BOX 7.

HELPING SMALL BUSINESSES PRODUCE BIOFUELS FROM AGRICULTURAL AND BIOMASS WASTES

The UN Environment Programme's Rural Energy Enterprise Development Programme (REED) is offering enterprise development services and start-up financing to "clean energy" enterprises in five African countries, Brazil, and China. Since 2000, REED has financed 44 enterprises that are now returning capital each year to an investment fund that is then reinvested in new enterprises. These financial returns are matched—and in many cases exceeded—by the non-financial returns of economic development, environmental improvement, and better access to modern energy services for poorly served communities. Although quantifying these returns is difficult, an interim evaluation of non-financial impacts of REED investments was done on eight REED enterprises in 2004.

One of the enterprises covered in the study is the Tanzania's Biomass Energy Technology Limited (BETL). The company coordinates the sourcing and supply of agricultural and other biomass wastes as fuel for Tanga Cement Company Ltd. (TCCL), a collaboration that displaces up to 15 percent of the 44,000 tonnes of heavy fuel oil TCCL uses yearly to provide heat for its cement kilns. The substitution saves TCCL money, reduces greenhouse gas emissions, and generates a 43-percent gross profit margin for BETL on monthly deliveries of up to 1,200 tonnes (at $40–$60 per tonne).

Income from collecting and transporting biomass has been the most significant social impact of BETL's activities. Each tonne of biomass supplied to TCCL also generates income for a local provider of transport services. At the company level, BETL has employed one new staff member who is currently undergoing professional accountancy training. Women in urban areas earn US$60 a month collecting 40 bags of charcoal residues a day for the waste contractor used by BETL. This is 25-percent more than the minimum wage in Tanzania and constitutes low-level job creation with a genuine impact on poverty. Positive environmental impacts from BETL operations include local benefits arising from a waste disposal mechanism and the global benefit of reduced greenhouse gas emissions that would otherwise be produced from the combustion of heavy fuel oil at the cement processing facility.

Issue 5 – Implications for Food Security

INTRODUCTION

The further development and expansion of bioenergy will affect food security in a variety of ways. The current "food, feed, or fuel" debate tends to be overly simplistic and fails to reflect the full complexity of factors that determine food security at any given place and time. The substantial near- to medium-term impacts on food security will be driven largely by current-generation liquid biofuels for transportation, which depend almost exclusively on feedstock from food crops. The purpose of this section is to provide a broad framework that could guide initial analyses of the key relationships between liquid biofuels and food security.

The expansion of liquid biofuel production could affect food security at the household, national and global levels through each of four major dimensions: availability, access, stability, and utilization. These effects may be positive or negative, depending on the situation. For instance, whether a country or household is a net buyer or seller of energy services and food products will fundamentally influence whether biofuels will be beneficial or detrimental to their welfare.

LIQUID BIOFUELS AND THE FOUR DIMENSIONS OF FOOD SECURITY

The *availability* of adequate food supplies could be threatened by biofuel production to the extent that land, water, and other productive resources are diverted away from food production. Similarly, if biofuel production drives up commodity prices, as appears to be the case for maize in 2006 and early 2007, food *access* could be compromised for low-income net food purchasers. On the other hand, the market for biofuel feedstock offers a new and rapidly growing opportunity for agricultural producers and could contribute significantly to higher farm incomes. Modern bioenergy could make energy services more widely and cheaply available in remote rural areas, supporting productivity growth in agriculture or other sectors with positive implications for food availability and access.

Stability refers to the time dimension of food security, which could be affected by the growth of biofuels because price volatility from the petroleum sector would be more directly and strongly transmitted to the agricultural sector. Finally, utilization refers to peoples' ability to absorb the nutrients contained in their food and is closely linked to health and nutrition factors such as access to clean water and medical services. If biofuel feedstock production competes for water supplies, it could make water less readily available for household use, threatening the health status and thus the food security status of affected individuals. On the other hand, if modern bioenergy replaces more polluting sources or expands the availability of energy services, it could make cooking both cheaper and cleaner, with positive implications for food utilization.

To the extent that increased demand for biofuel feedstock diverts supplies of food crops (for example, maize) and diverts land from food crop production, global food prices will increase. Analyses are under way to quantify the impact of expanded biofuels production on global commodity prices, and in turn, the poor and food insecure. Considerations will vary depending on the type of fuel, country-specific policies, setting (urban or rural), farming system, and food security context.

Section 3: Key Sustainability Issues

Characteristics of land use associated with poverty, such as low intensity of financial capital, high use of natural and human capital, narrow natural resource bases, low returns to land and labour, few off-farm opportunities, and, as a result, low opportunity costs, must be considered in the analysis of bioenergy and food security. For instance, in the absence

ACCORDING TO FAO DATA FOR 2001–03, THERE ARE APPROXIMATELY 854 MILLION UNDERNOURISHED PEOPLE IN THE WORLD.

of comprehensive analyses and policies, commercial production of biofuels may target high-quality lands—due to better profit margins and high soil requirements of first-generation crops—such that biofuels as the "next big cash crop" will be grown on the best lands, leaving cereals and subsistence crops to the low-quality lands. Expanded biofuel production adds further uncertainty to other pressures related to food security, such as population growth, changing diets, rising demand for biomaterials, expanding organic agriculture, climate change, and extreme climatic events.

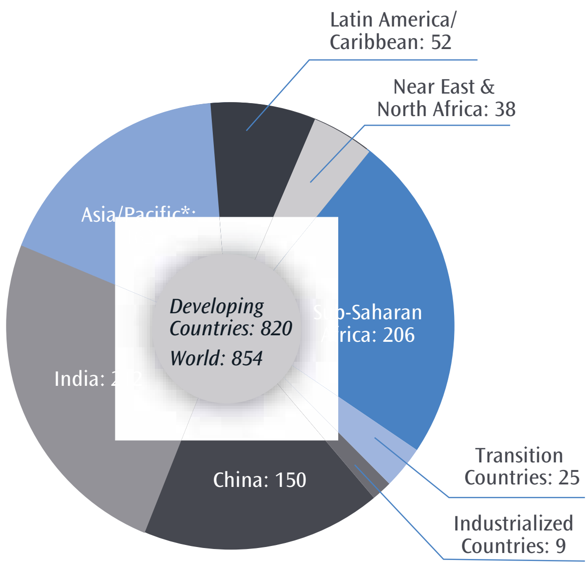
To an extent, the food security risks associated with biofuels are the mirror image of the opportunities. Agricultural commodity prices have long been influenced by energy prices, because of the importance of fertilisers and machinery as inputs in commodity production processes. Rising commodity prices, while beneficial to producers, will mean higher food prices with the degree of price rise depending on many factors, including energy prices, with negative consequences for poor consumers. Expanded use of agricultural commodities for biofuel production will strengthen this price relationship and could increase the volatility of food prices with negative food security implications.

ISSUES THAT NEED TO BE ADDRESSED

A. Who Are the Hungry?

According to FAO data for 2001–03, there are approximately 854 million undernourished people in the world. An estimated 820 million are in developing countries, 25 million in countries in transition, and 9 million in industrialised countries. Hunger claims up to 25,000 lives every day, two thirds of them children under the age of five, and it is currently the leading threat to global health, killing more people than AIDS, malaria, and tuberculosis combined. Although the proportion of undernourished in the world has declined from 20 percent to 17 percent since the mid 1990s, the absolute number of hungry people has remained the same.

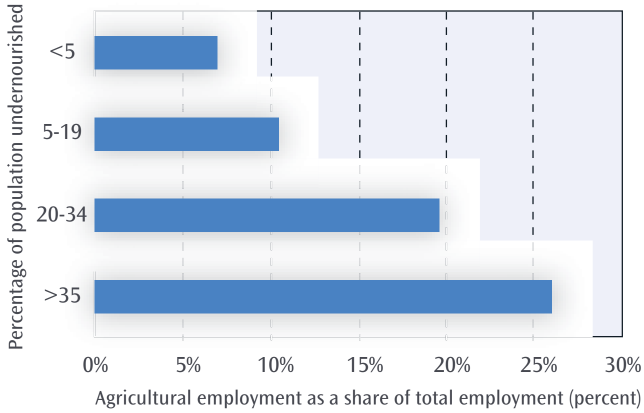
Figure 1. The World's Undernourished (2001–03, millions)



* excludes China and India

Any analysis of the impact of bioenergy on food security should highlight differences between developing, least developed, and low-income food deficit countries (LIFDCs). These two latter groups are typically the most food insecure, given high dependence on imports of primary staple foods and exports of primary tropical commodities. Because hunger in developing countries tends to be concentrated in rural areas, little sustained progress in food security is possible without paying particular attention to agriculture and rural development.

