Chapter 13
Key Strategies for Policymakers

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13.1 Strategy Options at the Global Level

13.1.1 Background for Sustainable Deployment Strategies and Response Measures

Biofuels[1] have been identified as having diverse environmental, social, and economic impacts, as discussed in Chap. 2. For this reason, the use of biofuels to realize a sustainable society requires study that takes into account the respective characteristics of biofuel deployment on a global, regional, national, and local scale. In this chapter, we examine deployment strategies for sustainable biofuels on a global scale by surveying the current and future issues that need to be considered. These issues include environmental impacts starting with the reduction of greenhouse gas (GHG) emissions from biofuels and including other issues such as energy security, food security, rural development, agriculture and industrial policy, trade, and north-south issues. We then examine ways that biofuel deployment strategies can address these issues to realize a sustainable society.

[1] In this chapter, "biofuels" refer to liquid fuels such as bioethanol and biodiesel, including second-generation biofuels such as those derived by decomposing cellulose. Fuelwood and other biomass and gas recovery through conventional means such as methane fermentation of waste are excluded. However, "bioenergy" includes conventional biomass energy such as from fuelwood.

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13.1.1.1 Biofuels and Their Environmental Impact

Biofuels are carbon neutral at the usage stage and, because they are renewable, can be studied as a means of addressing global warming. However, there are many items that need to be considered including changes in land use, encompassing forest conservation, as well as impacts on air, water, and soil quality and impacts on water resources, ecosystems, and biodiversity. It is also important to assess the indirect impact on land use. For these reasons, biofuels have been studied by the Scientific Committee on Problems of the Environment (SCOPE) of International Council for Science (ICS) as a worldwide body and by the USA and other countries (SCOPE 2008; UDAID 2009; USEPA 2011), in addition to existing study by the United Nations organizations cited later in this chapter. In order to assess these items appropriately, it is necessary to study deployment strategies from a global perspective.

The United Nations Environmental Programme (UNEP 2009) reports that the GHG balance in LCA for biofuels varies widely depending on the raw materials, biofuel generation technology, and methodological assumptions. For example, bioethanol from sugarcane can reduce GHG emissions by between 70% and 140% compared with gasoline, whereas corn can reduce GHG emissions as much as 60% but may also increase them by as much as 5%. Biodiesel from palm oil can reduce GHG emissions by as much as 80%, but when palm oil is harvested by converting natural forests into plantations, it can increase GHG emissions by 870–2000% when taking into account the impact of the land use change (UNEP 2009). In other words, biofuels do not always have the effect of reducing GHG emissions when compared with fossil fuels such as gasoline and diesel oil, if we consider direct emissions from the harvesting of biofuel crops and indirect emissions from land use changes.

Furthermore, the use of fertilizers causes eutrophication of water bodies and acidification of rainwater, while decomposition of fertilizer generates nitrogen oxides that have an impact on ozone layer depletion. It has been pointed out that these impacts are insufficiently covered by LCAs and require future study (UNEP 2009).

In addition to GHG emissions, land use change can have a potentially major negative impact on biodiversity by changing living creatures' habitats, except where wasteland is used to cultivate energy crops. Jatropha has drawn interest as a raw material crop for biofuel but is also identified as being a potentially invasive species that could disrupt ecosystems.

It is also necessary to consider the nutrient contamination of water bodies as a result of intensive agriculture. There is the additional concern that irrigation and other practices involved in harvesting biofuel crops will also increase consumption of agricultural water and, combined with extreme weather events (flooding and droughts) caused by climate change, could create issues for water resource management (UNEP 2009; World Bank a 2010).

The use and combustion of biofuels reduce localized emissions of some air pollutants such as particulate matter (PM10), volatile organic compounds (VOCs), sulfur oxide, and carbon monoxide but are also reported to increase nitrogen oxide (NOx) and aldehyde emissions. Biodiesels are reported to increase NOx emissions but reduce PM and VOC emissions compared with low-sulfur diesel oil. In many cases, liquefied petroleum gas (LPG) and compressed natural gas (CNG) achieve greater reductions (World Bank a 2010; Arai 2009).

Land use change from biofuel use falls into two categories: impacts that are directly caused by harvesting of biofuel crops and indirect impacts due to changes in the harvesting of other crops which are induced by expanding of biofuel crops harvesting. Both lead to the conversion of land that is needed for forestry or for agriculture to increase food production. This could constrain resources even further. While the predicted impact depends on the target that is set for biofuel use, there are studies indicating that there will not be a major increase in land conversion because of large food demand from China and India and relatively low production of biomass, although land conversion has increased in Africa and Central and South America and to a lesser extent in the USA and Australia (World Bank a 2010). Furthermore, it is thought that natural forests and grassland that are not being used for forestry will be the main target for conversion into biofuel cropping (World Bank a 2010).

It is reported that between 475 and 580 million hectares (Mha) of abandoned agricultural land could be brought back into agricultural production, but not all of these can be returned to productivity, for reasons such as water and nutrient shortages. Furthermore, some countries such as India and China prohibit the conversion of planted forests to return them to agricultural production (World Bank a 2010).

13.1.1.2 Food Security and Biofuels

Manufacturing and use of biofuels are closely connected with food security, namely, the stable supply of food at affordable prices, which is an issue for developing countries in particular.

The Food and Agriculture Organization of the United Nations (FAO) estimates that 925 million people were undernourished in 2010 (FAO 2010) and maintains that food production must increase in order to accommodate future population growth. It is estimated that crop yields per unit area will continue to increase at the recent historic average of 1.5% annually to meet increased demand from population growth, but meeting increased demand for feeds to accompany increased meat consumption will not be possible. This indicates that it will also be difficult to increase the volume of biofuel crops to cope with increased demand for biofuels. While there is a bare minimum expansion of agricultural land necessary for increased food production in response to population growth, there are many estimates regarding the extent of land use changes that will result from changes in food demand and the cropland expansion that will result from increased biofuel use. These estimates vary widely due to differences in underlying assumptions and estimation methodologies (World Bank a 2010). For example, the Gallagher Report (RFA 2008) estimates that between 144 and 334 Mha of additional land will be needed by 2020, equivalent to between 10% and 24% of all cropland in use in 2008.

