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Biofuels: Uses & Abuses

Biofuels are known to be a double edged sword. On the one hand, biofuels are heralded as an answer to growing energy needs while emitting less carbon emissions. Yet, at the same time, the production of biofuels has, for the most part, been a source of even more carbon emissions. The use of scarce agricultural land to grow these biofuels has also resulted in issues of food insecurity. This edition of NTS-Alert examines the progress thus far in utilizing biofuels as a sustainable energy source.

Differentiating Biofuels

Biofuels are renewable fuels that are made from plants. Given the global race to reduce carbon emissions, countries are working towards adopting such fuels into their economies. The European Union for instance aims to implement a binding target of making 10 percent of the transport fuels consumed by 2020 from renewable sources - most of which are expected to be biofuels. While many are quick to suggest that biofuels are dangerous, not many are aware of the various types of biofuels, which have different methods of production and scientific properties. This section takes a look at some of the varying types of biofuels available.

In this edition:

Corn-based Ethanol

Ethanol is a clear, colourless alcohol fuel made from the sugars found in grains, such as corn, sorghum, and wheat, as well as potato skins, rice, and yard clippings. There are several ways to make ethanol from biomass. The most commonly used processes today use yeast to ferment the sugars and starch in corn. Corn is the main ingredient for ethanol in the United States due to its abundance and low price.

According to Alex Farrell, an energy and resource scientist at the University of California, Berkeley, roughly 23% of the corn crop goes to ethanol, which in turn provides 3% of the nation's transportation fuels. Worldwide, however, biofuels make up less than 1% of transportation fuel. Current technologies could push that as high as 2–3%, "but anything much larger than that will have to be based on significantly different technologies".

Another disadvantage of corn ethanol has been the fact that producing it requires a substantial amount of heat and energy. Coal or natural gas is burned to turn the corn into grain alcohol, making this an environmentally undesirable process. One gallon of fossil fuel makes only 1.3 gallons of ethanol while burning corn ethanol reduces

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carbon dioxide emissions by only 22%. (One gallon of gas emits 20.4 pounds of CO2, while one gallon of corn ethanol emits 16.2 pounds of CO2.) In addition to this, corn planting and harvesting demand massive amounts of water – a typical corn ethanol facility uses 500 gallons of water a minute – and the heavy use of machinery, the latter of which degrades the quality of the soil. Moreover, the fact that corn kernels are needed for ethanol production, corn and a fuel source competes with it being a food source.

Sugarcane-based Ethanol

Ethanol can also be made from sugarcane, of which Brazil is the world's largest producer of sugarcane-based ethanol and has become almost entirely energy independent. In Brazil, more than five million vehicles and almost nine in ten new vehicles run on both gasoline and ethanol derived from sugar cane since 2003. According to Jackson Schneider, president of Anfavea, Brazil's car manufacturing association, such vehicles are predicted to make up 52% of the market by 2013, and increase from just 12% in 2007. The biofuel industry is rapidly expanding as governments and companies try to wean themselves off oil, and Brazil is a world leader, by producing 22 billion liters of ethanol biofuel derived from sugar cane in 2007.

Beyond the use of ethanol for passenger cars, Brazil is also a leader in generating electricity from renewable sources. According Brazil's Ministry of Energy and Mines, energy derived from biomass and hydroelectric plants account for 45% of the entire Brazilian energy matrix.

Sugarcane-based ethanol has several advantages over corn-based ethanol. Firstly, it requires far less energy than from corn; the cane begins to ferment the moment the stalk is cut and there is no need to convert starch to sugar. The distillation and fermentation process is quick and easy and the heat or energy needed for the process is generated not by fossil fuels but by cane ethanol. Secondly, the ethanol yield per acre of sugarcane is more than twice that of corn; sugarcane can be harvested seven times a year compared to soy and corn's single yearly harvest. And, engines that run on cane ethanol crank out more power than typical gas engines because cane ethanol burns at a higher compression.

Thirdly, greenhouse gas emissions are also lower than corn with nine pounds of CO2 per cane gallon for a 56 percent reduction of CO2 over regular gasoline. However, such emission rate calculations can only prove effective assuming that forest areas have not been cleared to grow sugarcane crops, thereby ensuring that carbon stored in the forest plants are not given off. In addition to this, similar to corn ethanol, the threat sugarcane ethanol poses to food security is always an issue (see report on Threat to Food and Water Security).

Palm Oil

Palm oil is a form of edible vegetable oil obtained from the fruit of the oil palm tree. According to the Malaysian Palm Oil Council statistics, global palm oil production was nearly levelled global soybean oil production at 30 million metric tons in 2004. It may have now surpassed soybean oil as the most widely produced vegetable oil in the world. It is also an important component of soaps, washing powders and personal care products, and has controversially found a new use as a feedstock for biofuel. Indonesia and Malaysia are prime markets for biofuel, in particular palm oil as they account for 83 percent of production and 89 percent of global exports.