Figure 2. Agricultural Employment and Undernourishment (2001–03)



Approximately 30 percent of world grain supplies are currently used to feed livestock (and only indirectly to feed people); thus, the implications of biofuels development on food security will also be linked to changes in dietary patterns. One third of the projected increase in food demand over the next three decades is expected to come from dietary changes as more people are able to afford calorie-intensive meat and dairy products. Producing these items requires relatively large resource inputs, including additional land and water to grow crops for animal feed. A continued rapid rise in world demand for meat and dairy will reduce the availability of supplies to satisfy both biofuel and food security, exacerbating the tension between these two ends.

B. Impact on Food Availability

Liquid biofuel production could threaten the availability of adequate food supplies by diverting land and other productive resources away from food crops. Many of the crops currently used as biofuel feedstock require high-quality agricultural land and significant inputs of fertilisers, pesticides, and water.

Currently, on a global scale and under the current state of liquid biofuel production, food production and biofuel production are substitutes. But well-designed modern bioenergy systems may in fact augment local food production. For example, if leguminous nitrogen-fixing crops for biofuel production are rotated with cereals, the overall productivity of the system may be enhanced. The degree of potential competition will hinge on a variety of factors, including agricultural yields and the pace at which second-generation biofuel technologies develop. As second-generation technologies based on lignocellulosic feedstock become commercially viable, this will lessen the possible negative effects of land and resource competition on food availability. Still, a risk could follow these technologies: they might increase the likelihood of a greater push to plow up “waste lands” (including rangelands and savannas) to plant switchgrass and other hardy biofuels as well as displaced cereals and subsistence crops.

Overproduction of food in industrialised countries, where supply has long exceeded demand in part due to domestic subsidies, has depressed agricultural commodity prices. For decades, these low prices have been a major cause of economic stagnation in rural areas. As biofuels absorb crop surpluses in industrialised countries, commodity prices will rise, increasing income for farmers in poor countries and perhaps reducing the political pressure for other forms of agricultural subsidies in industrialised nations, albeit with several possible costs: high budgetary subsidies in industrialised countries, higher food prices for poor consumers worldwide, and higher costs for emergency food relief. However, the expected price increases due to greater demand for biofuel crops may induce farmers to increase production and thereby mitigate some of these price effects in the longer term.

C. Impact on Food Access

Food prices are one of the most important determinants of food access. As mentioned earlier, global food commodity prices are expected to increase in the near- to medium-term due to expanded biofuel production. Price increases have already occurred in major biofuel feedstock markets, for example, sugar, maize, rapeseed oil, palm oil, and soybean. In addition to raising feedstock prices, increased demand for energy crops might elevate the prices of basic foods, such as cereals, which comprise the major proportion of daily dietary intake of the poorest and least food secure. Thus, possible income gains to producers due to higher commodity prices may be offset by negative welfare effects on consumers, as their economic access to food is compromised.

There are indications that increased production of biofuels may link petroleum prices and those of biofuel feedstock. Prices of sugar and molasses already show high correlations with world oil prices. Increased production of biofuels adds another layer of uncertainty and risk to volatile price relationships by linking food and oil prices. With inelastic demand (through biofuel consumption mandates) comprising an increasing share of a given crop's market, this also gives rise to greater price variability and market volatility. Increased price volatility may be more detrimental to food security than long-term price trends, to the extent that the poor are usually less able to adjust in the short term. Increased trade in biofuels has the potential to mitigate some of this price volatility. Appropriate trade policies could potentially minimise tensions between biofuel and food production by allowing trade to flow internationally in response to fluctuations in domestic supply and demand, thus helping to stabilise prices.

IMPLEMENTATION ISSUES

A. Develop an Analytical Framework for Food Security and Bioenergy

More research and analysis is needed to fully understand the long-term impacts of expanded bioenergy production and use on food security. Such understanding is necessary to guide the design of interventions aimed at promoting the positive effects and averting or compensating the negative effects.

The effects of bioenergy on food security will be context-specific, depending on the particular technology and country characteristics involved. Liquid biofuels derived from food crops will have different food security implications than modern bioenergy systems based on lignocellulosic or waste materials. An analytical framework based on country typologies should be developed to facilitate the understanding of country-specific effects. The four dimensions of food security discussed above should provide the starting point for the development of this analytical framework.

B. Enhance Agricultural Productivity and Sustainability

Agricultural research aimed at improving productivity, conserving water, and building soil fertility can lessen the tension between food, feed, and fuel production by increasing overall agricultural output in a sustainable manner. Planting arid, semi-arid, degraded, and marginal lands that are unsuitable for food production with inedible biofuels crops such as jatropha would not compete directly with current food production and could help rehabilitate such soils.[4] Other agronomic practices that minimise soil disturbance and enhance the accumulation of soil organic matter, such as conservation agriculture, are improving soil fertility and water-use efficiency. The incorporation of crops for energy production in rotation with food crops could improve productivity and disease and pest resistance while diversifying income opportunities for producers. These and other productivity-enhancing measures should be promoted.

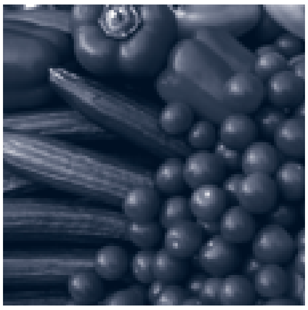
C. Understand the Policy Nexus for Liquid Biofuels

At least four distinct policy domains are shaping development of the liquid biofuels sector: energy, environment, agriculture, and trade. Similarly, policies at the national, regional, and global levels are highly relevant and may interact in unexpected ways. Policy makers need to understand the interactions among these various policy domains and levels and to ensure that food security considerations are given priority. Integrated policy analysis that considers the effects and interactions of the relevant policy domains at different levels is required. The food security impacts of these policies on developing countries are highly contingent on local circumstances, but also depend on the global food situation.

Both agricultural and energy markets are highly distorted, making it is difficult to predict the net effect of reforms in either sector. Although existing agricultural subsidies clearly depress commodity prices, making liquid biofuels more competitive with petroleum-based fuels, additional direct subsidies for biofuels are still required in most cases to overcome the cost advantage enjoyed by petroleum products. Whether such subsidies may be justified in the short term to enable an emerging biofuel industry to become established needs to be evaluated in a rigorous cost-benefit framework. In any case, subsidies could be wasted unless the country is or can become a competitive producer of the necessary feedstock and achieve the technological capacity and economies of scale required to produce biofuels efficiently.

Ethanol or biodiesel blending requirements mandated on environmental grounds may be inconsistent with trade barriers erected against imports of those products. By impeding imports of more efficiently produced biofuels from abroad, the combination of the two policies may divert more land from food production than would have been necessary to meet the blending requirement alone. Similarly, investments based on expected export opportunities that themselves depend on preferential market access, large consumption subsidies in the importing countries, or both—which could be eroded—must be carefully evaluated.

There are examples of investment and policy support to small-scale, labour-intensive biofuel production systems aimed at providing employment and income for smallholders. For instance, Brazil recently introduced a “social biodiesel” programme focused on small rural cooperatives, which is targeted specifically at poverty reduction. The Brazilian government is now providing families of labourers with a new market for their oilseed crops with the aim of improving socio-economic conditions. The results of the programme remain to be evaluated.



[4] That said, it seems unlikely that significant quantities of biofuel feedstock can be produced on marginal lands; some of this land is already used for livestock grazing, competing with food production.

Issue 6 — Implications for Government Budget

INTRODUCTION

Modern bioenergy runs the gamut from being commercially competitive today (as with biomass waste for heat and electricity in some situations) to requiring significant government subsidies. To date, large government subsidies have been universally provided to liquid biofuels.[5] The most commonly used instrument for this purpose is a reduction in fuel taxes and charges. This is often coupled with consumption mandates, production subsidies, and, especially in the case of ethanol, import restrictions.