Food purchasing costs account for a large portion of household expenditures for low-income households, and food security becomes an issue if biofuels cause food prices to rise. In fact, biofuels were one of the factors blamed for the global food crisis of 2008. Other factors blamed included increased demand for grains and meat in emerging countries such as China and India, climate conditions including a drought in Australia, the sharp decline of the US dollar, implementation of export restrictions in food-exporting countries in order to combat domestic food price inflation, and speculative trends in international markets.

Recent reports indicate that the impact of biofuels on food prices is relatively small, both cumulatively and on a global scale. For example, it is estimated that increased global production of biofuels in the 2 years ending in June 2008 only accounted for a little over 12% of the rise in the International Monetary Fund's food price index (World Bank a 2010).

However, looking toward the future, prices for corn will increase by 23–72% by 2020 if countries implement their biofuel deployment plans. The World Energy Outlook 2008 by the International Energy Agency (IEA) projects a scenario in which food prices are calculated to rise by 10% by 2020 if biofuel deployment is maintained at 2008 levels (World Bank a 2010).

The impact of biofuel use on the food supply and food prices must be carefully considered. The joint statement issued by the FAO's World Summit on Food Security (FAO 2009) and the leaders statement of the G8 Hokkaido Toyako Summit both call for a balance between policies promoting the sustainable production and use of biofuels and food security.

13.1.1.3 Rural Development, Agricultural and Industrial Policy, and Biofuels

The FAO points out that new agricultural investment to accompany biofuel use has the potential to create new markets and employment in agriculture, which has struggled with sharply dropping food prices over the last few decades (FAO 2008). According to the FAO, an appropriate increase in biofuel production in rural areas will improve infrastructure development and enhance access to markets. Furthermore, it will help to modernize agriculture and rural economies, improve access to modern energy, and improve indoor air pollution through the use of biofuels that are less polluting to the environment. If good practices such as no-tillage cropping and direct seeding can be employed to harvest biofuel crops, negative impacts, including carbon dioxide (CO_2) emissions and consumption of water resources, can be lessened. In addition, development of local production systems that combine food and energy crops correctly can reduce waste and raise the overall production efficiency.

Notably, the Cabinet of the Japanese Government approved a Biomass Nippon Strategy in December 2002, further revising it in March 2006. The strategy outlines concrete initiatives and a plan of action for encouraging the use of biomass, including biofuels, with the additional perspective of revitalizing agricultural, forestry, and fishing communities. Under the strategy, the Japanese government is implementing policies for significant deployment of biofuels (Government of Japan 2006).

13.1.1.4 Energy Security and Biofuels

The UNEP reports that global production of ethanol for transport fuel increased from 17 billion liters to 52 billion liters between 2000 and 2007, while biodiesel increased from 1 billion liters to 11 billion liters in the same period. Biofuels altogether provided 1.8% of the world's transport fuel, with ethanol providing 5.46% of global gasoline use, while biodiesel provided just 1.5% of global diesel use (UNEP 2009). According to a joint report by the Organisation for Economic Co-operation and Development (OECD) and the FAO, ethanol production is estimated to increase to 159 billion liters by 2019 with biodiesel production increasing to 41 billion liters, which, even considered together, will not account for a significant share of the overall consumption of transport fuel (OECD-FAO 2010). As a result, while the role of biofuels from an energy security perspective varies by country depending on national circumstances, biofuels do not play a major role from a global perspective. However, the situation could change due to uncertain factors including future policies to promote biofuels, economic circumstances such as crude oil prices, environmental standards, developments in second-generation biofuel technologies, and competition between food production and biofuel production from agricultural resources.

13.1.1.5 Trade, North-South Issues, and Biofuels

Global international trade in biofuels only accounts for around one-tenth of all biofuel production, but global trade in ethanol fuels is estimated to have tripled from less than 1 billion liters in 2000 to around 3 billion liters in 2007. The USA is the world's largest ethanol-importing nation, with Brazil the largest exporting nation. More than 10% of all biodiesel production in 2007 was traded internationally, with Indonesia and Malaysia being the major biodiesel exporting nations (World Bank a 2010).

The USA and EU have targeted domestic biofuel production in consideration of their respective domestic biofuel use targets, and no countries other than Brazil currently have the production capacity to become major biofuel-exporting countries. South and Central America and Africa have gaps between their biofuel production potential and actual production and as such have the potential to become exporting countries in the future. In India, trade opportunities are restricted by high tariffs. Although OECD countries have low tariffs for biofuel imports, these countries spend heavily on subsidies to protect their domestic agricultural industries. Furthermore, it has been pointed out that regulations such as the EU's sustainability criteria serve as barriers to trade (World Bank a 2010).

Global trade in biofuels is expected to increase in the future, due to increased demand coming from targets for biofuel use in developed countries, and the potential developing countries have to increase supply through agricultural development. Biofuel imports will also be critical to countries such as Japan that are unable to meet their domestic targets for biofuel use through domestic production alone. The OECD contends that import tariffs on biofuel ingredient crops that are aimed at protecting domestic production and import tariffs on biofuels actually serve as hidden taxes that raise the cost of using biofuels. Furthermore, opening up these markets will reduce the cost and enhance production efficiency as well as decrease dependency on fossil fuels and reduce impacts on the environment (OECD 2008). While certification schemes for biofuels bring about product differentiation based on how biofuels are manufactured and their impacts as determined by life cycle analysis, there is continuing debate about these schemes' relevance to World Trade Organization (WTO) rules when they are used to restrict trade (UNCTAD 2008).

As to the treatment of biofuels in environmental conventions, the Convention on Biological Diversity specifies that production and use of biofuels should be sustainable from a biodiversity perspective and in particular should minimize negative impacts on the lives of indigenous and local communities. The Conference of the Parties (COP) to the Convention on Biological Diversity has issued a decision urging national governments to apply a precautionary approach to the introduction of modified organisms for the production of biofuels, in accordance with the Preamble to the Convention and the Cartagena Protocol (CBD/COP 10 Decision X/37 2010). The implementation framework for the United Nations Framework Convention on Climate Change puts into practice the Reducing Emissions from Deforestation and Forest Degradation (REDD+) program. REDD+ issues funds and credits as economic incentives for reducing CO_2 emissions through clean development mechanism (CDM) projects or efforts by developing countries to restrict deforestation and forest degradation, in the interest of having forests as important carbon stores but also as future sources of material for biofuels. These measures form a response based on the principles prescribed by the Convention on Biological Diversity and Framework Convention on Climate Change, which place common but differentiated responsibilities among developed countries and developing countries, and are important for strengthening international systems to support the sustainable development and use of biofuels.

