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Short Communication

Biofuel: Boon or bane

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Biofuels are going to play an extremely important role in meeting India's energy needs. The country's energy demand is expected to grow at an annual rate of 4.8% over the next couple of decades. Most of the energy requirements are currently satisfied by fossil fuels – coal, petroleum-based products and natural gas. Domestic production of crude oil can only fulfill 25 to 30% of national consumption. In fact, oil imports during August, 2010 were valued at US $ 7795 million which was 12.4% higher than oil imports valued at US $ 6936 million in the corresponding period last year. India was the sixth largest net importer of oil in the world, importing about 70%, of its oil needs and fourth largest consumer of oil in the world.

Key words: Biofuel, ethanol, blends, biodiesel.

INTRODUCTION

Ethanol, currently produced in India by the fermentation of sugarcane molasses, is an excellent biofuel and can be blended with petrol. Likewise, biodiesel, which can be manufactured by the transesterification of vegetable oil, can be blended with diesel to reduce the consumption of diesel from petroleum. Ethanol and biodiesel are gaining acceptance worldwide as good substitutes for oil in the transportation sector. Brazil uses pure ethanol in about 20% of their vehicles and 22 to 26% ethanol-petrol blend in the rest of their vehicles. The United States and Australia use a 10% ethanol blend. With a normal production rate of 1,900 million liters a year, India is the world's fourth largest producer of ethanol after Brazil, the United States and China. Beginning 1 January 2003, the Government of India mandated the use of a 5% ethanol blend in petrol sold in nine sugarcane-producing states. The Government will expand the 5% ethanol mandate to the rest of country in a phased manner. Biodiesel production is rapidly growing in Europe and the United States. Current estimates shows production of 2.2 Mt/year in Europe, with Germany (1.1 Mt/year), France (0.5Mt/year) and Italy (0.4 Mt/year) being the leading producers. The European Union mandated that its members derive at least 2% of their fuel consumption from biofuels by 2005 and 5.75% by 2010. Biodiesel production is about 245,000 t/year in the United States.

The Government of India has developed an ambitious National Biodiesel Mission to meet 20% of the country's diesel requirements by 2011 to 2012. Since the demand for edible vegetable oil exceeds supply, the Government decided to use non-edible oil from *Jatropha Curcas* oilseeds as biodiesel feedstock. Extensive research has shown that *J. curcas* offers the following advantages: it requires low water and fertilizer for cultivation, not browsed by cattle or sheep, pest resistant, easy propagation, high seed yield and ability to produce high protein manure. The National Biodiesel Mission will be implemented in two stages: 1) a demonstration project carried out between 2003 to 2007, which will cultivate 400,000 hectares of land and yield about 3.75 tons oilseed per hectare annually. The expected annual biodiesel production from the project is 1.2 t/ha/year for a total of 480,000 tons per annum.

The Government will build a transesterification plant with a biodiesel production capacity of 80,000 t/year as part of the demonstration project; and 2) a commercialization period from 2007 to 2012 will continue Jatropha cultivation and install more transesterification plants which will position India to meet 20% of its diesel needs through biodiesel.

BENEFITS FROM THE USE OF BIOFUELS IN INDIA

Reduced emission of harmful pollutants

Ethanol and biodiesel are both oxygenated compounds containing no sulphur. These fuels do not produce sulphur oxides, which lead to acid rain formation. Sulphur

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is removed from petrol and diesel by a process called hydro-desulphurisation. The hydro-desulphurisation of diesel causes a loss in lubricity, which has to be rectified by introducing an additive. Biodiesel has natural lubricity, and thus no lubricity-enhancing additive is required. Since ethanol and biodiesel contain oxygen, the amount of carbon monoxide (CO) and unburnt hydrocarbons in the exhaust is reduced. With the introduction of ethanol in Brazil, CO emission from automobiles decreased from 50 g/km in 1980 to 5.8 g/km in 1995. The emission of nitrogen oxides (No_x) from biofuels is slightly greater when compared to petroleum, but this problem can be ameliorated by using de-No_x catalysts, which work well with biofuels due to the absence of sulphur.

