

CONTEXT

Rising demand for energy in emerging countries, dependence on oil from politically unstable regions and expected fossil fuel shortages have made energy security an increasingly critical issue. In addition, the projected impacts of climate change are forcing governments to limit greenhouse gas (GHG) emissions. These factors, along with the promise of new rural employment, have made biofuels a booming sector. Developing and industrialized countries have put biofuels at the top of their agendas, and world production is expected to rise fourfold by 2020. Yet concerns about fuels from agriculture are growing - directly linked to concerns about food security and strains on natural resources. An oil crisis would set back development efforts and the double impact of high food and oil prices would be devastating for the world's poorest. The vast range of issues and diverging interests related to biofuels require careful mapping of the topic.

SUMMARY: 10 THINGS TO KNOW

1. Biofuels are liquid or gaseous fuels from biomass, used not only for motor vehicles but also for stationary applications. Bioethanol is produced mainly from sugarcane or maize and is blended with gasoline; biodiesel is mainly from rapeseed and palm oil. Today, biofuels account for 1 percent of road transport fuels and are expected to account for 4-7 percent by 2030.
2. First-generation biofuels are derived from the edible part of food crops, while second-generation biofuels will be made from any plant material. Second-generation biofuels have a much higher potential to substitute fossil fuels and to reduce GHG, but will reach commercial scale only in about 10-15 years.
3. Biofuel production is booming, driven by government blending targets and subsidies, justified by energy security concerns and the wish to increase energy independence.
4. Tripling of oil prices since 2000 has severely affected net importers among developing countries, forcing them to divert funding from critical development needs such as health and education, and increasing public debt.
5. Tropical countries have the highest potential to produce biofuel crops: higher energy yields, better GHG balance if properly produced, lower costs and in some countries large reserves of uncultivated cropland. Large-scale biofuel production is an opportunity for certain developing countries to lower their dependence on oil imports.
6. Biofuels have the potential to create rural employment and contribute to rural development by providing decentralized small-scale sources of energy (off-grid rural electrification, substitution of diesel).
7. Biofuel production from food crops, along with rising food demand in emerging countries have already led, and will presumably continue to lead, to food price increases. This is a threat to the urban poor and to non-self sufficient farmers, but may also be an opportunity for farmers in the South who will benefit from higher producer prices and less competition from cheap imports of subsidized food from the North.
8. The expansion of agriculture for biofuels, if not properly managed, will lead to land degradation, water pollution and water scarcity, biodiversity loss, and deforestation.
9. Energy efficiency measures and fuel switching (e.g. away from coal) offer much greater and cheaper potentials for climate change mitigation than expansion of biofuel production.
10. The social and environmental opportunities and risks of biofuels are not priced in the market; therefore public policymaking is central at all levels.

WHAT ARE BIOFUELS?

BIOETHANOL AND BIODIESEL

Biofuels are liquid or gaseous fuels derived from renewable biomass. They are used as replacements for gasoline or diesel in motor vehicles as well as for stationary applications. The most widespread biofuels are bioethanol and biodiesel, which are produced from agricultural crops. This paper focuses on liquid biofuels, in particular on bioethanol and biodiesel.

Biofuels are synonymous with agro-fuels and have no environmental benefit per se.

Bioethanol is by far the most widely used biofuel for transportation. Blended with gasoline in a mixture not exceeding 10 percent, it can be used in cars without modifying the motor, or pure in redesigned engines. Bioethanol has less energy content than gasoline; therefore engines running only on ethanol have a consumption rate that is up to 30 percent higher. At present, about two thirds of bioethanol production comes from Brazilian sugarcane and US maize, and replace 3 percent of global gasoline consumed.

Ethanol is traditionally used for making alcoholic beverages.

Biodiesel is a diesel-like fuel and can also be used blended in a mixture not exceeding 10 percent with diesel oil in cars, or pure in modified engines. Today biodiesel replaces 0.3 percent of global diesel. It is mainly produced from rapeseed oil in Germany, which accounted for nearly half of world biodiesel production in 2005. Straight vegetable oil can also be used as biodiesel; it can be produced from oil seeds that can be processed locally in rural areas, using a simple press. The resulting liquid has a lower quality than industrial-scale biodiesel, which is transformed by a chemical process, but it can be used in simple diesel-type motors to generate electricity and power for pumps, or in special cooking stoves.

FEEDSTOCK AND AGRICULTURE

Today, biofuels are mainly produced from plants with high sugar or starch content, or from plants yielding oil. Ethanol is produced from sugarcane in the tropics, and from maize (and other grain) or sugar beet under northern latitudes. Biodiesel is produced from rapeseed, palm, soy or cooking fat. Sugarcane and palm oil plantations show the highest yield per hectare and are rapidly expanding in many countries. Sugarcane is mostly planted on already available agricultural land, whilst both palm oil and soy plantations have been linked to large-scale deforestation. The potential for biofuel production is particularly large in tropical countries where high energy-crop yields, low cost of labor and land, and little use of energy provide an economic and environmental advantage.