In any case, it has become essential to respond to north-south issues that accompany financial and technical assistance measures for developing countries and to establish appropriate trade rules in order to use biofuels sustainably at the global level.

13.1.2 Current Study into Sustainable Deployment Strategies

Amid such issues, the United Nations and other organizations are at the center of various international trends such as policy proposals aimed at promoting the sustainable use of biofuels at the global level. Several of these initiatives including UNEP's proposal of measures for the sustainable production of biofuels with an emphasis on environmental aspects as a UN initiative and a study by the FAO done principally from the perspectives of food security and agricultural promotion are introduced briefly in this section. We also describe UN-Energy's principles on sustainable biofuels from the perspective of renewable energy use, and biofuel initiatives by the Global Bioenergy Partnership (GBEP), which was launched by the G8 as a more comprehensive and concrete effort with the involvement of major stakeholder countries and organizations. Lastly, OECD policy proposals that cover economic aspects from the perspective of developed countries are presented.

UNEP released the *Assessing Biofuels* report (UNEP 2009), which was prepared by an international panel on sustainable resource management. The report points out that countries' current biofuel policies do not have adequate scientific bases for their estimates of GHG reductions and that biofuels currently offer only a slight overall potential for GHG reduction, while the costs so far, as identified by the OECD (OECD 2008), are extremely high. It also states that the sustainable production of biofuels is achievable if a strategy is implemented to enhance resource productivity and identifies four measures to enhance resource productivity: (1) the use of obligations for biofuel use and biofuel targets and standards, encompassing the development of resource management programs by country and region, and development and implementation of standards and certifications for biofuel production; (2) promotion of sustainable land use for biomass production, encompassing measures such as the study of comprehensive guidelines for land use management; (3) more efficient use of biomass including the use of residues and waste and cascading use of biomass; and (4) increased energy and material productivity in transport, industry, and households as the basis for advancing a low-carbon, recycle-oriented society.

The FAO pursues efforts with a particular emphasis on five policy principles and areas, focusing in particular on the relationship between food security and biofuels. These are the following: (1) protecting the impoverished and their food security, including the stable supply of food at appropriate prices to developing countries that import food; (2) using opportunities for agricultural and rural development, including financing and technical support to small-scale farmers; (3) securing the environmental sustainability of efforts to create climate change mitigation benefits, through the study of sustainability standards and certification systems and the deployment of biofuels; (4) reviewing existing biofuel policies encompassing the review of trade barriers for biofuels, the shift to second-generation biofuels, policy consistency such as for carbon taxes and emissions trading, and a less rapid shift to biofuels; and (5) strengthening international systems for supporting sustainable biofuel development, including mechanisms for achieving environmental targets that use sustainability criteria agreed on in an international forum. Currently, through the Bioenergy and Food Security Project, FAO is studying principles, criteria, and guidelines for biofuel use, with an emphasis on reducing trade barriers, reaching agreement on international sustainability criteria (standards), and capacity development in developing countries from an international perspective.

At the 2002 World Summit on Sustainable Development (WSSD), 20 UN organizations formed the UN-Energy program with the aim of securing consistency in UN organizations' multidisciplinary response. Regarding bioenergy, which includes biofuels, UN-Energy has identified key areas for implementing the sustainable use of biofuels and energy at the international level. Specifically, UN-Energy points to the need for monitoring and assessment of the impact of bioenergy development on agriculture, industry, health, environment, and trade and for sustainable cropping and use of energy crops conforming to the mechanisms of environment conventions such as the Framework Convention on Climate Change. UN-Energy further points to the necessity of technology development for bioenergy use and the establishment of standards and certification systems in a way that does not obstruct trade, as well as the need for technology transfer and development. UN-Energy has also identified items for national policymakers to study in deploying policies for biofuel use (UN-Energy 2007).

At the G8 Gleneagles Summit 2005, the G8 leaders agreed on the Gleneagles Plan of Action for climate change, clean energy, and sustainable development and made the decision to launch the Global Bioenergy Partnership (GBEP) to support wider, more cost-effective biomass and biofuels deployment, particularly in developing countries where the use of biomass is prevalent. Participants in the GBEP include the G8 countries, developing countries such as Brazil and China, and international organizations such as the FAO and IEA. The GBEP conducts study into efficient policies for supplying rules and tools for promoting sustainable bioenergy (biomass and biofuels). Specifically, these efforts are in the following three areas: developing voluntary standards and indicators that are practical and have a scientific basis to promote the sustainable development of bioenergy, testing a common methodological framework for measurement of GHG emission reduction from bioenergy use; and awareness raising to promote information exchange regarding bioenergy.

Every year, the GBEP reports the results of its studies to the G8 and G20. In particular, the GBEP is aiming to identify criteria and indicators that are consistent with multilateral trade agreements but intended to be used at the domestic level. In May 2011, the GBEP reached agreement on a list of indicators to report to the G8 Summit in 2011. The GBEP indicators comprise eight items each in the three areas of environmental, social, and economic and energy indicators. Environmental indicators include GHG emissions from a life cycle perspective, percentage of water resources used for harvesting and manufacturing, biodiversity, and changes in land use. Social indicators include legal instruments for the distribution and ownership of land for new bioenergy production, the price and supply of food, and changes in income, job creation, and time spent collecting biomass by women and children. Economic indicators include productivity, net energy balance, and diversity of energy supply sources as affected by the supply of biofuels (GBEP 2011).

The OECD has issued policy proposals for the assessment and deployment of biofuels, principally from an economic and trade perspective (OECD 2008). These policy proposals hold that there is no one best common policy for biofuel use and that it is necessary for each country to use an appropriate combination of policies that match their policy priorities and social and economic conditions. Furthermore, in order to conserve energy, it is necessary to move toward lower energy consumption and enhancing energy efficiency rather than substituting with biofuels. The growth of the biofuels sector also raises food prices and reduces food security in the medium term for the most vulnerable people in developing countries. As such, the OECD proposes establishing ambitious minimum standards for GHG reduction by biofuels while avoiding the harvesting of biofuel crops in environmentally sensitive lands such as wetlands. It also proposes opening international markets to bring about more efficient production of biofuels. These measures would reduce unintended secondary effects and lead to enhanced employment and income opportunities in developing countries through responsible trade.