Domestically, these countries (as well as others in Southeast Asia) are pursuing energy policies to include biofuels in the transport sector. In Malaysia, Prime Minister Abdullah Badawi announced in August 2005 that a National Biofuel Policy was being formulated. The policy called for the production of a biofuel blend of 5% processed palm oil and 95% diesel known as B5. The public would be encouraged to use this blend, by establishing an industry standard for palm biodiesel quality and promote the setting up of biodiesel plants in the country for export purposes.

Threat to Food and Water Security

The issue of food and water security still mars the credibility of biofuel production. Biofuels production threatens limited water reserves and therefore can seriously impact states' ability to meet food demands. By growing these biofuel crops additional water and land resources, conventionally used for food crops, would have to be utilized. According to the International Water Management Institute (IWMI) based in Sri Lanka, China and India, who are expected to account for nearly 70 percent of global oil demand between 2007 and 2030, are using cheaper biofuels derived from crops to help power their economies. This would therefore only worsen existing problems of food and water scarcity in various poverty-stricken parts of the countries.

Moreover, the water needed to process crops into biofuel is negligible compared with the amounts that go to growing them. Research at IWMI has shown that at a global average, the biomass needed to produce one litre of biofuel evaporates between 1000 and 4000 litres of water, depending on the type of feedstock and conversion techniques used. Sugarcane in Brazil evaporates around 2200 litres for every litre of ethanol. But in this water-rich region, the demand is easily met by abundant rainfall. In more arid countries, irrigation must make up the shortfall. In India, for example, a litre of sugarcane ethanol requires 3500 litres of irrigation water and almost all of India's sugarcane — the country's major ethanol crop — is irrigated, as is about 45 per cent of China's top biofuel crop, maize.

Yet increasing population and energy needs further aggravate the situation. By 2030, India's demand for cereal is set to rise by 60% and more than double for sugar. Analysis by the IWMI indicates that even under the most optimistic scenario, the demand for irrigation water will increase by 13 per cent — equivalent to 84,000 billion litres, or roughly the annual flow of the Krishna River. Growing sugarcane to produce the 9 billion litres of bioethanol needed to meet just 10 per cent of India's petrol demand by 2030 could add another 22,000 billion litres of irrigation water to the figure. And this is assuming that water efficiency improves.

In China, cereal demand is expected to grow by 45 per cent, mainly to feed animals. The amount of irrigation water that will be needed to meet this is estimated at 73,000 billion litres — an increase of 14 per cent from current demand for cereal crops. Growing maize to produce enough ethanol to meet 9 per cent of China's predicted demand for gasoline by 2030 could add another 26,000 billion litres.

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However, using such a blend of fuel has so far not been commercially viable due to the rising price of crude palm oil (CPO). Since the announcement of the policy, the price of CPO has more than doubled and has moved in tandem with the rising price of crude oil. From just RM1,350 per tonne of CPO in August 2005, the price of CPO has risen to RM3,710 just before Malaysia's general elections on 8th March 2008. Despite the issuance of over 90 government licences to companies for the production of biodiesel, the high CPO price has derailed or temporarily stopped the implementation of the other initiatives of the policy.

A Malaysian made biodiesel – the Envo Diesel – was launched in March 2006, but plans for its limited use have yet to be implemented. According to Malaysian Palm Oil Board chairman Datuk Sabri Ahmad, Malaysia will gradually be implementing a 2% blend of biofuel and diesel (B2) into domestic vehicle consumption in 2008.

This follows developments in neighbouring countries. In Thailand, the use of B2, became mandatory in February. this however resulted in a shortage of crude palm oil, thereby driving up the price of cooking palm oil. The Thai Energy Ministry has since then, considered setting up a national crude palm oil reserve in order to secure supplies to serve both the food sector and biodiesel production. According to the ministry's permanent secretary, Pornchai Rujiprapa, details of stock volumes, management and sources of funds would be finalised with the Agriculture and Commerce ministries. The reserve policy would also help prepare for the introduction of B5, which is now undergoing market testing and is expected to replace B2 by 2011. In order to meet crude palm oil demands, the Thai government is making available three billion baht in soft loans to offer planters in order to raise palm crops.

Yet, the palm oil industry still faces intense criticism over lack of sustainable measures used in production. Slash and burn methods have caused even more carbon emissions, which have not only contributed to global warming but also the annual transboundary haze over the Southeast Asian region. The expansion of biofuel crop lands have also resulted in internal conflicts over resources. In July 2007, about 1,500 angry villagers attacked the grounds of an oil palm plantation company in South Sumatra. The incident, which took place in the Ogan Komering Ulu regency, was the culmination of a lengthy land ownership dispute with Laju Perdana Indah, a subsidiary of the Salim Group. Such unrest has also been reported throughout the archipelago in recent years as plantation companies seek to increase their acreage in response to high international commodity prices.