Theoretically, almost all crops could be transformed into biofuels, but each process bears different social, environmental and economic benefits and risks. In the past few years, *Jatropha*, a perennial plant yielding oil seeds, has been highlighted for its particular characteristics. *Jatropha* has non-edible seeds, can grow on poor soils, requires minor inputs, and can reduce erosion and promote land restoration. To obtain higher and more profitable yields, fertilizers and irrigation are needed. Sweet sorghum is another environmentally friendly biofuel crop which can be used for ethanol production and has the advantage of being drought-resistant. Plant species that have not been used in agriculture yet, such as sweet sorghum or *Jatropha*, require intense research before they can play a significant role. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), for example, is developing biofuel crops for marginal farmers in developing countries. It has recently introduced a promising variety of high-yield sweet sorghum.

Crop varieties with a high energy yield are being developed using all available breeding techniques, including genetic modification.

More info about *Jatropha* at <http://www.Jatrophabiodiesel.org/>

International Crops Research Institute for the Semi-Arid Tropics: <http://www.icrisat.org>

PRODUCTION AND PROCESSING

Compared to oil refining, biofuel production is more decentralized, requires far more manpower and can be processed through a variety of technologies. Today, first-generation technologies are applied to process the edible part of plants. In future, second-generation biofuels will be derived from any cellulose-rich material, enabling the large-scale conversion of non-food products.

Cellulose is the primary component of the solid structure in all plants.

First-generation technologies are well known and established. Ethanol is produced through fermentation of sugar, which can also be derived from starch using enzymes. Pressed vegetable oils can be used as a fuel additive to diesel, without further processing. The chemical process of transesterification, however, produces a higher-quality fuel. Valuable byproducts such as bagasse and vinasse can be used as a source of electricity, heat, fertilizers or animal feed.

Bagasse is a residue from sugar manufacturing that is burned to produce heat and electricity in the ethanol manufacturing process.

Second-generation technologies are under development and should reach commercial scale within 10-15 years. They make additional use of lingo-cellulosic carbon as contained in food crop

Vinasse is the waste-water rich in energy and minerals which remains after ethanol production.

wastes and forestry wastes, fast-growing woody crops or perennial grasses to produce ethanol. Woody biomass can also be converted into synthetic biodiesel. Most research and development is done in OECD countries, where some pilot plants already exist. The advantages of second-generation technologies are that:

- They have a higher potential to reduce greenhouse gases.
- Feedstock is much more abundant than food crops and does not compete with the latter.
- They require less agrochemical inputs and exert less strain on land and water resources.
- Second generation technologies can reduce land degradation.

Among the disadvantages are that:

- They use advanced patented technologies which are copyright protected.
- They usually require large-scale plantations.
- Initial investment costs are high.

In future, economically viable second-generation technologies should lead to an important expansion of global biofuel production. Still, low-cost biofuels from tropical countries are expected to remain competitive.

WHY ARE BIOFUELS AN ISSUE?

ENERGY DEMAND AND ENERGY SECURITY

World energy consumption is expected to grow by 50 percent by 2030. Over 70 percent of this increase will come from developing countries, led by China and India, and about 80 percent of the demand is likely to be met by fossil fuels. But oil production will soon decline in many countries, and supply will come from even fewer countries. The threat to the world's energy security is growing and a disruption of oil supply would be particularly detrimental to poor countries.

IEA, World Outlook 2006
<http://www.worldenergyoutlook.com/graphics.htm>

Dependence on imported oil makes poor developing countries without fossil fuel resources critically vulnerable to any disruption of prices and supply. Recent price increases have had devastating effects for some of these countries. In some cases, foreign exchange spending on oil imports has been much higher than debt relief and certain countries have spent much more on fossil fuels than on health or on poverty reduction. Transportation, machinery and power generation are becoming unaffordable for many. High oil prices can seriously set back poverty reduction and economic development efforts. Failure by governments to pass the rising costs on to consumers can cause even more serious public expenditure problems (global fossil fuel subsidies are estimated at USD 250 billion/year). In today's world energy context, increasing the diversification of the energy mix and reducing the reliance on fossil fuels are pressing objectives for the net-importers among developing countries.

GREENHOUSE GASES AND CLIMATE CHANGE

From an environmental perspective, the promotion of biofuels aims at reducing global greenhouse gas emissions to limit climate change. Plants grown to produce biofuels absorb as much carbon dioxide during photosynthesis as biofuels release during combustion. In this regard, the key question is how much GHG is emitted during the whole biofuel production chain, taking into consideration the emissions from cultivation, extraction, transport, processing, distribution and combustion. The GHG balances of biofuels vary massively, ranging from more GHG released than fixed by the plants, to 90 percent reduction when substituting fossil fuels. The main factors influencing GHG balances are:

- Previous use of the land where biofuel crops are grown (forest, peatlands).
- Choice of crop and region of cultivation.
- Cultivation method (use and volume of agrochemicals and farm machinery, etc.).
- Processing system (type of energy required, energy efficiency).