In addition, the OECD contends that further study of the environmental risks from land use changes is needed, encompassing high-efficiency production of biofuels in tropical and subtropical regions as well as indirect land use changes.

13.1.3 Tools for Sustainable Use Strategies

13.1.3.1 Policy Tools for Sustainable Use Strategies

An overview of current challenges and policy recommendations relating to the sustainable use of biofuels was introduced in previous sections. Clearly, it is necessary to approach the sustainable use of biofuels in a way that takes into account environmental conservation issues, food security, community development, energy security, trade, and the "north-south divide." We show that the Food and Agriculture Organization (FAO), United Nations Environment Programme (UNEP), and other organizations are issuing policy recommendations that meet these needs. Here, we focus on concrete policy methods by extracting strategy tools from such recommendations. These proposed policy methods can be broadly divided into eight categories outlined below. These are closely related to each other. For example, where standards, indicators, and certification systems are applied, sustainable land use is promoted by the standards and methods if they are set appropriately. From an international perspective, some of the more important strategies and initiatives are development of standards and indicators, the application of certification systems, international market liberalization, and technology transfer to developing countries.

A. Development of Standards and Indicators and the Application of Certification Systems for the Sustainable Production and Use of Biofuels

The setting of standards for CO_2 emission and land use conversion, based on LCA (life cycle assessment), and for strict legal compliance and community consultation makes it possible to evaluate and manage not only the environmental impacts of biofuel use and production but also impacts on a broad range of other areas, including community development and trade, by regulating social and economic impacts and sustainability. In addition, combining standards and indicators with a certification system guarantees the effectiveness of those standards. In the EU, for example, the introduction of a voluntary certification system is being recommended.

B. Promotion of Sustainable Land Use for Biofuel Crop Production (Including Land Use Management Planning and Increasing Yields)

To increase the production of food or biofuel energy crops, it is essential to increase agricultural crop yields. This requires expanding farmed areas, which means developing into precious natural ecosystems. Expanding the cultivation of biofuel energy crops has both direct and indirect impacts. For this reason, it is important to try and improve yields per unit area using methods that are both environmentally and people friendly. And with the aim of sustainable land utilization, land use management plans and guidelines must be developed that take into account agriculture, forestry, mining, and other industries at regional, country, and international levels.

C. Reviewing Support Systems for Efficient Production and Distribution, Liberalization of International Markets, and Lowering of Trade Barriers

In addition to providing longstanding protection of domestic agriculture, sometimes subsidies are provided and import duties are levied on raw biofuel materials and products to hasten the expansion of biofuel utilization. By reviewing such financial measures, it is possible to promote more efficient and inexpensive production, reducing environmental impacts and dependence on fossil fuels (OECD 2008). Revising these measures can also serve to stimulate increased production at a sustainable level and to steer biofuel production to the most efficient regions and countries. Fair trade also leads to improved opportunities for employment and income in developing countries.

D. Transfer of Technology for Cultivating Biofuel Crops to Developing Countries

The transfer of technology to developing countries for increasing biofuel crop yields and improving of fermenting raw materials and recovery rates tends to reduce environmental impacts due to improved biofuel crop cultivation and biofuel production.

E. Efficient Use of Biomass and Biofuels

It is important to investigate the connection between the use of biofuels with biomass use, taking into account the second-generation biofuels that are expected to be widely diffused in the near future, as well as their use in generators, or so-called stationary facilities. As pointed out by the UNEP (UNEP 2009), the use of waste matter and production residue, and “cascading” (first using biomass as a raw material for production and then recovering the energy of the waste matter generated by production), increases the potential for reducing CO_2 emissions from the biomass. In addition, it is generally reported that the use of biomass is more energy efficient when used in stationary facilities rather than for transport. These methods indirectly reduce the demand for biomass fuels and thereby enable their use to be limited to a level that can be met by sustainable production.

F. Improving Energy Efficiency for Transport, Industrial, and Household Uses

Improving energy efficiency makes it possible to reduce overall demand for liquid fuels. As a result, the demand for biofuels, as fossil fuel substitutes, also decreases, improving their sustainability.

G. Promotion of Surveys and Research Assessing the Value of Ecosystem Services and Developing Second-Generation Biofuel Production Technology

To address the impact of expanding biofuel usage on ecosystem services and develop measures to address such impacts, one of the options proposed by the United Nations University for ensuring sustainable use of biofuels involves paying for ecosystem services. Evaluation methods, however, need to be investigated in further research. Second-generation and more advanced biofuels, made by cellulose decomposition, are not yet cost competitive, so it is necessary to promote further study and research to address this issue.

The UN-Energy program, UNEP, and United Nations University Institute of Advanced Studies (UNU-IAS) have all recommended sustainability standards, indicators, and certification systems as effective tools in strategies to promote sustainable biofuel utilization at an international level. The Global Bioenergy Partnership (GBEP) is also examining their introduction. Because such measures have already been partially implemented and proven to some extent in international consensus and practice, in ISO 14001 and other fields like forestry, they are now the center of attention and are being studied in light of the latest trends.

13.1.3.2 Outline of Standards, Indicators, and Certification Systems for Sustainable Biofuels

Like the certification system of the ISO 14001: environmental management standard, standards, indicators, and certification systems are designed to promote measures that counter adverse environmental impacts by defining the standards and indicators necessary to achieve specified targets of environmental conservation. Products and enterprises that meet those requirements can then be awarded certification. Standards define the concept of sustainability, while indicators serve as quantitative, or in some cases qualitative, criteria for measuring and assessing compatibility with the standard. Standards and indicators can be used independently to define policy goals or as part of a certification system to define specific certification criteria that differ from existing standards and indicators.

A certification system that covers all stages from production through processing and distribution is referred to as "chain of custody certification" or "COC certification." One example of such a chain is the processing of ethanol or vegetable oil from a certified farm, followed by fermentation/extraction and proper delivery to consumers. Since biofuels are liquids, the risk exists that they may become mixed up or confused in the process of distribution, either with other certified fuels or with an uncertified fuel. For this reason, measures such as those below have been introduced for tracking biofuels through the certified product supply chain.