Import restrictions are trade distorting and discourage efficient producers from selling to the global market, but they are fiscally cheap and used liberally by governments. Consumption mandates need not have government fiscal implications, although consumption mandates have been paired with tax incentives to date because of the generally higher production costs of liquid biofuels. Direct subsidies and all forms of tax incentives have budgetary implications, which should be carefully assessed by governments considering biofuel programmes.

ISSUES THAT NEED TO BE ADDRESSED

A. Tax Reductions for Liquid Biofuels

Fuel taxation typically seeks to satisfy multiple objectives. In the case of transport fuels, for which ethanol and biodiesel substitute, these objectives include raising government revenue for general (non-transport) expenditure purposes; efficiently allocating resources to and within the transport sectors; financing road provision and maintenance; reducing congestion; reducing the environmental externalities of road transport; and redistributing income. Some of the objectives apply equally to all forms of transport fuels and, as such, there should be no tax differentiation for these ends. For example, two externalities of road transport—congestion and damage to roads—do not depend on the fuel type. Exempting biofuels fully from the fuel excise tax to make them cost-competitive, as some countries have done, is not appropriate for this reason. Accounting for environmental externalities is one area where different levels of fuel excise taxes should be applied depending on the environmental characteristics of each fuel.

Taxes on petroleum products are a critical source of government revenue for low-income countries because collecting fuel taxes is relatively straightforward compared to other forms of taxation such as income tax. Gasoline tax is progressive because rich households spend a higher proportion of their budgets on gasoline than do poor households. Because ethanol is used largely as a substitute for gasoline, providing a large tax reduction for ethanol blended into gasoline reduces government revenue from this tax, targeting mainly the non-poor.

Tax reductions are possible if fuel taxes are high to begin with. In many developing countries, the tax rate on diesel—which is used economy-wide in goods and public passenger transport, and which many governments seek to keep relatively inexpensive—is low compared with the tax rate on gasoline. In these situations, it would be difficult to use tax reduction alone as a fiscal instrument to promote biodiesel consumption.

[5] Subsidies here follow the definition provided by the World Trade Organization and include not only direct payments to producers, but also reductions in taxes and other charges that reduce government revenues otherwise due.

B. Size of Subsidies and Tax Reductions

A detailed study of subsidies for ethanol in the United States calculated that these subsidies totalled US$5 billion in 2006, about half of this in the form of fuel tax credits and reductions. The subsidy amounted to more than 40 percent of the market price (Koplow 2006). Brazil also provides large tax reductions. In June 2005, the tax difference between pure ethanol and the gasoline/ethanol blend in the state of São Paulo, which accounted for more than one half of total hydrous ethanol consumption in the country, amounted to US$0.30 per litre of ethanol (Kojima and Johnson 2005). In Thailand in April 2006, ethanol enjoyed a tax advantage of as much as US$0.65 a litre, against the Asia-Pacific premium gasoline price of US$0.51 a litre in that month (Kojima, Mitchell, and Ward, "Considering Trade Policies for Liquid Biofuels," forthcoming).

These subsidies are considerably larger than the benefits of potentially lower greenhouse gas emissions that arise from switching to liquid biofuels: a CO_2-equivalent price range, expected for the foreseeable future, of between US$8 and US$20 per tonne would generally provide about $0.01–0.04 per litre of biofuel (the upper end of the range for biodiesel).

C. When Fiscal Support Might Be Appropriate

Fuel taxes are not very efficient in reducing externalities from emissions that contribute to urban air pollution. This is because local pollutant emissions and their environmental externalities depend not only on fuel choice, but also on vehicle technology, maintenance, driving patterns, and the location and time of emissions.

Other emissions of high relevance to local air pollution, such as carbon monoxide and hydrocarbons, are also reduced by increasing the ethanol content of transportation fuel. (See Table 2.)

Table 2. Impact of Increased Ethanol Content on CO and HC Emissions

Pollutant	Percentage of Ethanol in the Gasoline Mixture			
	0%	12%	18%	22%
CO	200–450	150	120	100
HC	140	110	105	100

Sergie V. Bajay et al., "Energy from Biomass in Brazil," in Frank Rosillo-Calle, Sergie V. Bajay, and Harry Rothman, eds., Industrial Uses of Biomass Energy (London and New York: Taylor & Francis, 2000)

But fuel taxes are efficient for reducing externalities associated with carbon dioxide emissions because these emissions are linked directly to fuel consumption. For efficient taxation, tax rates on fuels that have external costs should be adjusted upward to reduce their consumption to a social optimum; it is inefficient to subsidise "cleaner" fuels. A carbon tax based on each fuel's lifecycle CO_2 emission characteristics would be appropriate.

Because the magnitude of the subsidies historically

...SUBSIDIES ARE CONSIDERABLY LARGER THAN THE BENEFITS OF POTENTIALLY LOWER GREENHOUSE GAS EMISSIONS THAT ARISE FROM SWITCHING TO LIQUID BIOFUELS....

and currently provided to maintain a domestic biofuel market is very large, governments should examine alternative uses of the budget set aside for subsidizing biofuels to ensure that the objective of welfare maximisation is not seriously compromised. In general, it is important that government incentives be designed to promote development efficiently. This means promoting specific energy technologies primarily when it can be reasonably concluded that the chosen technology is a cost-effective way of achieving policy and social goals (such as rural development). Under all circumstances, the social benefits of promoting a given technology should outweigh the social costs associated with the subsidies. This is especially important in low-income countries where limited government resources compete for basic needs, ranging from the provision of clean water and primary health care to primary education.

IMPLEMENTATION ISSUES

If a specific modern bioenergy source is commercially viable, the proper role of government is to establish a transparent and stable regulatory framework with effective enforcement, and to properly account for externalities by differential taxation. If a bioenergy source is not yet commercially viable and government support is required, then the government should carefully consider the trade-offs involved through economic analysis to weigh upfront the social costs and benefits of the bioenergy being considered for subsidies, as well as when, where, and how to embark on the bioenergy programme. Economic analysis can also be a valuable tool for reshaping planned or existing energy programmes to maximise their efficiency and their net benefits to society, although monetary valuation of some non-market effects can be controversial.

The economics of bioenergy are site and situation specific, and each country will produce different results. Opportunity costs (including those of land, water, and labour), rather than the prices paid, should be used to ensure that the costs of subsidised inputs and alternative uses of resources are properly reflected. It is also important to examine who captures most of the subsidies. The welfare consequences will differ, for example, depending on whether the subsidies are going to large agri-business establishments or smallholders. The application of these criteria to other parts of the energy sector would help in creating a more level playing field between different technologies and feedstock.

Applying different tax rates to liquid fuels presents administrative and regulatory challenges in the form of commercial malpractice, including mislabelling, adulteration, and illegal sales. Taxing biofuels can also be more administratively challenging because there are more points of tax collection, especially if the fuels are produced on a small scale by numerous producers. Understanding these challenges, learning from the experience of other countries, and involving the tax authorities from the outset is essential.

Issue 7 — Implications for Trade, Foreign Exchange Balances, and Energy Security

INTRODUCTION

Trade in energy and agriculture is marked by wide disparities. In the case of energy, a relatively small number of countries dominate exports, while most countries import most—and in some cases all—of the fuels they consume. Decades of direct and indirect subsidies to the energy sector as a whole and for electricity infrastructure and tariffs have contributed to the current energy system. World agriculture is also marked by extensive distortions, many of which are harmful to poor countries that depend heavily on agriculture.

The early development of the biofuels market is inevitably shaped by these existing trade distortions—and indeed, biofuels also receive direct subsidies and trade protection of their own, which affect the energy and agriculture markets with which they intersect. One of the great challenges for biofuels policy development is to effectively navigate the chaotic and often manipulated markets in which they operate—providing initial subsidies where appropriate, but minimizing their size and resulting market distortions. In the future, large-scale development of biofuels will likely raise agricultural commodity prices, increasing income for those in poor countries who are net sellers of food and reducing the political pressures for other types of agricultural subsidies in industrialised nations. However, this will occur at the dual costs of high budgetary subsidies in industrialised countries and higher food prices for poor consumers around the world.