GHG balances are particularly successful today in Brazil for sugarcane ethanol and in the North for cooking fat. In contrast, starch crops grown in a temperate climate generally require high fossil energy inputs and therefore show much lower GHG reduction. The great variations in GHG emissions make forecasts and consequently decision making difficult. In addition, other environmental parameters such as negative impacts on natural resources must also be taken into consideration. The optimal crop, cultivation method and means of processing for each context have to be found. Analytical tools such as Life-Cycle Analysis (LCA) can help identify the best environmental alternatives, however, social parameters have not yet been integrated in this tool.

Life-Cycle Analysis is a technique to assess the potential environmental impacts of identified inputs and outputs associated with a product or a process.

EMPA Ökobilanz von Energieprodukten: ökologische Bewertung von Biotreibstoffen:
<http://www.empa.ch/plugin/template/empa/3/60112/---/!1>

Today, biofuels tend to be an expensive way of reducing GHG, especially if all subsidies, tax reductions and opportunity costs are taken into account. Where the aim is to reduce GHG emissions, biofuel production is usually less effective and less cost-efficient. Energy saving measures and fuel switching (e.g. away from coal) offer much higher and cheaper potential for GHG reduction.

SUBSIDIES AND TRADE BARRIERS

Agriculture in the North is subsidized at a level of about USD 300 billion/year. This has led to severe market distortions and trade constraints that add to developing countries' difficulties of exporting to richer countries while also producing enough food for their own populations. Biofuels are often perceived as a good opportunity to possibly reduce trade distortions due to existing support for agriculture, by shifting the offer away from exportable foodstuffs. Biofuels are a new reason for subsidizing crops and are therefore usually backed by farmers' lobbies. Today, subsidies for biofuels are very important in the United States and the European Union, and there are various types of protectionist measures in most countries. Heavily subsidized Northern biofuel industries are not able to compete without such measures. The dangers of resulting market distortions include promotion of biofuel crops in climate zones where energy yields are unfavorable, fossil fuel inputs are high, and costs non-competitive. Trade barriers aimed at Southern imports will delay development of biofuels in developing countries with comparative advantages.

International Institute for Environment and Development (IIED) Biofuels production, trade and sustainable development: emerging issues
<http://www.iied.org/pubs/pdf/full/15504IIED.pdf>

UNCTAD The Emerging Biofuels Market: Regulatory, Trade and Development Implications:
<http://www.unctad.org/TEMPLATES/webflyer.asp?docid=7754&intItemID=3830&lang=1>

Today, the WTO classification of biofuels as tradable goods is uncertain: are they industrial, agricultural or environmental goods? Depending on their status, biofuels will be subject to different sets of trading rules and will be treated differently in multilateral trade negotiations. There is increasing evidence that the least trade-distorting way of categorizing biofuels would be to declare them industrial goods so that the risk of harmful subsidization can be curtailed.

MARKET AND TRADE

The recent global interest in biofuels has been translated into a rapidly expanding international market. Global bioethanol production more than doubled in 2000-2005, with Brazil and the United States each producing about one third of world production in 2005. The world biofuel market is driven by blending-target policies, which account for about 2.8 percent of the 2006 demand for transportation fuel. Today, less than 10 percent of bioethanol production enters the international market, but exports are expected to grow very rapidly in the coming years. Analysts forecast a 30 percent annual growth rate for the industry over the medium term.

WHAT IS THE INTERNATIONAL COMMUNITY DOING?

THE UNITED NATIONS, INTERNATIONAL ORGANIZATIONS AND NGOS

Numerous international players are addressing the issue of biofuels and want to take a leading role. Several initiatives are scattered among UN bodies, as there is no single entity in the UN system that has prime responsibility for energy. Specific topics involving biofuels are covered by nearly every UN organization. UN Energy, which was created to coordinate UN agencies including the World Bank on energy matters, recently published an important report on biofuels. The FAO launched its International Bioenergy Platform in May 2006, which is to work in close cooperation with the G8 Global Bioenergy Partnership. The United Nations Conference on Trade and Development (UNCTAD) introduced the UN Biofuels Initiative in June 2005; this initiative is being carried out in partnership with FAO, UNDP, UNEP and the United Nations Industrial Development Organization (UNIDO). The initiative aims at building capacity for the production, use and trade of biofuels in developing countries, including through use of the Kyoto Protocol project-based carbon trading mechanism - the Clean Development Mechanism (CDM).

UN Energy:
<http://esa.un.org/un-energy/>
Sustainable Bioenergy – A Framework for Decision Makers:
<http://esa.un.org/un-energy/pdf/susdev.Biofuels.FAO.pdf>

Since 1978, the International Energy Agency (IEA) has a Bioenergy Program in which Switzerland is participating. The IEA also publishes the annual "World Energy Outlook", which is a highly regarded reference report.