– Identity Preserved (IP): In this system certified biofuels are separated from the plantation and tracked until reaching the user.
– Segregation (SE): In this system mixing of certified biofuels (batch mixing) is recognized and tracked.
– Mass Balance (MB): In this system, if a certified biofuel is intended to be mixed with another biofuel, the quantity of that particular certified biofuel is defined as a proportion of the total certified biofuel. A manager monitors the mixing proportions, which depend on the fuel's final use.
– Credit Trading (CT): This system does not involve any tracking, tracing, or monitoring of the biofuel itself. Instead, it enables cultivators and users to trade volume credits online (known as "Book and Claim (BC) in the case of the Roundtable on Sustainable Palm Oil (RSPO), Bangun 2011) under the supervision of managers, as done with green electric power, for example.

These kinds of reference standards and indicators and certification systems are already utilized in the fields of forestry and marine products. Good examples are the certification system of the Forest Stewardship Council (FSC) and the system implemented by the Marine Stewardship Council (MSC). (See the FSC and MSC websites.)

The features of standards and indicators and certification systems based on them are outlined below (UNCTAD 2008; UNEP 2009; Scarlat 2011).

A. Diverse Principles, Standards, and Indicators Can Be Defined to Address the Various Environmental, Social, and Economic Impacts of Biofuels

In addition to dealing with principles concerning the reduction of greenhouse gas emissions, taking into account product life cycle and factors such as land use change, many certification systems currently being developed also deal with other important issues. These may include environmental considerations, such as biodiversity conservation and land use change; social considerations, such as food security and social well-being; and economic considerations, such as productivity. In addition, these systems can also incorporate local viewpoints by recognizing the particular interpretations of individual countries, as in the case of the RSPO. They can also establish an international system, like the sustainability standards for bioenergy now under consideration by the International Organization for Standardization (ISO), and incorporate global-scale, unified standards and indicators in alignment with international agreements such as the UN Framework Convention on Climate Change and WTO treaties.

B. Certification Is Not Mandatory

Choosing to certify a product makes it possible to differentiate it, by providing buyers with information about sustainability relating to the product. In particular, COC certification can assure buyers that they are definitely getting a product that meets specified standards and indicators. In this way, producers can add value to products, thereby benefitting themselves. Certification can even have a substantial impact on market share.

C. In Combination with Other Policy Measures, a Certification System Can Drive Initiatives That Mitigate the Impacts of Biofuels

Certification can be linked to tax deductions and other incentives, and as in the case of the EU and USA, it can serve as a precondition for measuring product consumption to reach the national goals.

On the other hand, there are limitations and problems with standards, indicators, and certification systems, such as the following:

A. Scope and Effectiveness of Standards and Indicators

In setting standards and indicators, it is possible that some problems will be ignored. For example, when making evaluations based on limited LCA criteria, it can be difficult to quantify social standards. Also, since the evaluation of macro effects, such as the impacts of biofuel production on food and land prices and forest depletion, depend on the adopted methods of evaluation, there is a risk that subjective points of view can creep into the analysis. Although it is necessary both that criteria are comprehensive and that a standard is technically and administratively practicable, these requirements cannot necessarily be satisfied. Note that there is potential for confusion when trying to make categorizations, i.e., certification is needed for a crop used for biofuels but not for the crop consumed as foods. In policy matters as well, this can lead to two kinds of standards, resulting indirectly in an increase in land use conversion.

Addressing indirect land use change would require implementing certification over the whole planet, in order to get a complete picture of the system. However, since this is totally unrealistic, standards, indicators, and certification systems cannot be very effective in dealing with indirect land use change. Devices such as the iLUC factor (indirect land use change factor) for specific products, i.e., the evaluation based on a global-scale life cycle for each consuming country/region and product/production process, are necessary, but data usability is still a problem.

B. Coexistence of Multiple Certification Systems

There are many certification systems now in existence, but the fact that they are all different tends to reduce their effectiveness and reliability. Multiple systems also tend to result in market fragmentation and reduced transparency. For this reason, only international certification schemes can achieve environmental goals. However, it must be noted that certified products only account for a small part of the market. It is also important that developing countries, farmers' associations, and local NGOs are properly represented and are able to contribute to the international processes of creating standards, indicators, and certification systems and to reaching agreements between countries. Unfortunately, this is not necessarily the case at present.

As opposed to creating new standards for biofuel crop production, especially for biofuels, the "meta-standard approach" makes use of existing standards for sustainable agriculture and forestry. The use of existing standards offers numerous benefits: assured reliability, easier acceptability to buyers, quick implementation, greater cost effectiveness, less confusion between different standards, and promotion of convergence (Committee on the Sustainability Criteria regarding Introduction of Biofuels 2009).

C. Cost of Certification

Firstly, the cost of certification to producers consists of the cost of conforming to standards and indicators plus the cost of acquiring certification. Although these costs depend on the number, stringency, and comprehensiveness of the standards and indicators defined by the certification system, production costs are likely to increase substantially. In addition, the cost of certification is likely to be more burdensome in developing countries than in developed countries and to small-scale producers than large-scale producers.

D. Connections to Trade

In the years ahead, the role of international trade is expected to become more important, which should lead to more effective utilization of biofuels. However, to assess the connection of biofuels with WTO agreements, which set the general rules of international trade, it should be noted that the present level of biofuel production and international trade is relatively small and that certification systems for biofuels are quite new. In view of this, there is not yet any established view how biofuel certification systems can be dealt with under the current international trading rules (UNCTAD 2008).

More specifically, there is no clear consensus about whether certification systems developed by NGOs or other private organizations fall under WTO rules or whether they should be regarded merely as marketing strategies. Although certification serves to differentiate products based on their methods of production and their LCA-determined impacts, any differentiation based on process and production methods (PPM) may be in violation of WTO agreements. Also, there is still some debate about whether certified biofuels can be justified as exceptions to the rules (under Article 20 of GATT) as measures necessary to protect human, animal, and plant life and health or measures to conserve limited natural resources. And doubts remain about the differentiation of products on the basis that they meet a broad range of objectives such as workers' rights and food security or on the basis of their production process. Note that no study appears to have been done on certification systems in relation to government support schemes or subsidies in light of international trade agreements (UNCTAD 2008).