One of the disadvantages in using pure ethanol is that aldehyde emissions are higher than those of gasoline, but it must be observed that these aldehyde emissions are predominantly acetaldehydes. Acetaldehydes emissions generate less adverse health effects when compared to formaldehydes emitted from gasoline engines.

Reduction in greenhouse gas emissions

The net CO_2 emission of burning a biofuel like ethanol is zero since the CO_2 emitted on combustion is equal to that absorbed from the atmosphere by photosynthesis during the growth of the plant (sugarcane) used to manufacture ethanol. This is illustrated by the following equations:

$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6$ (plant sugar) $+ 6O_2$ (photosynthesis)
$C_6H_{12}O_6 + 3H_2O \rightarrow 3C_2H_2OH$ (ethanol) $+ 3O_2$ (hydrolysis and fermentation)
$3C_2H_5OH + 9O_2 \rightarrow 6CO_2 + 9H_2O$ (combustion of ethanol)

Life cycle analysis, from well to wheels, shows that ethanol has the lowest CO_2 emission among the major transportation fuels. Biofuels contribute significantly to climate change mitigation by reducing CO_2 emissions. Biodiesel projects can qualify as CDM projects and thus bring in additional income through the sale of certified emission reductions.

Increased employment

At the beginning of the new millennium, 260 million people in India did not have access to a consumption basket, which defines the poverty line. India is home to 22% of the worlds poor. A programme that generates employment is therefore particularly welcome. The biofuels sector has the potential to serve as a source of substantial employment. The investment in the ethanol industry per job created is $11,000, which is significantly less than the $220,000 per job in the petroleum field . In India, the sugar industry, which is the backbone of ethanol production, is the biggest agroindustry in the country. The sugar industry is the source of the livelihood of 45 million farmers and their dependants, comprising 7.5% of the rural population. Another half a million people are employed as skilled or semi-skilled labourers in sugarcane cultivation.

The first phase of the National Biodiesel Mission demonstration project will generate employment of 127.6 million person days in plantation by 2007. On a sustained basis, the program will create 36.8 million person days in seed collection and 3,680 person years for running the seed collection and oil-extraction centres.

Energy security and decreased dependence on oil imports

India ranks sixth in the world in terms of energy demand, accounting for 3.5% of the world commercial energy demand in 2001. But at 479 kg of oil equivalent, the per capita energy consumption is still very low, and the energy demand is expected to grow at the rate of 4.8% per annum. India's domestic production of crude oil currently satisfies only about 25% of this consumption. Dependence on imported fuels leaves many countries vulnerable to possible disruptions in supplies, which may result in physical hardships and economic burdens. The volatility of oil prices poses great risks for the world's economic and political stability, with unusually dramatic effects on energy-importing developing nations. Renewable energy, including biofuels, can help diversify energy supply and increase energy security.

Improved social well-being

A large part of India's population, mostly in rural areas, does not have access to energy services. The enhanced use of renewables (mainly biofuels) in rural areas is closely linked to poverty reductions because greater access to energy services can:

i) Improve access to pumped drinking water. Potable water can reduce hunger by allowing for cooked food (95% of food needs cooking);
ii) Reduce the time spent by women and children on basic survival activities (gathering firewood, fetching water, cooking, etc.);
iii) Allow lighting which increases security and enables the night time use of educational media and communication at school and home; and
iv) Reduce indoor pollution caused by firewood use, together with a reduction in deforestation.

Lack of access to affordable energy services among the rural poor seriously affects their chances of benefiting

from economic development and improved living standards. Women, older people and children suffer disproportionately because of their relative dependence on traditional fuels and their exposure to smoke from cooking, the main cause of respiratory diseases.

Electricity through transmission lines to many rural areas is unlikely to happen in the near future, so access to modern decentralized small-scale energy technologies, particularly renewables (including biofuels), are an important element for effective poverty alleviation policies. A programme that develops energy from raw material grown in rural areas will go a long way in providing energy security to the rural people.

Increase in nutrients to soil, decrease in soil erosion and land degradation

In ethanol production from sugarcane, the by-products like vinasse (solid residue left after distillation) and filter cake contain valuable nutrients. Using these organic fertilizers instead of chemical fertilizers reduces the need for chemicals, which could be hazardous and avoids pollution of ground water and rivers. International Crop Research Institute for Semi-Arid Tropics (ICRISAT) compares the nutrient content of filter cake obtained from various oilseeds in biodiesel manufacture with that of commonly used fertilizers like Di-Ammonium Phosphate (DAP) and Urea and demonstrates that the filter cake is an effective fertilizer: Also the cultivation of land for sugarcane and oilseed-bearing crops contributes to a decrease in soil erosion and land degradation.