IEA Bioenergy:
<http://www.ieabioenergy.com/>
World Energy Outlook:
<http://www.worldenergyoutlook.org/>

NGO activities focus on the sustainability issues of biofuels and express their concerns about specific issues related to their area of expertise. They are active in formulating and implementing voluntary certificate systems, e.g. FSC for wood, RSPO for palm oil. There is an urgent need for general biofuel standards, and several initiatives have been launched. The Roundtable on Sustainable Biofuels, one of these promising initiatives, was started by the Swiss Federal Technical Institute in Lausanne (EPFL). It is a multi-stakeholder effort that brings together representatives from governments, corporations and nongovernmental organizations.

FSC Forest Stewardship Council:
<http://www.fsc.org/>
RSPO Roundtable on Sustainable Palm Oil:
<http://www.rspo.org/>
Roundtable on Sustainable Biofuels:
http://cgse.epfl.ch/page6566_0.html

PRIVATE-SECTOR INITIATIVES

The biofuel industry is booming, and corporations are jumping into this promising market. The automotive and fuel industry is particularly interested in liquid biofuels, as this form of renewable energy can be used in existing engines and distributed through the existing distribution channels for fossil fuels.

Recently, the British company NRG Chemical Engineering invested 1.3 billion USD in biofuel plantations and processing plants in the Philippines; DaimlerChrysler is running a pilot program for *Jatropha*-based biodiesel in India; Brazil and the United States are making large investments in Latin America. The UBS recently created the first biofuels index and Ernst & Young released its Biofuels Country Attractiveness Indices, which rank countries in terms of their commercial attractiveness to biofuels (without taking energy efficiency or social aspects into account).

Ernst & Young Renewable Energy Country Attractiveness Indices: [http://www.ey.com/Global/assets.nsf/International/Industry_Utilities_BiofuelsIndices-Q1-07/\\$file/Industry_Utilities_Biofuels_Q12007.pdf](http://www.ey.com/Global/assets.nsf/International/Industry_Utilities_BiofuelsIndices-Q1-07/$file/Industry_Utilities_Biofuels_Q12007.pdf)

WHAT ARE THE REGULATORY TRENDS AND PRODUCTION PATTERNS?

THE UNITED STATES, EUROPEAN UNION AND SWITZERLAND

Based on the structure of US and EU demand and despite heavy subsidies and tariffs, the United States and the European Union will not have the capacity for sufficient levels of domestic production and will have to import biofuels to meet their blending targets.

In the United States, ethanol is produced from maize but requires large inputs of water, fertilizers and fossil fuels. In 2005, about 15 percent of total maize production was used for ethanol and about 3 percent of US gasoline consumption was replaced by it. In 2006, for the first time the US converted more corn into ethanol than it exported. The core consideration for the United States is energy security. Other objectives are job creation and support for businesses in rural areas. Biofuels are heavily subsidized regardless of their environmental impacts and energy inefficiencies.

Biofuels: At What Cost? Government Support for Ethanol and Biodiesel in the United States http://www.globalsubsidies.org/article.php3?id_article=6

The European Union required Member States to adopt biofuel blending targets of 2% by the end of 2005 (only 1.4% achieved) and 5.75% by end of 2010. To meet these targets, the Commission is considering 30-85% imports.

EU Renewable Energy Portal: <http://www.agores.org/>
EU Communication from the Commission : An EU Strategy for Biofuels http://ec.europa.eu/agriculture/biomass/biofuel/com2006_34_en.pdf
Annex: Impact Assessment http://ec.europa.eu/agriculture/biomass/biofuel/sec2006_142_en.pdf

Switzerland currently has no overarching national biofuel program. Biofuels produced from crops grown in Switzerland are generally too expensive and the production potential is very limited. In March 2007, a new law was enacted by the Swiss Parliament exempting all biofuels from the 'mineral oil tax', regardless of where they are produced. This exemption is linked to minimum social and environmental standards that remain as yet undefined.

AFRICA

The African continent has several comparative advantages for producing biofuels. Some countries have large surfaces of suitable rain-fed lands that have not yet been cultivated, and generally agriculture can be largely improved. At the same time, many countries, even some with good agricultural potential, are struggling to provide sufficient food for their rapidly growing populations. In all cases, governments will have to balance their agriculture and energy policies very carefully when considering biofuels.

Due to its geographical and social situation, Mozambique may become an important biofuel producer: suitable climatic conditions for sugarcane and oil-tree crops, abundant arable land and a largely rural population. The Mozambican government is preparing an ambitious biofuel program aimed at decentralized production of electricity, gradual blending of gasoline and biofuel-gel as a substitute for kerosene and firewood in lighting and cooking.