For example, under the EU Renewable Energy Directive, the standard relating to biodiesel fuels stipulates that they should not be cultivated on converted peat lands and that they should reduce CO_2 emissions by at least 50% relative to conventional fuels on a life cycle basis. The directive recommends the use of a voluntary certification system to prove these requirements. However, the Indonesian government and US soybean producers have expressed fears that this standard violates WTO rules relating to PPM (Jakarta Globe 2010, GlobalSubsidies 2011 HP).

At the same time, some countries give “favored nation” treatment to particular international trading partners. For example, under a preferential import system for ethanol fuels in the USA, ethanol imports from Caribbean Basin Economic Recovery Act (CBERA) countries are exempt from import duties, although there is an upper limit on import volume. In 2006 these countries accounted for 25% of all imports of ethanol for fuel use, but until 2003 they accounted for 100% of the total import volume (Uchida 2007).

As the OECD has pointed out, eliminating this kind of trade barrier through an international consensus on WTO rules relating to certification systems can lead to a liberalization of international markets that gives rise to more efficient global biofuel production.

13.1.3.3 Current State of Standards, Indicators, and Certification for Sustainable Biofuels

According to the UNEP, there are at least 29 sustainable biomass or biofuel-related initiatives to establish standards, indicators, or certification systems presently being conducted by various national governments, NGOs, worldwide organizations, and other bodies (UNEP 2009). As of January 2011, the FAO’s Bioenergy and Food Security Criteria and Indicators Project (BEFSCI) was dealing with 17 initiatives, reviewing outlines of regulatory frameworks for the EU and other regions (5 cases), voluntary standard and certification schemes (10 cases), and scorecards (2 cases), with most of these cases being related to biofuels.

There are currently many activities in progress all over the world, but here, in accordance with the FAO classification, we will look at an outline of the main initiatives relating to voluntary standards, indicators, certification systems, and regulatory frameworks (See Tables 13.1 and 13.2).

A. Voluntary Standards, Indicators, and Certification Systems

The Global Bioenergy Partnership (GBEP) and the Roundtable on Sustainable Biofuels (RSB) are aiming to develop nonbinding, voluntary standards and indicators for sustainable biofuel use with a scientific foundation that is available worldwide. Criteria (standards) are defined as categories like sustainability elements, capacities, or processes that are employed for evaluating the environmental, economic, and social performance of bioenergy production and utilization. Indicators, on the other hand, are measurable outcomes based on the criteria. They are considered the means for measuring or describing the various perspectives of the criteria. Of the perspectives represented by the sustainability standards, the environmental, social, and economic perspectives are indispensable. Thus, indicators are required to enable appropriate evaluation of these three kinds of issues.

GBEP has recently agreed on 24 indicators in the three fields but found that the initial indicators they proposed to gage indirect impacts on land utilization due to

Table 13.1 Classification of standards and indicators on sustainable biofuels

Categories	Example of activities	Outline
1. Voluntary standards, indicators, and certification systems	Global Bioenergy Partnership (GBEP)	Development of voluntary standards and indicators by G8 initiative
1.1. International and regional activities	ISO, CEN	Voluntary standard, indicators, and certification systems developed by businesses and other stakeholders worldwide or European wide
A. Governments and international organizations		
B. NGO and others	RSB	Voluntary system of standards, indicators, and certification of stakeholders lead by EPFL
1.2. Activities on each biofuel energy crop	RSPO (oil palm), RTSP (soybean), BONSUCRO (sugarcane)	Voluntary systems of standards, indicators, and certification systems for each crop developed and agreed upon by stakeholders including producers
2. Regulatory framework in a region or country	EU, Germany, the Netherlands, Brazil, USA	Standards used by governments in order to comply with "fuel mixing targets" and/or "consumption targets" of biofuels
3. Score cards	IDB	Systems to improve the performance of a project by scoring systems through assessing environmental impacts, socioeconomic impacts, and impacts on food security of a biofuel project
	WB/WWF	

CEN the European Committee for Standardization, *IDB* Inter-American Development Bank, *WB/WWF* World Bank/World Wildlife Foundation

cultivation of bioenergy plants and indirect impacts relating to the price of agricultural products require further study. Also, indicators do not serve to express the direction and threshold values of measures and standards but to express the state of progress toward sustainable development in individual countries (GBEP 2011).

RSB is an organization led by the École Polytechnique Fédérale de Lausanne, consisting of more than 720 diverse stakeholder organizations, including biofuel users, producers, policymakers, companies, and financial institutions. The body is currently engaged in an initiative aimed at creating tools to help these stakeholders make judgments about sustainability. It recently released version 2 of its RSB Guidelines, which outline principles and standards for global-scale sustainable biofuel production, and in March 2011 launched a certification system connected to these guidelines. This system conforms with regulations on biofuel requirements set by the government of Germany, which aims at expanding the use of biodiesel and will become an important importer in the future, as well as biofuel regulations based on the EU directive.

A survey of initiatives relating to specific biofuel crops reveals that there are current international initiatives by bodies connected with the oil palm, soybean, and sugarcane industries.

Table 13.2 Overview of standards and indicators of biofuels

Name	GBEP	RSB Ver.2	RSPO	RTRS	Bonsucro	EU	USA	Japan (proposal)
Features and Scope	Voluntary					Compulsory		
	Intergovernmental	Multi-stake holder				Regional, country specific		
	International					Regional	Country specific	
	Crops in general		Palm oil specific	Soybean specific	Sugarcane specific	Crops in general		
Specific certification system established	–	X	X	X	X	X([a])	–	–
Environment	X	X	X	X	X	X	X	X
Reduction of GHGs (GHGs emissions)								
Land use change([b])	X	X	X	X	X	X	X	X
Carbon stocks								
Others (soil, water, air, biodiversity, waste management, ecosystem conservation, natural resource and utilization and energy saving, env. impact assessment, agricultural chemicals and integrated pest management, etc.)	X	X	X	X	X	X	X	–
Economic (productivity, promotion of tech. Rural development, good practice, long-term economic viability, etc.)	X	X	X	X	X	–	–	–
Social	X	X	–	X	–	X	–	X
Food security, poverty/social development								
Human and labor rights, health (occupational)	X	X	X	X	X	X	–	–

(continued)

Table 13.2 (continued)

Name	GBEP	RSB Ver.2	RSPO	RTRS	Bonsucro	EU	USA	Japan (proposal)
Land rights	X	X	X	X	X	X	–	–
Good governance (stakeholder consultation), legality (compliance)	–	X	X	X	X	X	–	X
Other	–	X	X	X	X	X	–	–
Planning, monitoring of implementation, transparency, COC requirement, etc.)								