ISSUES THAT NEED TO BE ADDRESSED

A. Ramifications for Foreign Exchange Balances

Of the world's 50 poorest countries, 38 are net importers of petroleum and 25 import all of their petroleum requirements. Recent oil price increases have had devastating effects on many of the world's poor countries, some of which now spend as much as six times as much on fuel as they do on health. Others spend twice the money on fuels as on poverty reduction. And in still others, the foreign exchange drain from higher oil prices is five times the gain from recent debt relief. At a time when energy analysts predict a period of unpredictable oil markets, with prices dependent on developments in some of the world's least stable regions, fossil fuel dependence has become a major risk for many developing economies.

Diversifying global fuel supplies could have beneficial effects on the global oil market. By some estimates, rising production of biofuels could meet

IN THE CASE OF ENERGY, A RELATIVELY SMALL NUMBER OF COUNTRIES DOMINATE EXPORTS, WHILE MOST COUNTRIES IMPORT MOST—AND IN SOME CASES ALL—OF THE FUELS THEY CONSUME.

most and perhaps all of the growth in liquid fuel demand in the next few decades, particularly if second-generation technologies are available and if simultaneous investment in more-efficient transport limits the amount of growth. At a time when oil production is already in decline in many nations, greater biofuel use could help bring the oil market into balance and greatly reduce oil prices.

Diversified fuel portfolios would also have benefits at the national level. Analysis has shown that in the case of electricity markets, diversification has substantial value even if the added energy source has a surface price significantly above its dominant competitor—because of the ability to mitigate future price risks. In the case of biofuels, this benefit may be mitigated by the fact that in the early years, biofuel prices will tend to rise and fall in line with the much larger world oil market.

The United States and Europe have coupled subsidies for biofuels with import tariffs that ensure that these subsidies will benefit domestic farmers rather than those in other countries. This has led to the strange irony of virtually unimpeded trade in oil, while trade in biofuels is greatly restricted. Most experts agree that opening international markets to biofuels would accelerate investment and ensure that production occurs in locations where the production costs are lowest. Poor countries in Central America and sub-Saharan Africa are among those likely to benefit. Needless to say, this greatly accelerated investment and production should be assessed closely at the national and international levels to avoid potentially irreversible sustainability impacts.

B. Impacts on Agricultural Trade Policy

Agricultural commodities dominate the export earnings of many poor countries, but these earnings are limited by the fact that agricultural subsidies and other protectionist policies in industrialised countries have reduced international agricultural prices and limited access to the world's wealthiest markets. In the United States, the government provides 16 percent of total farmer income, in Europe, 32 percent, and in Japan, 56 percent. Unlike with energy, most agricultural commodity prices today are well below the real price of 20 years ago. Trade agreements such as NAFTA have provided developing countries with new trade opportunities but also flooded poor countries with cheap grain, while efforts to reduce industrial-country price supports and other subsidies have largely failed.

Some economists argue that biofuels producers are now benefiting from low feedstock prices that are themselves the product of agricultural subsidies. This depends on the feedstock, and applies importantly to sugar. Prices of other feedstock, such as maize, would be less affected, although, as discussed below, maize prices have risen sharply in the last year. While it is true that if trade barriers were removed, some agricultural commodity prices would rise, this effect would be moderated as producers responded to new incentives.

Rapidly rising demand for ethanol has already had an impact on the price of two agricultural commodities, sugar and maize, in 2005 and 2006, bringing

UNLIKE WITH ENERGY, MOST AGRICULTURAL COMMODITY PRICES TODAY ARE WELL BELOW THE REAL PRICE OF 20 YEARS AGO.

substantial rewards to farmers not only in Brazil and the United States but around the world, since both commodities are widely traded internationally. In the case of maize, the futures market suggests that prices will be sustained at their highest levels in more than two decades. This is also a concern because in some regions of the world, particularly in Africa and parts of Latin America, maize is the staple food among the poor.

The linking of agricultural commodity prices to the vicissitudes of the world oil market clearly presents risks, but it is an essential transition to the development of a biofuels industry that does not rely on major food commodity crops.
Rising prices for maize and sugar are a major new incentive to develop second-generation cellulosic

technologies that convert grasses, trees, and waste products into ethanol, as well as other technologies that allow the conversion of biomass into a variety of synthetic fuels.

IMPLEMENTATION ISSUES

The development of biofuels industries requires substantial government intervention, giving policy makers ample opportunity to both advance and thwart a variety of development goals. One thing is clear: biofuels policy should not be considered in a vacuum, but rather in the context of wider energy and agriculture policies.

A. Biofuel Subsidies

While subsidies might be necessary for the early development of biofuel industries, their use should be carefully modulated and reduced over time so they do not become the kind of long-term subsidy that has occurred with the oil industry in many countries. It has been suggested that these incentives be made countercyclical so that they decline as oil prices rise, making subsidies less necessary.

B. Blending Requirements

By requiring that ethanol and biodiesel be blended with fossil fuels in minimal amounts to achieve air quality goals, market development can be accelerated. In some cases, however, this may result in the shifting of costs from taxpayers to consumers. These mandates can easily be increased over time while taxpayer subsidies are reduced, as has happened in Brazil or Germany. Shifting costs to consumers, especially in the case of diesel, can have a significant welfare-reducing effect. Diesel is used economy-wide, both for passenger and goods transport.

Policy changes must be implemented thoughtfully to avoid problems. In the 1990s, when Brazil transitioned from subsidies to blending requirements and oil prices decreased, the scale of Brazilian subsidies needed to supply ethanol at competitive prices became commensurately prohibitive. As the government became unable to deliver subsidies at a scale that would make ethanol competitive, biofuel prices increased as ethanol production declined, and the values of ethanol-only vehicles plummeted, leading owners to suffer major financial losses. Memories of this major historical failure are in part driving the current Brazilian enthusiasm for flexible-fuel vehicles, which do not make their owners dependent upon a specific fuel, subsidies, or blending requirements. In Germany, the reduction in tax incentives for biodiesel has resulted in higher prices and subsequently lower demand for the fuel.

C. Capacity Building

Realizing the full economic benefits of biofuels development, and minimizing the risks, will depend on building the human and infrastructure capacity to support it at the national level. While strong agricultural economies are prerequisites to a strong biofuels industry, the bioenergy sector could benefit from efforts that take its specificities into account. A few international initiatives are already seeking to realise such benefits:

- *The International Bioenergy Partnership (IBEP) seeks to ensure the delivery of sustainable, equitable, and accessible bioenergy sources and services in support of sustainable development, energy security, poverty reduction, and climate change mitigation;*
- *The Global Bioenergy Partnership (GBEP) has the mandate of facilitating a global political forum to promote bioenergy and to encourage the production, marketing, and use of green fuels, with particular focus on developing countries;*

Section 3: Key Sustainability Issues

- *The BioFuels Initiative of UNCTAD was conceived to offer a facilitating hub for biofuels programmes already under way in a number of institutions. It aims to provide access to sound economic and trade policy analysis, capacity-building activities, consensus-building tools, and assessments of the potential of individual developing countries to engage in the emerging biofuels market;*
- *The Global Village Energy Partnership (GVEP) has been supporting and helping developing countries set up energy action plans and assisting with the associated studies and demand analyses. It has also started to provide financial support, capacity building, and technical assistance to energy SMEs in developing countries.*

REALIZING THE FULL ECONOMIC BENEFITS OF BIOFUELS DEVELOPMENT, AND MINIMIZING THE RISKS, WILL DEPEND ON BUILDING THE HUMAN AND INFRASTRUCTURE CAPACITY TO SUPPORT IT AT THE NATIONAL LEVEL.

Issue 8 — Impacts on Biodiversity and Natural Resource Management

INTRODUCTION

One of the greatest benefits of using biomass for energy is the potential to significantly reduce the greenhouse gas (GHG) emissions associated with fossil fuels. (See Issue 9.) One of the greatest risks, however, is the potential impact on land used for feedstock production and harvesting (particularly virgin land or land with high conservation value), and the associated effects on habitat, biodiversity, and water, air, and soil quality. Additionally, changes in the carbon content of soils, or in carbon stocks in forests and peat lands related to bioenergy production, might offset some or all of the GHG benefits.