The Nigerian National Petroleum Corporation recently signed an agreement with the Brazilian state-owned oil company Petrobras to build an ethanol plant on the shore of the Niger River, aimed at supplying the local market and helping Nigeria achieve a 10 percent ethanol blend in its gasoline supply. Brazil intends to strengthen South-South cooperation and uses its biofuel know-how for this purpose.

A survey on Tanzania's biofuels potential and implications was carried out by GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit). As in many other least developed countries, imports of petroleum products account for 40 percent of all imports in Tanzania, which absorbs

large amounts of scarce foreign reserves. At the same time, Tanzania has a large potential for expansion of rain-fed crop production. The study concludes that steps need to be taken rapidly to promote the production of biofuels and that, with current oil prices, Tanzania's ethanol is likely to rapidly become competitive on commercial terms.

GTZ Study 2005: Liquid Biofuels for Transportation in Tanzania
<http://www.gtz.de/de/dokumente/en-biofuels-for-transportation-in-tanzania-2005.pdf>

Zimbabwe pioneered the production of ethanol in Africa. It started a program in 1980 and has since been blending gasoline with 12-15 percent ethanol. As sugar-producing countries, South Africa and Swaziland are well positioned to become exporters of bioethanol. Madagascar is also in the process of developing its ethanol industry on the basis of sugarcane. Zambia is reported to have a large amount of high-potential available land and could become an important ethanol producer. It has also set fuel blending targets and is promoting the planting of *Jatropha*.

ASIA

The increasing demand for fossil fuels worldwide is led by China and India. China's share of world carbon dioxide emissions is rapidly overtaking the share of the United States, which is currently the world's highest. China is also the second largest importer of crude oil. It currently accounts for about 9 percent of world ethanol production, deriving it mainly from maize, cassava and rice. China is exploring other possibilities of biofuel production, but considering the scarcity of its agricultural land, its potential is limited and it will probably become a large net importer. In the face of increased and undesirable competition between food and fuel, China has recently decided to stop ethanol projects based on food crops and to rely exclusively on non-food energy crops.

GTZ Study 2006: Liquid Biofuels for Transportation: Chinese Potential and Implications for Sustainable Agriculture and Energy in the 21st Century
http://www.ifcbiofuels.org/pdfs/biofuelsinchina_GTZ2005.pdf

Driven by a growing dependence on petroleum imports, India started an ethanol blending program in five states in 2003. A byproduct of sugar production from sugarcane was used to produce ethanol but production declined in 2004 because of drought. A new large-scale program was initiated for biodiesel production with *Jatropha* and *Pongamia*. These non-edible oil plants can be grown on marginal lands. This strategy was chosen because of food security concerns and the potential of generating jobs in poor rural areas. However, several substantial uncertainties remain: How much marginal land is really available? What are the real potential yields and the appropriate production technologies? What is the right scale of production?

TERI/GTZ Study 2005: Liquid Biofuels for Transportation: India country study on potential and implications for sustainable agriculture and energy
<http://www.gtz.de/de/dokumente/en-biofuels-for-transportation-in-india-2005.pdf>

As the world's largest palm oil producer, Malaysia has a dual strategy of reducing its dependence on fossil fuels and becoming a major biofuel exporter. Malaysia and Indonesia are both rapidly developing their palm oil industry and may soon become major biodiesel suppliers. Both countries have been criticized for expanding their palm oil plantations at the expense of rainforest, leading to massive deforestation. Pakistan is a traditional sugar exporter, and is currently implementing pilot ethanol projects. As a large sugar producer, Thailand set itself a 10 percent ethanol blending target in 2007. Japan and South Korea, which have also adopted blending targets, are set to become large importers of biofuels.

LATIN AMERICA

In general, Latin America has available land and a suitable climate for both bioethanol and biodiesel. With Brazil as the leading pioneer of ethanol production and new prospects for North American markets, the region has important preconditions and driving forces to become the market's global leader. Many countries such as Argentina, Costa Rica, Colombia, El Salvador, Jamaica, Mexico, Nicaragua, Paraguay, Peru and Venezuela have adopted biofuel programs or are planning to do so.

LAMNET: Latin America Thematic Network on Bioenergy
<http://www.bioenergy-lamnet.org/>

The Brazilian government launched its national ethanol program (Proalcool) in 1975 with considerable subsidies. Proalcool was generally successful and was terminated in the 1990s with the liberalization of the price of ethanol. Brazil has managed to replace 40 percent of its gasoline consumption. It is now the world's largest producer and exporter of ethanol. Its share of the global ethanol export market is about 50 percent. The production of ethanol is estimated to have generated 1 million new jobs while keeping 30 percent (60,000) of sugarcane plantations in the hands of independent and mostly small-scale farmers. Negative impacts of soybean for biodiesel (deforestation), sugar field burning (release of GHG) and poor labor conditions have been reported from Brazil. The burning of plant residues, however, is being replaced by mechanized harvesting. The industry uses sugarcane bagasse for processing instead of fossil fuels, and surplus electricity is sold to the grid. In 2005, Brazil started a biodiesel program and required that its diesel oil be blended with 2 percent biodiesel by 2008, with a goal of 5 percent by 2013, and 20 percent by 2020. The country has also introduced policies that help increase social and environmental benefits: it promotes biodiesel from the poor Northeast, crops grown on degraded arid land, and small-farm production. The program requires large distributors of biodiesel to have small-scale farmers account for 50 percent of supply and it has been reported that the program has already generated 100,000 jobs.