Indonesian Agriculture Ministry data show that oil palm plantations have grown by more than 200 per cent during the last decade - from 2.7 million ha in 1998 to 6.1 million ha in 2006. And with the price of crude palm oil in Rotterdam hitting a record high of US$1,000 per tonne last month, the demand for more plantation acreage is likely to grow. Local communities in Indonesia's outer islands are also paying a heavy price. Although many indigenous communities have lived on the same land for generations, their rights are not clear under Indonesian law. Land alienation for plantations has also been made easier by recent legislation that allows companies working with local governments to take over traditional lands if they show that their business is in accordance with official development plans.

Jatropha

During an Expert Consultation on Biofuels in September 2007 organised by the Asia Pacific Association of Agricultural Research Institutions (APAARI), scientists noted that given the rampant poverty still existing Asia, the challenge is for governments to balance their food and biofuel production. Hence, there is an urgent need

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Parts of China and India have already breached the limits of sustainable water use, even without the added strain of trying to grow significant quantities of biofuels. Visible signs of the growing problem include rivers that are drying up, such as the Yellow River, which no longer reaches the sea during dry months; falling water tables in the North China Plain and in India's breadbasket region, the Punjab; and pollution and intense competition over water

Rising food prices, due to the use of limited land for growing biofuels instead of staple food crops, threatens the livelihood of not just the poor in developing countries, but also impact the world at large. According to a recent report on China's Dairy Industry by the UK based independent online business information portal Report Buyer, the price China’s dairy industry is greatly influenced by the trends in international dairy markets. The report based on the work of experts from China’s Dairy Department and the Beijing Orient Agribusiness Consultants noted that rises in the price of milk was due to the rising prices of corn, which is now being used to manufacture biofuels. Raw milk prices have risen, being directly linked to the fact that prices for foodstock for cows has risen

The United Nations World Food Programme (WFP) has expressed grave concern over the food price hikes (as much as 40%) as it reduces the amount of food aid needed to be distributed to poor countries dependent on foreign assistance for their survival. According to Josette Sheeran, Head of the WFP, based on the voluntary contributions from the world's wealthy nations, the WFP has a budget of US $2.9bn for the year 2008 to feed 73 million people in 78 countries (which make up less than a 10th of the total number of the world's undernourished). However, given the annual food price increases and dramatic hikes in fuel costs, that budget is no longer enough even to maintain current food deliveries.

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to strengthen policy research and identify a complementary approach that benefits both food and bioenergy sectors.

Fortunately, advanced research and development has discovered more sustainable forms of biofuels. Jatropha, for instance, is a valuable multi-purpose crop to alleviate soil degradation, desertification and deforestation, which can be used for bio-energy to replace petro-diesel, for soap production and climatic protection. The plant can also assist in increasing rural incomes, self-sustainability and alleviating rural poverty. It can as well help to increase income from plantations and agro-industries. Factors contributing to Jatropha's viability are primarily its low cost seeds, high oil content, short gestation period, ability to grow on both fertile and degraded soil, resistance to periods of both low and high rainfall, and relative ease of harvesting (due to plant's small size and durability in dry weather conditions).

In recent years, the Indian government has shown a major interest in Jatropha, and alongside other developing countries, a number of international groups are now sharing this interest. There have been substantial political and social pressures to promote the growing of such crops (in particular Jatropha curcas) in India, as a means of economic empowerment, social upliftment and poverty alleviation within marginalized communities. India has already announced plans to plant about 7.7 million acres of jatropha plantations by 2009, and to have identified another 98.8 million acres of wasteland by then to grow the plant.

Cellulosic Ethanols

Other scientific advances have resulted in what has come to be known as 2nd and 3rd generation biofuels. Studies – such as that by Joseph Fargione of the Nature Conservancy in Minneapolis, USA – have shown that biofuels made from waste biomass, or perennial crops grown on abandoned agricultural lands, offer "immediate and sustained greenhouse-gas advantages" as compared to "first generation" biofuels such as palm and corn oil. In the US, these 2nd and 3rd generation biofuels are known as cellulosic ethanols and can be made from switchgrass or woodchip, and are said to produce more net energy and emit significantly fewer greenhouse gases than corn-based ethanol.

In Singapore, plans to use wood waste-based biodiesel are underway. Environmental technology firm Biofuel Industries is set to build the first biomass cogeneration plant that will sell its power to the national grid. The S$30-million plant, to be located in the industrial district of Tuas, will produce 9.9 megawatts of electricity. Although its generation capacity is relatively small, it is part of its plan to create an integrated recycling business in Singapore. By turning wood waste into fuel chips, the plant is expected to halve electricity production costs. In an interview with ChannelnewsAsia, the company noted that it earns revenue from collecting the waste, exporting the recycled fuel chips and eventually selling the power to the grid. Construction of the plant is expected to start in late 2008.