X: Items included
GBEP: Global Bioenergy Partnership 2011
EU: Directive 2009/28/EC, the promotion of the use of energy from renewable sources
USA: Renewable Fuel Standard 2010, EPA must estimate impacts of RFS other than CO2 reduction
JP: Report of the Committee on the Sustainability Criteria regarding Introduction of Biofuels, Japan (in Japanese) 2009
RSB: Roundtable on Sustainable Biofuels, Version 2.0 2010
RSPO: Roundtable on Sustainable Biofuels, 2007
RTRS: Round Table on Responsible Soy Association, Version 1.0 2010
Bonsucro, Better Sugar Cane Initiative, 2010
[a]Specific certification systems have not been established, but voluntary certification of other systems can be used
[b]Impacts of indirect land use change are not included in the current

a. *Oil Palm*

Palm oil, obtained from the fruits of oil palms, is one of the most abundant vegetable oils in the world, with global production estimated at approximately 46 million tons (2010 estimate, Yushi (Oils and Fats) 2011). In addition to its use in food products such as cooking oil, margarine, and shortening, it is used as a raw material for soap and increasingly for the production of biodiesel fuel. The main producers of palm oil are Indonesia and Malaysia. Although the proportion of their palm oil output that is used as a raw material for biofuels is relatively small, demand for food products is growing, and the conversion of forests and peat lands to plantations has become a problem. In view of this, in 2003 the Roundtable on Sustainable Palm Oil (RSPO) was formed to promote sustainable methods of oil palm cultivation and palm oil production. RSPO members include oil palm growers, palm oil processors and traders, consumer good manufacturers, retailers, banks and investors, and NGOs. Currently, there are more than 400 members and 110 supporting members.

RSPO has set forth eight principles and 39 criteria to promote sustainable production and consumption. For example, its environmental standards and indicators stipulate that after 2005 new plantations must not be converted from virgin forest or areas of high conservation value and that levels of pollution and waste products must be reduced. To prove that these standards and indicators are strictly observed, a certification system was introduced for plantations and extraction plants, and a COC certification system was introduced for the supply chain. For regular certification, the certifying body visits the plantation or plant to conduct an auditing, during which they examine documentation and the site/facilities and interview relevant parties. A summary of the auditing report is then posted on the Internet. For COC certification, in addition to an identity preserved (IP) system that allows the use of palm oil produced by certified facilities, segregation (SG) and mass balance (MB) systems were also adopted. Book and Claim (BC) was also introduced for credit trading. Also, to promote awareness among consumers, RSPO developed a trademark, which is expected to come into use in 2011. As of January 2011, there were 81 certified processing plants and a total of approximately 760,000 ha of certified plantations in Malaysia and Indonesia, and 3.8 million tons of palm oil has so far been certified (Bangan 2011). Nonetheless, RSPO still faces significant problems. Standards and indicators relating to greenhouse gases are still only under consideration, and the demand for certified palm oil is low relative to the supply.

b. *Soybeans*

Soybeans account for approximately 29% of the total worldwide production of vegetable oil, second only to palm oil. Like the palm oil industry, in 2006 the Roundtable on Responsible Soy (RTRS) was founded, with the aim of promoting the responsible production and use of soybeans, through the participation of stakeholders and the application of international standards. The membership of RTRS is made up of growers, the soybean oil industry, traders, financial institutions, and NGOs, while individuals and governments can participate as observers. As of 2009 the total membership was approximately 110 organizations, of which half were producers. In May 2009, principles and standards for field testing were approved by the general assembly, and a pilot project was launched. Then in 2010 standards developed from five principles were adopted at the general assembly (RTRS 2010). Work is also in progress on preparing the implementation of a certification system, under a similar framework to that of the palm oil industry, and a certification trading platform corresponding to palm oil's book and trade feature was expected to go into effect in April 2011. Note that it has been agreed that soybean oil certified by the RTRS in cooperation with the EU can be considered as a biofuel that complies with the requirements of the EU's Renewable Energy Directive (RED), provided that it satisfies specific requirements.

c. *Sugarcane*

Bonsucro is an international nonprofit organization that aims at social, environmental, and economic sustainability of sugarcane-related activities by promoting the development and use of global standards. The membership is similar to those of the other crops mentioned, e.g., sugar producers, NGOs, and other stakeholders. In March 2011, Bonsucro introduced a certification system. It formulated Bonsucro's production standards and developed a set of indicators based on five principles, such as strict compliance with applicable laws. The requirement for certification is 100% compliance with core indicators and 80% compliance with other indicators (Bonsucro 2011). The body has also developed a supply chain certification scheme, making use of MB-based methods. The first supplies of certified sugar are expected to be available around April 2011. Provisions have also been made for compliance with the EU's Renewable Energy Directive (RED) and Fuel Quality Directive by including two corresponding sections in the standards. Compliance with these sections will be considered to represent compliance with the EU directives.

B. Regulatory Frameworks in Countries and Regions

Just as US and EU standards and indicator systems are making a substantial impact on the world, through the international biofuels market, standards and indicators at the national level have become powerful policy instruments.

In USA, life cycle-based standards relating to the reduction of greenhouse gas emissions have been adopted for biofuels used for transportation equipment. In August 2005, the Renewable Fuel Standard (RFS), which mandates the use of biofuels for powering automobiles, was incorporated into the 2005 Energy Policy Law. The standard stipulated the use of a total of 4 billion gallons (approx. 15 million kL) of biofuels by 2006, with a steady increase in subsequent years up to a total of 7.5 billion gallons (approx. 28 million kL) by 2012. Then in December 2007 the Energy Independence and Security Act of 2007 was introduced, which unveiled medium-term policy guidelines on improving energy efficiency and expanding the production of renewable energy. By upgrading the RFS (to RFS-2), the act set even more ambitious requirements for biofuel production: 9 billion gallons per year by 2008, increasing in stages to 36 billion gallons by 2022. It also stipulated that new biofuels derived from raw materials other than corn must account for at least 21 billion gallons of the 36 billion gallon target for 2022. Furthermore, biofuels must account for at least 20% of all fuel for transport by 2020. Under this RFS program, biofuels are classified into four types, with targets set for the quantity of each type used. These biofuels must comply with a standard for cutting greenhouse gas emissions relative to fossil fuels. The US Environmental Protection Agency is also assessing other environmental impacts of RFS-2. For example, the production and use of regular ethanol produced from corn must generate at least 20% less greenhouse gas emissions than regular gasoline, based on LCA, taking into account major indirect impacts such as land use change (Hill 2011).