Traditional palm oil producers like Ecuador and Colombia, and exporters of sugarcane like Guatemala and El Salvador are also taking advantage of emerging opportunities. Colombia has introduced a blending requirement with biodiesel and ethanol. Peru intends to blend 10 percent of its gasoline with ethanol and to become an exporter to the US market. Very important investments from the United States have been made in Peru to build infrastructure such as production plants and pipelines.

Issue paper on biofuels in Latin America and the Caribbean
<http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=927710>

WHAT ARE THE POTENTIAL BENEFITS?

POVERTY REDUCTION AND RURAL DEVELOPMENT

A great advantage of biofuels is that their production is much more labor-intensive than fossil fuels and that they create employment in rural areas. The structure of the global agricultural market, however, has enabled a small number of people and large companies to profit the most. The challenge is to make farmers own more of the value chain. Independent growers coming together in farmers' cooperatives will have to organize themselves to supply quality feedstock to producers. In view of the weight and bulk of most biomass feedstock, it is necessary to install collection and conversion plants in the rural areas where the crop is grown. Consequently, economic activities will increase there first and semi-skilled industrial jobs such as truck driving, machinery operation and maintenance work will also be created.

IFPRI The Promises and Challenges of Biofuels for the Poor in Developing Countries
http://www.ifpri.org/pubs/books/ar2005/ar2005_essay.asp

Access to electricity through grid extension is unlikely to increase in many poor parts of the world, and high oil prices are already preventing diesel generators from running in villages. Therefore, there is a high potential for small-scale decentralized power generation for rural areas based on biomass conversion. Diesel engines can run on filtered vegetable oil and produce electricity or mechanical power. Energy crops like oil seeds require few inputs and can be grown on marginal land. This would allow an expansion of land for agriculture and open new markets for farmers. The potential of marginal lands, however, must be carefully assessed and suitable plants have to be selected and improved before farmers can become widely involved in farming these crops. Pilot projects using plant oil for decentralized power supply are being implemented, for example in the Brazilian Amazon region, in India and Malaysia.

In addition, using biofuels for cooking instead of traditional fuels such as charcoal or firewood could significantly reduce in-house air pollution, a major health problem for women and children (respiratory illnesses and premature deaths). New improved cooking stoves that can run on plant oil are currently being developed.

FUEL SUBSTITUTION AND ENVIRONMENTAL BENEFITS

The positive contribution that fuel substitution will make to climate change and its negative impact on soils, water and biodiversity will depend on how and where biofuels are produced. However, it is difficult to estimate what potential biofuels offer to replace fossil fuels because of the myriad of feedstock and production technologies and controversial data on available land. According to the most optimistic scenarios and with second-generation technologies, biomass for energy could satisfy twice the current energy demand; but less favorable scenarios show that bioenergy would cover only a fraction of current world energy needs. Today, biofuels account for 1 percent of road transport fuels and, according to the IEA, are expected to make a worldwide contribution of 4-7 percent by 2030 (other reliable estimates vary between 2-10 percent). As environmental costs and benefits are not priced on the market, governments and international bodies face the challenge of finding mechanisms to internalize these costs and to chart the right course for industry.

LAND CONSERVATION AND RESTORATION

There is a shortage of reliable data, but it is likely that soil degradation has affected nearly 2 billion hectares of land worldwide. The effects of climate change are expected to severely worsen this trend. Population pressure and over-utilization, as well as unsound agricultural practices and deforestation are the main causes of soil erosion and land degradation. Dedicated biofuel plantations grown on degraded soils may help restore land. Planting perennial plants like *Jatropha* can store moisture, fix organic matter and restore nutrients to the soil. Second-generation biofuels based on cellulose-conversion technologies will open up new prospects. In this case, trees, shrubs and grasses producing large amounts of biomass would be used. They could also grow in areas that have low rainfall and poor soils, i.e. where they are less likely to compete with food crops. In general, more research is needed to develop biofuel crops for arid land and wastelands.

WHAT ARE THE ENVIRONMENTAL AND SOCIAL RISKS?