On the other hand, bioenergy production offers the potential to reduce the environmental load relative to conventional industrialised agriculture—if, for instance, farming practices are adjusted to maximise total energy yield (rather than the oil, starch, or sugar contents of crops), diversify plant varieties, and reduce chemical inputs. Bioenergy applications in transportation, electricity, and combined heat and power (CHP) also hold promise for reducing the negative environmental impacts of fossil fuel use in these areas. Where households have access to modern bioenergy (or any modern energy for that matter), the phasing out of traditional biomass energy use can prevent the depletion of natural resources associated with wood burning and other activities. Biogas applications also avoid pollution in the form of organic waste that would otherwise overflow, or flow untreated, into the environment, affecting local biodiversity and natural resources.

"Bioenergy provides us with an extraordinary opportunity to address several challenges: climate change, energy security and development of rural areas. Investments, however, need to be planned and managed carefully to avoid generating new environmental and social problems, some of which could have irreversible consequences. Measures to ensure sustainability of bioenergy include matching of crops with local conditions, good agricultural management practices and development of local markets that provide the energy poor with modern energy services." —Achim Steiner, Executive Director of UNEP

ISSUES THAT NEED TO BE ADDRESSED

A. Feedstock Choice, Land Use, and Soil Health

Depending on the type of crop grown, what it is replacing, and the methods of cultivation and harvesting, bioenergy can have negative or positive effects on land use, soil and water quality, and biodiversity. Dedicated energy crops that are appropriate to the regions where they are planted—such as native perennial trees and grasses—can minimise the need for chemical inputs, thus avoiding some of the pollution associated with feedstock production while also reducing water needs and providing habitat for birds and other wildlife. Perennial grasses and short-rotation forestry could also increase the soil carbon content as compared to annual agricultural crops.

In the future, second-generation technologies that rely on agricultural and forestry residues or other forms of waste could significantly reduce land requirements for biofuel production. At the same time, it is important to recognise that such residues are necessary for maintaining soil and ecosystem health, and that a certain amount must remain on the ground. Logging residues are an important source of forest nutrients and help protect the soil from rain, sun, and wind, lowering the risk of erosion; agricultural residues play a similar role in farm fields.[xvii] More research is needed to determine how much residue can be removed safely to avoid degrading soil quality and reducing yields.

Depending on the feedstock choice and what it is replacing, good farming methods can achieve increases in productivity with neutral or even positive impacts on the surrounding environment. A variety of management practices, such as the use of bio-char[6], intercropping, crop rotation, double cropping, and conservation tillage, can reduce soil erosion, improve soil quality, reduce water consumption, and reduce susceptibility of crops to pests and disease—thereby reducing the need for chemical fertilisers and pesticides. It is important to note that while conservation agriculture techniques can minimise and even reverse negative environmental impacts by stemming soil erosion and building new soil, these benefits are gained only if sufficient soil cover, mostly from crop residues, is left on the ground.

In addition to stemming soil erosion, conservation agriculture techniques can help address climate change concerns by capturing carbon in the form of new soil organic matter. The potential for carbon sequestration in large areas would be reduced, however, if most of this organic matter were converted into bioenergy, resulting in the re-release of the carbon into the atmosphere. Especially for second-generation fuels where the entire feedstock product (including crop residues) can be utilised, it might be difficult to convince farmers to leave a certain percentage of the harvest on the field.

Using perennial crops as protective buffers or wildlife corridors can bring environmental benefits as well, including reducing chemical runoff and providing habitat for birds and other wildlife. Some crops, such as jatropha, can actually reverse desertification by helping to improve the condition of degraded lands.[xviii] However, even more-sustainable energy crops cannot substitute for natural forests or prairies.[xix]

B. Impact on Grasslands, Tropical Forests, and Other Biodiverse Ecosystems

Ultimately, the problems associated with bioenergy land use (particularly of virgin land), including deforestation, biodiversity loss, soil erosion, and nutrient leaching, will remain the most vexing and deserve the most attention. In India, Sri Lanka, and Thailand, wood harvesting by the urban poor has produced a halo of deforestation around roads, towns, and cities, while an estimated 400-kilometer radius of land has been cleared for fuelwood around Khartoum, Sudan.[xx] Where crops are grown for energy purposes, use of large-scale mono-cropping could lead to significant biodiversity loss, soil erosion, and nutrient leaching. Most models of environmentally sustainable agriculture are based on multi-cropping rather than mono-cropping.

Even varied and more-sustainable crops grown for energy purposes could have negative environmental impacts if they replace wild forests or grasslands. Other potential impacts include the eutrophication of water bodies, acidification of soils and surface waters, and ozone depletion (all of which are associated with nitrogen releases from agriculture), as well as the loss of biodiversity and its associated functions.[xxi] Finally, the loss of pastoral lifestyles

[6] Bio-char, or black carbon, is generally derived from charcoal generated through the incomplete combustion of biomass

associated with shrinking grasslands, and the loss of feed production for domesticated and wild herbivores that depend on these lands, could have significant negative economic and social impacts.

C. Impact on Water Quality and Availability

FAO expects that no major water crisis will affect irrigated agriculture at the global level by 2030, by which time there will be a relatively small increase in irrigation water withdrawal compared to a 1998 baseline. However, severe water shortages are already occurring at the local level, particularly in the Near East and North Africa. Agriculture currently uses 70 percent of the world's (and 85 percent of the developing world's) available fresh water, primarily for the production of food and non-food raw material. Rain-fed agriculture is practised on 83 percent of all cultivated land and supplies more than 60 percent of the global food supply, although research indicates that use of irrigation could more than double the highest yields from rain-fed agriculture. Three-quarters of the world's irrigated land is in developing countries, where it accounts for about 20 percent of all agricultural land and provides about 40 percent of all crop production.[xxii]

Many of the existing concerns about water use and quality can be addressed by using water more efficiently, recycling more of it for fertiliser, and digesting it for biogas. Although such changes take time, FAO projects that over the next 30 years, the effective irrigated area in developing countries can increase by 34 percent while relying on only 14 percent more water. This is possible due to the declining shares of water-intensive crops in agricultural consumption, and the feasibility of increasing the average efficiency of irrigation water use over the next 30 years.[xxiii] While this addresses concerns about potential water availability to meet food and material production needs, however, it does not account for bioenergy uses.[xxiv] Indeed, problems with water availability and use may represent a limitation on agricultural bioenergy production.

The physical availability of water as well as legal rights and access to water will be vital issues for both biomass cultivation and processing (depending on the conversion process—some, like gasification, will use very little water). Water availability will influence feedstock choice, the siting of conversion facilities, and other bioenergy business decisions. In turn, these variables could influence the availability of water and associated human security.

D. Impact on Air Quality

Air quality problems associated with bioenergy feedstock production are relatively minor and can be reduced through such measures as shifting from petroleum diesel to biodiesel for operating farm machinery and adopting regulations that limit or eliminate field burning and other polluting practices. The air quality and health problems associated with traditional biomass burning for heating and cooking are well known and the focus of many efforts around the world, as discussed in Issue 1.

Air pollution impacts from the use of ethanol and biodiesel in transportation are lower than those from fossil fuels, and this has been one motivation for turning to biofuels. Biogas contributes to improved air quality as well, although this occurs more locally (e.g., reducing odours from human and animal waste near waste disposal sites and residential areas). The benefits to global air quality and climate are discussed in Issue 9.

E. Impact of Second-Generation Technologies

Over time, the environmental advantages of bioenergy relative to fossil sources will likely increase as new and more efficient feedstock sources and conversion technologies are developed and as crop yields increase. It is important to get to this future as soon as possible by moving quickly to commercialise second-generation technologies—such as cellulosic ethanol, torrification, and Fischer-Tropsch synthetic fuels from gasified biomass—that rely on less resource-intensive feedstock. Bio-power based on second-generation technologies is also likely to be increasingly advantageous relative to fossil sources.

