversial, with disagreement about how significant this is, what is causing it, what the impact is, and what can or should be done about it.

Poverty reduction potential

Researchers at the Overseas Development Institute have argued that biofuels could help to reduce poverty in the developing world, through increased , wider economic growth multipliers and by stabilising oil prices (many developing countries are net importers of oil). However, this potential is described as 'fragile', and is reduced where feedstock production tends to be large scale, or causes pressure on limited agricultural resources: capital investment, land, water, and the net cost of food for the poor.

With regards to the potential for poverty reduction or exacerbation, biofuels rely on many of the same policy, regulatory or investment shortcomings that impede agriculture as a route to poverty reduction. Since many of these shortcomings require policy improvements at a country level rather than a global one, they argue for a country-by-country analysis of the potential poverty impacts of biofuels.

This would consider, among other things, land administration systems, market coordination and prioritizing investment in biodiesel, as this 'generates more labour, has lower transportation costs and uses simpler technology'. Also necessary are reductions in the tariffs on biofuel imports regardless of the country of origin, especially due to the increased efficiency of biofuel production in countries such as Brazil.

Sustainable biofuel production

Responsible policies and economic instruments would help to ensure that biofuel commercialization, including the development of new cellulosic technologies, is sustainable. Responsible commercialization of biofuels represents an opportunity to enhance sustainable economic prospects in Africa, Latin America and impoverished Asia.

Soil erosion and deforestation

Large-scale deforestation of mature trees (which help remove CO_2 through photosynthesis — much better than does sugar cane or most other biofuel feedstock crops do) contributes to un-sustainable global warming atmospheric greenhouse gas levels, loss of habitat, and a reduction of valuable biodiversity (both on land as in oceans). Demand for biofuel has led to clearing land for palm oil plantations. In Indonesia alone, over 9,400,000 acres (38,000 km^2) of forest have been converted to plantations since 1996

A portion of the biomass should be retained onsite to support the soil resource. Normally this will be in the form of raw biomass, but processed biomass is also an option. If the exported biomass is used to produce syngas, the process can be used to co-produce biochar, a low-temperature charcoal used as a soil amendment to increase soil organic matter to a degree not practical with less recalcitrant forms of organic carbon. For co-production of biochar to be widely adopted, the soil amendment and carbon sequestration value of co-produced charcoal must exceed its net value as a source of energy.

Some commentators claim that removal of additional cellulosic biomass for biofuel production will further deplete soils.

Impact on water resources

Increased use of biofuels puts increasing pressure on water resources in at least two ways: water use for the irrigation of crops used as feedstocks for biodiesel production; and water use in the production of biofuels in refineries, mostly for boiling and cooling.

In many parts of the world supplemental or full irrigation is needed to grow feedstocks. For example, if in the production of corn (maize) half the water needs of crops are met through irrigation and the other half through rainfall, about 860 liters of water are needed to produce one liter of ethanol. However, in the United States only 5-15% of the water required for corn comes from irrigation while the other 85-95% comes from natural rainfall.

In the United States, the number of ethanol factories has almost tripled from 50 in 2000 to about 140 in 2010. A further 60 or so are under construction, and many more are planned. Projects are being challenged by residents at courts in Missouri (where water is drawn from the Ozark Aquifer), Iowa, Nebraska, Kansas (all of which draw water from the non-renewable Ogallala Aquifer), central Illinois (where water is drawn from the) and Minnesota.

For example, the four ethanol crops: corn, sugarcane, sweet sorghum and pine yield net energy. However, increasing production in order to meet the U.S. Energy Independence and Security Act mandates for renewable fuels by 2022 would take a heavy toll in the states of Florida and Georgia. The sweet sorghum, which performed the best of the four, would increase the amount of freshwater withdrawals from the two states by almost 25%.

Loss of biodiversity

Critics argue that expansion of farming for biofuel production causes unacceptable loss of biodiversity for a much less significant decrease in fossil fuel consumption. The loss of biodiversity also makes heavy dependence on biofuels very risky by reducing our ability to deal with blights affecting the few important biofuel crops. Food crops have recovered from blights when the old stock was mixed with blight resistant wild strains, but as biodiversity is lost to excessive agriculture, the possibilities for recovering from blights are lost.

Energy efficiency and energy balance

Production of biofuels from raw materials requires energy (for farming, transport and conversion to final product, and the production / application of fertilizers, pesticides, herbicides, and fungicides), and has environmental consequences.