LAND USE AND FOOD SECURITY

About 14 million hectares of land, i.e. about 1 percent of the world's arable land, are currently used for the production of biofuels. According to IEA scenarios, in 2030 this share will rise to 2.5-3.8 percent. Biofuel potentials will be limited by the demand for food, but this could be offset by higher agricultural productivity as a result of major investments, better management of agricultural land and progress in biotechnology. Tropical developing countries have the highest potential to improve their volume of production. The degree of potential competition with food products will also depend on the pace at which second-generation biofuels are developed and whether suitable plants can be grown on wastelands. Biofuel crops that have the potential to be cultivated on marginal lands may still compete with livestock grazing. The key question each country must answer is: how much land should be dedicated to biofuel crops and what are the opportunity costs of biofuel production?

Rising demand for biofuel feedstock has already led to increases in food prices, intensifying a general trend due to rising demand for food products, especially meat and dairy products. Least-developed countries and low-income countries that are net importers of agricultural goods are threatened by this trend. The International Food Policy Research Institute (IFPRI) has built different food price scenarios. They show a price increase e.g. of about 20% for maize, 40% for sugar cane and 40% for oil seeds over the next years due to increased demand for food and biofuels. As has been seen for maize, countries that export their surpluses and subsidy-driven commodities will increasingly use them to produce their own biofuels. This will also potentially have an impact on international food aid, which consists of surplus food from the North. On the other hand, the reduction of distortions in local agricultural markets that are due to food aid could also provide farmers in developing countries with new opportunities. However, expansion of biofuels and rising food prices will tend to threaten subsistence farmers, farmers with insecure land tenure, and the urban poor. In this context, improving agriculture to reduce food production deficits is becoming more essential than ever in developing countries. Balancing food and energy security is the coming challenge and the importance of rural development is again increasing.

IFPRI Bioenergy and agriculture: promises and challenges; Biofuels and the Global Food Balance http://www.ifpri.org/2020/focus/focus14/focus14_03.pdf

Land tenure is a fundamental issue for biofuels. The expansion of farmland for biofuel production may exacerbate the problem of landlessness by dislocating farmers without clear land titles. This has already been reported in Colombia, for example. Small-scale farmers in countries where legal structures for land tenure are not in place and/or not properly enforced are threatened by the expansion of biofuel production and require special safeguards.

BIODIVERSITY LOSS AND DEFORESTATION

Biodiversity provides ecosystems with the capacity to prevent and recover from natural or man-made disasters. The expansion of agriculture and intensive mono-cropping is closely linked to biodiversity loss. It must be noted that deforestation and other land use changes account for an estimated 20% of global carbon dioxide emissions. Large-scale deforestation has occurred as a result of the expansion of soy in Brazil and palm oil plantations in Malaysia and Indonesia, for example. Apart from enforcing existing laws, a set of measures can be applied to mitigate biodiversity loss, such as digital land mapping for land monitoring, adequate land management plans, wildlife sanctuaries and corridors. To tackle biodiversity loss, regulations have to be defined for producers and standards for buyers.

WWF Sustainability Standards for Bioenergy http://www.wwf.de/fileadmin/WWF_DE/PDF/neu/SustainabilityStandards_for_Bioenergy.pdf

SOIL EROSION AND LAND DEGRADATION

The expansion and intensification of agriculture due to the use of irrigation, agrochemicals and heavy machinery can lead to further soil erosion and land degradation. Depending on the soil type, topography and weather conditions such as heavy rainfall or wind, certain areas are particularly vulnerable. Access to information and the dissemination of sound practices and standards need to be promoted to address these issues. By contrast, perennial energy crops creating year-round plant coverage have the potential to improve soils and reduce degradation. For the years to come and before second-generation technologies or perennial plants like *Jatropha* are widely used, it is very likely that the negative impacts of biofuel production on soils will increase and become a serious problem.

WATER USE AND POLLUTION

Water for agriculture is a major concern both in terms of availability and quality, as farming already consumes 70 percent of available freshwater on a global scale. An increase in irrigated land without sustainable management of ground and surface water will lead to water scarcity. Competition and conflicts may arise over water for agriculture, drinking and ecosystems. Arid and semi-arid regions of the Near East and North Africa are particularly vulnerable. Another impact on water comes from agrochemicals that pollute surface and ground water. Run-off water containing high amounts of fertilizers leads to eutrophication of lakes and coastal zones. Examples can be found in many lakes in Europe and in the Gulf of Mexico, where nitrate runoff from farming has led to so-called Dead Zones that are void of aquatic life.

Water availability is further aggravated by impacts of climate change on the hydrological cycle. Some countries promoting biofuels on a large scale may very soon reach their limits in terms of water availability. Techniques and know-how for effective irrigation and proper water management are available, and important improvements can be made in this field. Regional long-term strategies and water management plans are needed to address these issues, as well as intensive and concerted research and development of drought-resistant crops.

LABOR AND HUMAN HEALTH

Biofuels have the potential to create jobs in rural areas, but a large share of these jobs will only be for low-skilled seasonal agricultural workers. These workers, who are often migrants, are especially vulnerable. There are still too many reports of forced labor, child labor and dangerous working conditions in sugarcane fields and processing facilities. Agricultural workers also face health risks, primarily due to the inappropriate use of agrochemicals. Often, they are not informed about the risks of their work, nor provided with safety equipment. Social criteria including better working conditions should be a component of the standards for biofuel production and trade.