IMPLEMENTATION ISSUES

A. Effectiveness of Land-Use Controls

Despite the considerable challenges, models do exist for mitigating many of the risks associated with large-scale biomass production, particularly with regard to biofuel feedstock. To address concerns about biodiversity loss, for example, the Brazilian state of São Paulo requires that sugar cane producers set aside 20 percent of their total planted area as natural reserves.[xxv] In India, which has more than 300 species of oil-bearing trees, a multi-species biodiesel programme may help to ensure plant genetic diversity.[xxvi] And at least some palm oil industries in Southeast Asia have promoted wildlife sanctuaries and green corridors to enhance biodiversity.[xxvii] These efforts are supported at the international level by the Roundtable on Sustainable Palm Oil, formed in 2004 in response to rising concerns about the environmental impacts of oil palm plantations.

Nevertheless, there is still a dire need for environmental policies and regulations at the local, national, and regional levels—particularly in developing countries—to ensure that bioenergy's impacts on land, wildlife, and water, air, and soil quality are minimised. Devising and enforcing such regulations will be a challenge, especially if there are perceived or real trade-offs between environmental sustainability goals and economic viability.

B. Need for Further Research

More research is needed to determine which crops and management practices can best minimise impacts and maximise benefits. To date, most studies on the impacts of feedstock production have been species and context specific; there is less understanding of which practices are most effective and least harmful to wildlife and surrounding ecosystems under different and broader circumstances. In addition, more research is needed on: the potential for using natural pesticides and fertilisers; the potential impacts of large-scale plantations of oil-bearing trees, such as jatropha; the potential to increase crop yields while reducing inputs; the impacts of residue removal from cropland and forests (and how much can be safely harvested); and the options for perennial feedstock suitable for arid regions. It is also critical to better determine if the benefits of genetically modified (GM) crops can outweigh their costs. As mentioned earlier, although efforts are under way, further research on second-generation biomass conversion technologies is urgently required. Any research conducted should be available to all countries through ambitious and internationally supported technology transfer schemes.

C. Potential for Voluntary or Mandatory Certification

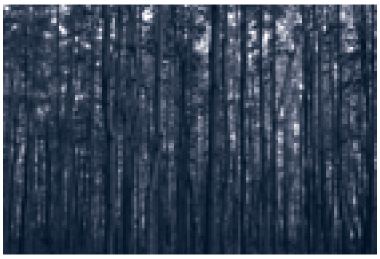
As global use of biomass for energy increases, impacts on the environment will likely also rise in the absence of the development and early introduction of standards, regulations, and efficient supply and conversion technologies. International standards and certification/assurance systems are critical to ensure that bioenergy is produced using the most sustainable methods possible. (See Box 8.)

For some bioenergy sources, such as wood, existing certification systems (e.g., the Forest Stewardship Council) can be a good starting point and reference framework. Important efforts are also under way by FAO, UNEP, UNIDO, UNCTAD, and the WTO to advance the design and approval of bioenergy certification standards and modalities. Of particular importance are criteria being developed by FAO in close cooperation with UN-Energy, academia, industry, and NGOs to advance understanding of bioenergy-food security linkages and to help assess bioenergy options quantitatively. Of particular interest for future certification and labelling schemes is the impact of large bioenergy projects on small-scale farmers, employment, equity, and gender.

BOX 8.

HELPING SMALL BUSINESSES PRODUCE BIOFUELS FROM AGRICULTURAL AND BIOMASS WASTES

The Global Bioenergy Partnership (GBEP), which emerged from a commitment made by the G8 at the Gleneagles Summit in 2005, is focusing initially on two main areas: trade and the sustainability of bioenergy. To ensure that bioenergy can achieve its potential benefits, sustainability of the entire lifecycle (production, conversion, and end-use) must be assured. Thus, GBEP partners, in particular UNEP, are in the process of defining sustainability criteria and suggestions for decision-makers in both industry and government that aim to reduce risks as the bioenergy market develops. Issues for which criteria will be developed include climate change, local air pollution, biodiversity, water, soil, land use, food security, and labour issues.



Issue 9 — Implications for Climate Change

INTRODUCTION

One of the major drivers of bioenergy development worldwide is concern about global climate change, caused primarily by fossil fuel burning, land use changes, and agriculture. The use of modern biomass for energy production has the potential to significantly reduce anthropogenic greenhouse gas (GHG) emissions. Transportation, including emissions from the production of transport fuels, is responsible for about one quarter of global energy-related GHG emissions, and that share is rising.[xxviii] Looking just at carbon dioxide (CO_2) emissions in recent decades, fossil fuel burning (mainly in industrialised countries) has accounted for 75–85 percent of global CO_2 emissions, while deforestation and other land-use changes (mainly in tropical developing countries) accounted for 15–25 percent.

To assess the GHG balance associated with different forms of bioenergy, it is essential to consider emissions throughout the full life-cycle. A better understanding is needed to fill gaps in knowledge regarding life-cycle GHG emissions (including nitrous oxide emissions) and other heat-trapping emissions associated with biomass production and use.

A. Factors Affecting Net GHG Emissions

Full life-cycle GHG emissions of bioenergy vary widely based on: land use changes; choice of feedstock; agricultural practices; refining or conversion process; and end-use practices. If, for example, prairie grassland is converted to maize or soy, treated with chemical fertilisers and pesticides, and refined with coal and natural gas, the resulting biofuel could have a greater impact on the climate over its life cycle than fossil fuels. Alternatively, if perennial crops replace annual crops (such as maize now grown to produce ethanol) and are processed with biomass energy that offsets coal-fired power, the resulting biofuel can significantly reduce GHG emissions compared to fossil fuels.

In general, crops that require high fossil energy inputs (such as conventional fertiliser) and valuable (farm) land, and that have relatively low energy yields per hectare, should be avoided. It is also critical to reduce if not eliminate the harvesting of non-renewable biomass resources, a problem in much of the developing world. However, even the planting and harvesting of "sustainable" energy crops can have a negative impact if these replace primary forests, resulting in large releases of carbon from the soil and forest biomass that negate any benefits of biofuels for decades.[xxix]

B. GHG Reduction Potential

Research on the net life-cycle GHG emissions associated with bioenergy production and use is still under development, and estimates vary widely due to variations in circumstances. Results are highly sensitive to assumptions about land use changes, the effects of fertiliser application, and by-product use.

With regard to transport fuels, the vast majority of studies have found that, even when all fossil inputs throughout the lifecycle are accounted for, producing and using biofuels from current feedstock results in some reductions in GHG emissions compared to petroleum fuels.[xxx] This is provided that there is no clearing of forestland or virgin cerrado, or draining of peat lands that store centuries of carbon from biomass.

In the case of electricity generation, biomass combustion to displace coal can reduce GHG emissions even further than using biomass for transport fuels.

Moreover, the use of biowastes destined for landfills to generate biogas for heat and power production reduces the amount of organic waste that would ultimately decompose and release methane, a GHG that is 21 times more potent than carbon dioxide.

In the future, "cascading" biomass over time—that is, using biomass materials for various uses and then recycling the wastes for energy—will maximise the CO_2-mitigation potential of biomass resources. It is possible to displace more fossil fuel feedstock, and thus derive a far greater carbon benefit, by first using biomass to produce a material (such as plastic) and subsequently using that material (at the end of its useful life) for energy production. Studies of the climate and economic impacts of cascading biomass have concluded that this practice could provide CO_2 benefits up to a factor of five compared to biomass used for energy alone.[xxxi]

C. Trade-offs: Costs and Limited Resources

Current research concludes that using biomass for combined heat and power (CHP), rather than for transport fuels or other uses, is the best option for reducing GHG emissions in the next decade—and also one of the cheapest.[xxxii] Thus, the greatest potential for reducing emissions comes from the replacement of coal rather than petroleum fuels. Analyses from many countries indicate that biofuels are currently a relatively expensive means of reducing GHG emissions relative to other mitigation measures, with the cost of CO_2-equivalent emissions reductions exceeding US$163 per tonne.[xxxiii] The one exception is Brazil, where ethanol from sugar cane is competitive with gasoline when oil prices are above US$50 a barrel.[xxxiv]

At the same time, the CO_2 avoided by using biofuels is only a part (albeit a significant part) of the societal benefit derived from transitioning to these fuels. While many renewable options exist to substitute for coal in the generation of heat and electricity, biofuels offer the only realistic near-term renewable option for displacing and supplementing liquid transport fuels. Yet even within the transport sector there are more cost-effective options for reducing carbon emissions, including investments in and promotion of public transportation, increased use of bicycles and other non-motorised vehicles, improvements in vehicle fuel-efficiency, and changes in urban planning and land use.[xxxv]

IMPLEMENTATION ISSUES

To minimise the GHG emissions associated with bioenergy production, policy makers need to safeguard virgin grasslands, primary forests, and other lands with high nature value, and to encourage the use of sustainable production and management practices for biomass feedstock. Indeed, such policies should extend beyond biomass production for energy to the agricultural and forestry sectors in general.