The energy balance of a biofuel (sometimes called "Net energy gain") is determined by the amount of energy put into the manufacture of fuel compared to the amount of energy released when it is burned in a vehicle. This varies by feedstock and according to the assumptions used. Biodiesel made from sunflowers may produce only 0.46 times the input rate of fuel energy. Biodiesel made from soybeans may produce 3.2 times the input rate of fossil fuels. This compares to 0.805 for gasoline and 0.843 for diesel made from petroleum.

Biofuels may require higher energy input per unit of BTU energy content produced than fossil fuels: petroleum can be pumped out of the ground and processed more efficiently than biofuels can be grown and processed. However, this is not necessarily a reason to use oil instead of biofuels, nor does it have an impact on the environmental benefits provided by a given biofuel.

Life cycle assessments of biofuel production show that under certain circumstances, biofuels produce only limited savings in energy and greenhouse gas emissions. Fertilizer inputs and transportation of biomass across large distances can reduce the greenhouse gas (GHG) savings achieved. The location of biofuel processing plants can be planned to minimize the need for transport, and agricultural regimes can be developed to limit the amount of fertiliser used for biomass production.

A European study on the greenhouse gas emissions found that well-to-wheel(WTW) CO_2 emissions of biodiesel from seed crops such as rapeseed could be almost as high as fossil diesel. It showed a similar result for bio-ethanol from starch crops, which could have almost as many WTW CO_2 emissions as fossil petrol. This study showed that second generation biofuels have far lower WTW CO_2 emissions

Other independent LCA studies show that biofuels save around 50% of the CO_2 emissions of the equivalent fossil fuels. This can be increased to 80-90% GHG emissions savings if second generation processes or reduced fertiliser growing regimes are used[1]. Further GHG savings can be achieved by using by-products to provide heat, such as using bagasse to power ethanol production from sugarcane. Collocation of synergistic processing plants can enhance efficiency. One example is to use the exhaust heat from an industrial process for ethanol production, which can then recycle cooler processing water, instead of evaporating hot water that warms the atmosphere

Biomass planting mandated by law (as in European Union) results in large quantities of biomass being transported to EU from Africa, Asia and Americas (Canada, USA, Brazil).[37] For example inPoland as much as 85% of biomass used is imported from outside of EU,[38] with single electric plant in £ódŸ importing over 7'000 tons of wood biomass from Republic of Komi (Russia) over distance of 7'000 kilometers on monthly basis.

Solar energy efficiency

Biofuels from plant materials convert energy that was originally captured from solar energy via photosynthesis. A comparison of conversion efficiency from solar to usable energy (taking into account the whole energy budgets) shows that photovoltaics are 100 times more efficient than corn ethanol and 10 times more efficient than the best biofuel. However, photovoltaics produce electricity rather than storable, portable liquid hydrocarbon fuel, so they are largely irrelevant for powering the large existing fleet of vehicles and equipment having internal combustion engines. Green plants are self-assembling organisms and therefore much cheaper to produce than photovoltaic cells.

Carbon emissions

Biofuels and other forms of renewable energy aim to be carbon neutral or even carbon negative. Carbon neutral means that the carbon released during the use of the fuel, e.g. through burning to power transport or generate electricity, is reabsorbed and balanced by the carbon absorbed by new plant growth. These plants are then harvested to make the next batch of fuel. Carbon neutral fuels lead to no net increases in human contributions to atmospheric carbon dioxide levels, reducing the human contributions to global warming. A carbon negative aim is achieved when a portion of the biomass is used for carbon sequestration. Calculating exactly how much greenhouse gas (GHG) is produced in burning biofuels is a complex and inexact process, which depends very much on the method by which the fuel is produced and other assumptions made in the calculation.

The carbon emissions (carbon footprint) produced by biofuels are calculated using a technique called Life Cycle Analysis (LCA). This uses a "cradle to grave" or "well to wheels" approach to calculate the total amount of carbon dioxide and other greenhouse gases emitted during biofuel production, from putting seed in the ground to using the fuel in cars and trucks. Many different LCAs have been done for different biofuels, with widely differing results. Several well-to-wheel analysis for biofuels has shown that first generation biofuels can reduce carbon emissions, with savings depending on the feedstock used, and second generation biofuels can produce even higher savings when compared to using fossil fuels. However, those studies did not take into account emissions from nitrogen fixation, or additional carbon emissions due to indirect land use changes.