CONCLUSION

The growing world energy demand, the insecurity of long-term supply and the consequences of fossil fuel use for climate change are driving governments to look for alternatives. Biofuels will probably not make a major contribution to meeting global energy demand or reducing global greenhouse gas emissions over the next 10-15 years. Biofuels, however, may have significant benefits and can offer attractive alternatives for developing countries with the right climate and available land. With dedicated biofuels programs, such developing countries can create much needed employment in rural areas, increase their access to energy and lessen their precarious dependence on the oil market.

Industrialized countries are increasingly transforming crops into biofuels. As a result, less crops are available for export, leading to rising food commodity prices in conjunction with general increases in demand for food and animal feed due to population growth and development. While this provides welcome price signals for rural producers, it is a threat for the urban poor and all other net buyers of food who lack the necessary means. At the same time it is an opportunity for farmers in developing countries who will have to compete less with cheap agricultural surpluses from the North and will have better opportunities to develop their own market. Biofuels are also contributing to greater focus on the need for progress in agriculture and rural development: investments are urgently needed in the South to lessen dependence on food and fuel imports. Research is also crucial to find the best biofuel crops and cultivation methods for each context.

The expansion of large-scale mono-cropping to produce first-generation biofuels from food crops is a threat to natural resources at the global level. However, sound agricultural practices can mitigate negative impacts, and certain crops could have positive impacts on degraded and arid lands. The potential for reduction and avoidance of greenhouse gases through substitution with biofuels is currently rather small, but it may significantly increase with the advance of more efficient and more sustainable biomass production and conversion technologies. In any case, biofuel use will only make sense if major improvements are made with regard to the efficiency of motors and vehicles in reducing fuel consumption.

As most social and environmental costs and benefits of biofuel production and use are not priced in the market, to ensure a generally favorable outcome, clear and comprehensive public policy choices are critically needed. Providing benefits from biofuels in developing countries will require participatory planning involving local communities, understanding food production and

consumption patterns, livestock grazing, natural resource settings, local and regional energy needs, and striking a balance between different options. Development agencies and NGOs also have a key role to play in the booming biofuel sector to ensure that the poor can benefit from the new market and from energy services, without increasing their vulnerability.

WHAT IS NEEDED?

The following tables present some key measures that should be seriously considered in the biofuel sector, and identifies associated opportunities as well as threats in the case of non-action.

INTERNATIONAL LEVEL

MEASURES	OPPORTUNITIES	THREATS FROM NON-ACTION
Introduction of recognized international social and environmental standards	Socially and environmentally acceptable production in the North and in the South, GHG reduction	Major strain on NR, incl. deforestation, labor exploitation, doubtful GHG reduction
Clarification of trade status and trade regimes	Incentive for investment and production in developing countries	Subsidy-driven and inefficient production in the North, market distortions at the expense of the South
Improvement of biofuel crops, agricultural research for North and South	Higher productivity, less strain on NR, use of arid land, land restoration, possibly less competition with food	Strain on NR, low productivity, land use change at the expense of food production

DEVELOPING COUNTRIES

MEASURES	OPPORTUNITIES	THREATS FROM NON-ACTION
Prioritization of food production and food security over biofuel production and energy security	Reduction of food supply deficiencies and food price vulnerability	Sharp rise in food prices and deteriorating food security
Enforcement of land tenure rights	Increased credit-worthiness and managerial flexibility for farmers	Displacement of farmers, increased rural-urban migration
Provision of large investments for agriculture and improvement of agricultural practices	Improved food and energy security and rural development, less strain on NR	Reduced food security and energy supply shocks
Consideration of all energy production alternatives and sound decision making for feedstock choices	Energy efficiency and GHG reduction, less strain on NR	Potentially inefficient, expensive and polluting outcomes, strains on NR
Prioritization of feedstock cultivation on wastelands and arid lands	Less competition with food production, land restoration	Competition with food crops
Establishment of employment-generating biofuel policies and of mechanisms to make poor farmers benefit	Creation of jobs, smaller-scale farmers own part of the value chain	Benefits mainly for a few large-scale producers
Distribution of energy services to rural areas	Education, health and economic development	Only urban areas benefit
Introduction of sustainable water management plans	Long-term sustainable production	Water scarcity, desertification
Setting up of safeguards against deforestation and biodiversity loss	Avoidance of deforestation, less biodiversity loss	Large-scale deforestation and biodiversity loss

GHG: Greenhouse gases; NR: Natural resources

by Yuka Greiler, Natural Resources and Environment Division, Swiss Agency for Development and Cooperation SDC, Freiburgstrasse 130, CH-3003 Berne
Copies can be ordered from sru@deza.admin.ch or downloaded from www.deza.admin.ch