An international certification scheme needs to be developed that includes GHG verification for the entire lifecycle of bioenergy products, particularly biofuels. In some countries today, biomass is considered "carbon neutral" because assessments fail to account for upstream emissions. While developing and implementing a widely accepted certification scheme will be a challenge, this should not deter governments, industry, and other actors from making the effort. The United Kingdom is now contemplating a scheme for imported biofuels that includes the entire supply chain in emissions

THE USE OF MODERN BIOMASS FOR ENERGY PRODUCTION HAS THE POTENTIAL TO SIGNIFICANTLY REDUCE ANTHROPOGENIC GREENHOUSE GAS (GHG" EMISSIONS.

accounting, and Belgium has already put such a scheme into legislation.[xxxvi]

Intense work is ongoing to fill gaps in the full understanding of life-cycle emissions, as well as studies that cover the full range of feedstock and processing pathways (e.g., biodiesel from palm oil or jatropha).[xxxvii]

A. Improving Production Efficiency

Energy-efficiency improvements across the board are essential. To the extent possible, particularly in the industrial world, biomass should be used to replace (rather than simply supplement) fossil fuels for energy production. Substituting biofuels for petroleum can provide a far greater benefit to the global climate than producing and burning the fuels merely to offset the projected increase in global energy demand. Where people still lack access to modern energy resources, providing access to modern bioenergy is preferable to using fossil fuels and (combined with energy-efficiency improvements) can help reduce future growth of GHG emissions.

B. Cellulosic Ethanol Production and Other Advanced Technologies

In the case of liquid biofuels, the greatest potential for reducing GHG emissions and their associated costs lies in the development of second-generation feedstock and fuels, due to their potentials for both large-scale production and emissions reduction. In particular, advanced technologies that convert lingocellulosic feedstock to fuel offer significant potential to reduce transport-related GHG emissions. Assuming oil prices remain high and major breakthroughs in reducing production costs occur, it may even be possible to achieve negative CO_2-abatement costs, while providing a host of other environmental and social benefits.

C. Carbon Capture & Storage Potential

Bioenergy production and use offer significant potential for carbon capture and sequestration. For example, one possible by-product of the biofuel conversion process is bio-char, which has been shown to help store carbon in the soil while also reducing soil emissions of nitrous oxide or methane and providing valuable fertiliser. Conservation agriculture, too, offers the potential to sequester substantial amounts of carbon in the soil in the form of organic matter; however, this practice might conflict with bioenergy production, as this would require converting much of the organic matter to energy.[xxxviii] (See Issue 8 for more on these issues.)

Section 4: Looking Forward

As discussed in the previous chapters, the bioenergy field, with its varying biomass sources, conversion technologies, and contexts (ecological, social, and institutional), is complex and requires a range of criteria and approaches. But this complexity should not restrain action. The movement towards more sustainable energy systems that draw from all potential renewable sources, including bioenergy, is a matter of urgency.

Over-generalising about the future of bioenergy would be both futile and disrespectful to readers, in particular decision-makers. This concluding section does not attempt to provide prescriptive actions, but rather to point to key areas that merit attention at the national and international levels. It suggests a framework for decision-makers to encourage the sustainable production and use of modern bioenergy in order to achieve maximum benefits to the poor and to the environment.

Because the point of convergence of the work of UN-Energy members is at the country level, this chapter focuses first at the national level, with the understanding that national actions have global impact. The chapter then addresses action at the international level, since UN-Energy recognises the importance of international efforts such as the CSD and is aware of the potential global impact of bioenergy.

NATIONAL LEVEL

At the national level, knowledge and policies are key in providing and sustaining a solid base for action in the bioenergy field. The following points are critical:

Knowledge

Resource Base: To be in a position to develop bioenergy actions and programmes, it is critical to understand the potential of biomass energy in a particular country or region. This is not an easy task, however, as it involves envisioning future agronomic opportunities, agricultural practices, and conversion technologies. While some assessment methodologies are available, others are being developed that allow for a clearer vision of the type and scale of feedstock at hand. Key areas of knowledge include:

- *Current production of agricultural products with bioenergy potential, as well as assessment of possible energy use and expansion of production;*
- *Current land uses, obtained with the help of surveys, mapping, and GIS;*
- *Production potential in rehabilitated marginal and degraded lands;*
- *Alternative uses of feedstock as well as current demand and uses of agricultural and forestry residues and by-products; and*
- *Availability of water and other resources.*

Technologies: Determining the best bioenergy production, conversion, and utilization technologies is complex (and potentially increasingly restricted information). Building a national research and technical capacity can save expensive imported knowledge, and collaboration among countries can bridge information gaps. Key areas of knowledge include:

- *Availability and accessibility of modern technologies for bioenergy conversion and use;*
- *Life-cycle analysis methodology and tools to assess bioenergy systems, including their economics, energy balance, carbon flows, and leakage effects.*

Section 4: Looking Forward

Stakeholders and Capacities: Maintaining the interdisciplinarity of bioenergy systems is very important. Actors in this field include the energy, agriculture, forestry, environment, rural development, and industry and trade sectors. Within these, there are players related to local and national governments, farmer organizations, and NGOs and civil society. Key areas of knowledge include:

- *Key stakeholders in national bioenergy efforts;*
- *Information generation and flow among these varying sectors;*
- *Capacities related to each stakeholder to help promote information flow, capacity building (see below), and courses and curricula.*

Economics of Production and Consumption: Assessing the relative economic competitiveness of bioenergy at the local, regional, and national levels is critical—based on the resource base, available technologies, and stakeholder capacities. Key aspects include:

- *Type of bioenergy and technology;*
- *Costs across the supply chain: raw material production or gathering, processing, transport, and infrastructure modifications (if any);*
- *Value of by-products;*
- *Local costs of alternative energy sources;*
- *Opportunity costs of land, labour, and water used;*
- *Monetizing environmental externalities.*

The above set of information and knowledge is the backbone to decision-making since it provides the physical, social, and economic basis for action. It is clear that the dynamics of the energy and agriculture contexts and the results of policy and technical decision-making will require the revisiting and updating of this material regularly.

Policy

Agriculture and Food Security: Expanded bioenergy use could affect household and national food security in positive or negative ways, depending on the situation. All four dimensions of food security—availability, access, stability, and utilization—require policy attention. Key agriculture and food security issues to consider when establishing the policy framework for bioenergy include:

- *Risks to food security of various bioenergy scenarios and possible ways to avert them;*
- *Positive impacts of expanded bioenergy due to diversification, new rural infrastructure, and jobs;*
- *Potential benefits or harm to affected populations;*
- *Present and future prices, markets, and subsidies;*
- *Potential export markets for possible surpluses;*
- *Impacts of second-generation systems on the structure of agriculture;*
- *International cooperation opportunities in bioenergy production and trade.*

Energy: For most oil-importing developing countries, bioenergy represents a real option to reduce foreign exchange needs; for tropical nations, it may represent the opening of new and diversified markets. But these opportunities will not happen unless policies are in place to eliminate barriers and pave the way to social, environmental, and economic benefits for all stakeholders. Key energy issues to consider when establishing the policy framework for bioenergy include:

- *Bioenergy's viability as an energy option and its present role in the national energy balance;*
- *Future role of bioenergy under various scenarios;*
- *Technological options in those scenarios;*
- *Knowledge and expertise available in the country;*

- *Bioenergy's role in energy-efficiency policies;*
- *Costs and prices of biomass-based energy carriers;*
- *Current taxation and subsidy situation in light of future bioenergy scenarios.*