Good fuel properties

Ethanol has a research octane number of 120, much higher than that of petrol, which is between 87 and 98. Thus, ethanol blending increases the octane number without having to add a carcinogenic substance like benzene or a health-risk posing chemical like methyl tertiary butyl ether (MTBE). The energy content of ethanol is only 26.9 MJ/kg compared to 44.0 MJ/kg for petrol. This would suggest that the fuel economy (km/l) of a petrol-powered engine would be 38.9% higher than that of an ethanol-powered engine. In actuality, this difference is 30% since ethanol engines can run more efficiently (at a higher compression ratio) because of the higher octane rating. For a 10% ethanol blend the fuel economy advantage of a petrol engine is only 3%. The flammability limit of ethanol (19% in air) is higher than that of petrol (7.6%), and likewise the auto-ignition temperature of ethanol is higher than that of petrol (366 versus 300°C). Thus, ethanol is safer than petrol due to the lower likelihood of catching fire.

Ethanol's higher latent heat of vaporization and greater propensity to absorb moisture may lead to engine starting and corrosion problems, respectively, but none of these problems have manifested in the millions of hours of running automobile engines in Brazil. Biodiesel has good fuel properties, comparable to or even better than petroleum diesel. It has 10% built-in oxygen content that helps it to burn fully. Its cetane number (an indication of its fuel burning efficiency) is 52 for biodiesel from Jatropha oil, higher than the 42 to 48 cetane number of most petroleum diesels. The esters of the long-chain fatty acids of biodiesel are excellent lubricants for the fuel injection system. It has a higher flash point than diesel, making it a safer fuel.

Other advantages are the almost zero sulphur content and the reduced amount of carbon monoxide, unburned hydrocarbons and particulate matter in the exhaust. But there are a few technical issues that need to be resolved. Biodiesel has a high viscosity at low temperatures, leading to flow problems at these temperatures. For long-term storage in hot, humid conditions, ethanol may require a biocide to prevent bacterial growth.

The other side of biofuels is not effective

The energy crisis driven by over-consumption and peak oil has provided an opportunity for powerful global partnerships between petroleum, grain, genetic engineering, and automotive corporations. These new food and fuel alliances are deciding the future of the world's agricultural landscapes. The biofuels boom will further consolidate their hold over our food and fuel systems and allow them to determine what, how and how much will be grown, resulting in more rural poverty, environmental destruction and hunger. The ultimate beneficiaries of the biofuel revolution will be grain merchant giants, petroleum companies, car companies; and biotech giants.

The biotech industry is using the current biofuel fever to greenwash its image by developing and deploying transgenic seeds for energy, not food production. Given the increasing public mistrust for and rejection of transgenic crops as food, biotechnology will be used by corporations to improve their image claiming that they will develop new genetically modified crops with enhanced biomass production or that contain the enzyme α amylase which will allow the ethanol process to begin while the corn is still in the field, a technology they claim has no negative impacts on human health. The deployment of such crops into the environment will add one more environmental threat to those already linked to GMO corn. As governments are persuaded by the promises of the global biofuel market, they devise national biofuel plans that will lock their agro-systems into production based on large scale, fuel monocultures, dependent upon intensive use of herbicides and chemical fertilizers, thus diverting millions of hectares of valuable cropland from much needed food production. There is a

great need for social analysis to anticipate the food security and environmental implications of the unfolding biofuel plans.

Clearly, the ecosystems of areas in which biofuel crops are being produced are being rapidly degraded, and biofuel production is neither environmentally and socially sustainable now nor in the future. It is also worrisome that public universities and research systems are falling prey to the seduction of big money and the influence of politics and corporate power. More importantly, we need to work together to ensure that all countries retain the right to achieve food sovereignty via agro ecologically-based, local food production systems, land reform, access to water, seeds and other resources and domestic farm and food policies that respond to the true needs of farmers and all consumers, especially the poor.

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