Latest studies also note that algae has great potential as a cellulosic ethanol as it can produce 60% percent of its weight as oil under stress and can be cultivated in the ocean or polluted/sewage waters. By doing so, agricultural land can be saved and better used for food crops.

There is, however, the issue of economic viability. Such research is still in its infant stages and experts suggest it would only be available in the next 2 decades or so. Moreover, establishing biorefineries for cellulosic ethanol is immensely costly due to the complex refining process. The U.S. Department of Energy has been able to partially fund the construction of six such cellulosic biorefineries, estimated to cost a total of US$1.2 billion. With that said, it would seem extremely difficult for developing countries to take on such advanced technology, and thereby would rather remain with their first generation biofuel industries. Unless a post-Kyoto Protocol arrangement can effectively accommodate cellulosic ethanol technology into its clean development mechanism, the technology gap between the developed and developing world will remain far and wide.

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Fuelling the Friendly Skies

The world's first biofuel commercial flight by Virgin Atlantic has drawn both international acclaim and criticism. While some hail it as a breakthrough in aviation history, others see it as a gimmick that fails to provide substantial evidence of reducing carbon emissions. The aircraft flew from London to Amsterdam, with one of its four main tanks carrying 80% standard jet fuel and a 20% t mix of coconut and babassu oil. This "stunt" has attempted to provide hope to the aviation industry by spawning the path of harnessing carbon-free fuels. Rising fuel prices – and possibly future environmental taxes as a means of regulating emissions from airlines – have also provided the impetus amongst companies to pursue cheaper alternatives, thereby increasing the demand for biofuels.

Yet, many environmental groups suggest the flight was misleading and not scientifically backed in reducing carbon emission. Moreover, the flight does little to control the booming aviation industry worldwide.

There is also the issue of ensuring safety standards. A commercial aircraft that is powered on 100% biofuel has still yet to be a reality due to the fact that biofuels solidify in cold temperatures – a condition that would be experienced at high altitudes. The Virgin Atlantic flight was a success because biofuels only made up 20% of the fuel. A 100% use of biofuel in a commercial airline would therefore require much more energy to ensure that the fuels do not freeze and also further tests and improvements in aircraft design and engineering to accommodate the environmentally friendly fuels.

So far, only specific military aircraft have the capacity to use 100% vegetable oil as the aircrafts are equipped with built-in fuel-line heaters to ensure that the oil does not clog up the engine. The *BioJet 1*, a 1968 Czechoslovakian L-29 fighter jet, is one such aircraft, which reached about 17,000 feet (5,200 meters) on 100% biodiesel during a test flight in the US in October 2007.

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Upcoming Global Biofuels Events

Given the immense global interdependence of the Biofuels Industry, international events play a significant role in facilitating greater exchange of information and perspectives amongst policy makers, industrialists, biotech developers. March 2008 would be a significant month, as 3 international biofuel conferences are held in various regions of the world.

The first on the list would be in Africa. The 3rd Annual African Biofuels Conference will take place in Johannesburg from the 10th to 12th March 2008. In addition to government-level plenary discussions and in-depth socio-economic sessions, the summit will also include multiple topic streams namely, Ethanol and Biodiesel, the Clean Development Mechanism (CDM) in biofuels projects and the role of Biomass as a feedstock.

In Europe, the annual World Biofuels Markets is scheduled to be held from the 12th to 14th March 2008 at the Brussels Expo. This annual event brings together strategic decision makers from the international biofuels industry. With more than 190 speakers, 100 exhibition stands and five pre-congress conferences, the expo is expecting an estimated 1,300 delegates from at least 60 countries in the region. This is Europe's largest biofuels event and offers a perfect opportunity to network with industry leaders and representatives from all areas, from producers to biotech developers, agribusiness to finance and investors, government and regulators and transport and end users. Regular participants in the Expo include 'big players' such as Shell, BP, Toyota and many other car manufacturers, Electrabel, Samsung, Mitsubishi, Accenture, Unilever, Fortis, Dexia, The Royal Bank of Scotland, Virgin Fuels and the European Commission.

Finally, in Asia, the Biofuels Summit in Bangkok will take place from the 27th to 29th of March 2008. Similar to the above mentioned events, this summit seeks to provide critical global information on technological advancements on leading biofuels such as jatropha and ethanol markets. Greater insight will also be given regarding the growth of biofuels within the Asian region as well as beyond.

These conferences are only a tip of the iceberg of the many other biofuel-related events that will be taking place throughout the year. Malaysia, the world's second largest palm oil producer in the world, will be hosting the Biofuels Asia 2008 conference from June 17 to 20.

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