Support to Bioenergy (Including Fiscal): For bioenergy sources that require government support—most prominently liquid biofuels—fiscal and other implications should be carefully considered. Key issues to consider include:

- *Economic and social costs and benefits of different types of support: subsidies, import tariffs and other import restrictions, and consumption mandates;*
- *Magnitude and types of subsidies: tax reduction, tax credits, loan guarantees, subsidised credits, income tax reduction, tax holidays, and cash subsidies linked to production levels;*
- *Net loss in government revenue and what other government programmes will be cut as a result, where additional taxes may be levied to offset the loss in revenue, and alternative uses of government subsidies;*
- *Impact of a consumption mandate on domestic fuel prices in times of supply shortage due to weather- or pest-related crop failures;*
- *Welfare impact if energy prices rise as a result;*
- *Economic and social benefits of increased bioenergy production and/or consumption as a result of government support.*

Rural Development: Bioenergy should open new opportunities for rural development, but not at the cost of food security or environmental damage that would undermine that development. Key rural development issues to consider when establishing the policy framework for bioenergy include:

- *Integration of bioenergy development into existing rural development policies and programmes;*
- *Number of jobs to be created under the various bioenergy scenarios;*
- *Quality, safety, and health characteristics of these new jobs;*
- *Impact on rural development (determined by establishing baselines and indicators);*
- *Incorporation of these indicators into wider efforts to assess sustainability of bioenergy activities;*
- *Monitoring and assessment of new investments due to bioenergy expansion.*

Land Use: Using biomass for energy production is only different from other agricultural land uses in that it is expanding at a rapid rate and involves new actors. Key land-use issues to consider when establishing the policy framework for bioenergy include:

- *Protecting small-scale farmers from loss of land due to pressures from large-scale producers;*
- *Respect for and protection of land tenure rights;*
- *Use of "informed decision-making" and full participation of stakeholders when determining land-use changes;*
- *Assessing existing land-use policies in light of potential expanded bioenergy use.*

Environment: Critical natural systems could either be greatly enhanced or further degraded by expanded modern bioenergy production; it is thus vital to assure sustainable production practices. Key sustainability issues to consider when establishing the policy framework for bioenergy include:

- *Impact assessments;*
- *Emissions monitoring and reduction;*
- *Biodiversity protection;*
- *Water use management;*
- *Soil health maintenance.*

Section 4: Looking Forward

Industry: The private sector will play a central role in the development of new and expanded bioenergy sources. Key industry players include:

- *Agro-industry, which will gain in importance as it transitions to providing energy in addition to food and feed;*
- *Forestry industry, which will gain new markets, new value-creation opportunities for its wastes and low-value timber, and enhanced scrutiny as forests are more intensively managed;*
- *Energy industry, including established electricity and fuel providers who are central to energy distribution, as well as large-scale investors in new energy and fuel generation capacity;*
- *Small- and medium-sized enterprises, which will be critical to the achievement of development goals associated with bioenergy provision.*

Research and Development: An appropriate role of the government is to fund research and development that has public-good aspects, including basic scientific research with no immediate commercial applications. Policy questions include:

- *Identifying bioenergy needs in the specific country context;*
- *Identifying where the R&D community in the country has comparative advantage;*
- *Ranking priorities so as to bring online as rapidly as possible those technology options with the greatest environmental and social benefits, as well as the best chances of becoming commercially competitive;*
- *Identifying policy needs and areas for policy research.*

While the above areas for policy development are highly relevant, even more important is the interaction and integration of these policies. Bioenergy can give rise to important trade-offs between different policy goals. Only by carefully assessing these trade-offs and integrating policies for land use, agriculture, and energy—and aligning them with policies for rural development, transport, and finance—can bioenergy policies be effectively designed. And only through a convergence of biodiversity, GHG emissions, and water-use policies can bioenergy find its proper environmental context and agricultural scale.

Action – Some Options

Develop intersectoral plans and programmes on bioenergy. This includes:

- *Identifying bioenergy options suitable for the country and ranking them in order of greatest environmental and social benefits and potential commercial competitiveness;*
- *Identifying R&D needs for both policy and technology innovations*
- *establishing normative and legislation frameworks;*
- *Formulating projects, which are critically important at this stage in the development of bioenergy. On-the-ground experience in a variety of contexts and the dissemination of lessons learned are necessary to foster the sustainable growth of these industries;*
- *Developing intersectoral cooperation among all sectors involved and affected by bioenergy.*

Support R&D for bioenergy, including:

- *Carrying out policy research for bioenergy, including appropriate forms of government support, identification of barriers to uptake, and policy response to the barriers;*
- *Identifying areas of unique interest in the developing-country context (for example, use of straight plant oil in stationary engines in remote*

areas for electricity generation) and funding R&D, as appropriate;

- *Facilitating collaboration among researchers nationally and internationally.*

Facilitate transfer of technologies and sharing of information, including:

- *Reducing border barriers to imports of technologies and materials needed;*
- *Tapping into modern technology information sources.*

Build capacity of and educate participating decision-makers, including:

- *Rural organization members and farmers/ producers;*
- *Policy makers;*
- *Investors and financiers;*
- *The public and consumers;*
- *Academic and research communities;*
- *Entrepreneurs;*
- *NGOs.*

Build capacity in the following areas:

- *Managerial skills;*
- *Technical skills;*
- *Trade-related issues;*
- *Marketing and public outreach;*
- *Negotiation and investment.*

Provide financial support, including:

- *Financial schemes at various levels, including for small-scale producers;*
- *Utilizing micro-finance and other innovative mechanisms;*
- *Providing public sector loan guarantees and other risk-mitigation mechanisms to enable more private investment in new technologies;*
- *Enabling public-private partnerships.*

INTERNATIONAL LEVEL

The International Bioenergy Platform (IBEP) has noted that, "Bioenergy requires a multidisciplinary and global approach if it is to play the key role expected by stakeholders from the energy, agriculture, and environment sectors." With this in mind, UN-Energy proposes the following steps towards sustainable bioenergy development at the global level:

- *Identify, develop, and monitor the qualitative and quantitative implications of expanded bioenergy development for key sectors, including agriculture, industry, health, environment, and trade;*
- *Promote international research on the social, scientific, technological, economic, policy, and environmental issues guiding bioenergy development;*
- *Encourage additional research and greater sharing of technology development by the concerned stakeholders, including private sector entities, and making greater use of existing international consultative arrangements, including the Consultative Group on International Agricultural Research;*
- *Promote the sound development and coordination of current information systems on bioenergy;*
- *Encourage the Parties to the Conventions on Biological Diversity and on Combating Desertification to consider opportunities for sustainable cultivation and utilization of energy crops;*

Section 4: Looking Forward

- *Establish internationally agreed standards and other certification models for production, conversion, use, and trade of bioenergy systems to protect both society and the environment;*[xxxix]

- *Develop sustainability criteria and analytical tools to be mainstreamed into projects and programmes;*

- *Establish methodologies under the Kyoto Protocol's Clean Development Mechanism for the assessment of bioenergy systems, including second-generation technologies; and*

- *Promote international transfer of technologies, expertise, and experience in bioenergy between all countries, in both the industrialised and developing worlds.*

The importance and uniqueness of bioenergy, the array of issues it brings together, and the relatively limited knowledge on how to tackle these, plus the combination of political, economic, and environmental interests in bioenergy development and expansion, have resulted thus far in a rather elusive consensus at the national and international levels. It is hoped that the present UN-Energy publication can contribute to the further mapping of a multi-stakeholder approach to bioenergy for sustainable development.

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Notes

Notes

UN-Energy

UN-Energy is the principal interagency mechanism in the field of energy that helps ensure (a) coherence in the UN system's multi-disciplinary response to WSSD; and (b) collective engagement on non-UN stakeholders.

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World Meteorological Organization .... www.wmo.ch

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UN-Energy seeks to structure the approach to the current discussion on bioenergy. "Sustainable Bioenergy: A Framework for Decision Makers" is the contribution of the UN system to the issues that need further attention, analysis and valuation, so that appropriate trade-offs can be made and both the energy needs of people met and the local and global environment adequately protected.

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