In the EU, the Renewable Energy Directive (2009/28/EC) requires that by 2020, renewable energy must account for at least 20% of the total final energy consumption in the EU. Targets for biofuel adoption for transport fuel are 5.75% by 2010 and 10% by 2020. The biofuel sustainability standard for this purpose features greenhouse gas reduction targets relative to fossil fuels, based on LCA (min. 35%), environmental impacts (e.g., not permitting raw materials for biofuels from areas of high biodiversity or high carbon storage capacity), and social impacts. As for indirect impacts, a report by the EC concludes that if the share of first-generation biofuels derived from agricultural crops is held to less than 5.6%, and second-generation biofuels are used for the remainder, then biofuels can be very useful in cutting CO_2 emissions, even when additional emissions due to indirect land use change are taken into account (EC 2010).

In addition, in order to verify that biofuels are complying with the above standards, voluntary certification systems are to be used.

Some individual countries, including the UK and Germany, have also formulated their own standards on biofuels in line with EU regulations. In Japan, a report from a workshop on biofuels sustainability ("Towards the formulation of a Japanese standard for biofuel sustainability") issued in 2009 indicated that the effectiveness of greenhouse gas emission reductions based on LCA, land use change, and the stability of supplies of biofuel crops that compete with food for crops are to be studied, as elements of standards and indicators, taking into consideration systems and methods for their operation.

As presented above, standard indicators are divided broadly into five fields: environmental, economic, social, energy, and factors relating to the monitoring of implementation status. The factor to which most attention is paid is greenhouse gas emissions in the environment. For this, quantitative standards (e.g., 35% reduction by the EU and 50% reduction by RSB) are often formulated, with reference to regular fossil fuels, based on LCA. Land use change is also considered in association with greenhouse gases; in the case of GBEP, for example, indicators will be studied further and formulated in the future that account for the indirect impacts of land use change. Other environment-related standards and indicators are generally formulated dealing with soil, water quality and quantity, air, waste, and biodiversity. Standards for specific crops also prescribe the implementation of environmental assessments before development, the integration of pest management, and the use of persistent agricultural chemicals.

Economic standards define productivity assurance, long-term economic viability, and the implementation of best practices. GBEP has a standard related to energy security such as net energy balance, energy diversity, and flexibility of the use of bioenergy, which Japan also emphasizes.

In the field of social standards, GBEP and RSB place importance on worldwide impacts, such as the assurance of food security and community development. At the same time, standards for specific products are concerned with workers' rights and health, land rights, regulatory compliance, and participation in stakeholder evaluations.

Implementation standards are usually concerned with the implementation status monitoring and the assurance of transparency by means such as information disclosure.

Note that EU and US standards and indicators are mainly concerned with CO_2 emissions and associated land use change. As for other standards, the EC and EPA have created separate reports for submission to their national assemblies.

In the case of Bonsucro, it incorporated its COC certification requirements into standards and indicators, but other initiatives set separate regulations for its certification system.

C. Conclusions

In order to improve standards, indicators, and certification systems effectiveness as tools in biofuel utilization strategies on an international scale in the years ahead, it will be important to develop and improve these measures in the directions outlined below, taking into account the current state of utilization and the pros of cons of these tools.

– Unifying existing programs and establishing internationally agreed principles, standards, and certification systems for biofuel sustainability that allow for flexibility for the environmental and socioeconomic diversity of various producing countries and which are quantitative, verifiable, and scientific and formulating systems to develop standard and certification by means of a participatory process in which the stakeholders of various regions are effectively represented
– Establishing standards, indicators, and certification that permit support for small-scale producers, particularly those in developing countries, and providing support for developing countries in improving their capacity to verify compliance
– Developing precise methods for evaluating macro impacts, such as the indirect impacts of using land for biofuels, and practical frameworks that enable rational implementation for highly cost-effective certification
– Investigating systems carefully, to ensure they promote sustainable development through trade, taking into consideration compatibility with WTO rules

13.1.4 Conclusion and Further Prospects

This paper describes the challenges of investigating the global sustainability of biofuels, policy recommendations by UNEP and other bodies, and the current state, features, and issues relating to certification, as an important tool to use in developing sustainable utilization strategies. The results bring many points to light. Firstly, the promotion of rapid, large-scale utilization of biofuels contributes to sharp rises in food prices, and with current technology, biofuel production is not economically viable without subsidies by producing countries, with some exceptions. In addition, in terms of absolute volume, biofuel production will remain relatively low comparing to fossil fuels, and large-scale substitution will be difficult in the short term. Standards, indicators, and certification systems relating to sustainable biofuels are being developed at various levels around the world. If these can be unified on an international scale and if conformity with international trade rules can be maintained, biofuel sustainability has the potential to play substantial roles in, for example, realizing ambitious standards for reduction of CO_2 emissions.

Currently, as part of the broad trend toward a global, sustainable society, various national- and international-level initiatives based on the UN Framework Convention on Climate Change and the Convention on Biological Diversity are being undertaken, and at the UN World Summit on Sustainable Development (UNCSD, RIO+20) to be held in 2012, one of the main agenda items for discussion will be a "green economy." As one element of renewable energy, biofuels are expected to make a significant contribution to the green economy (UNEP 2011). In addition, initiatives directed toward a sustainable planet will be in progress; 2014 will be the tenth and final year of the UN Decade of Education for Sustainable Development, and in 2015 the UN Millennium Development Goals (MDGs) are due to be achieved. At the same time, research is proceeding vigorously on the technological possibilities of manufacturing second-generation and more advanced biofuels and manufacturing biofuels from algae. In Japan, expectations of renewable energy are likely to keep growing in the aftermath of the recent nuclear reactor crisis. In view of all this, it is vital to keep formulating and implementing sustainable biofuel utilization strategies, linking them to local and national-level strategies, and taking into account the survey results reported here.

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