New Studies Portray Unbalanced Perspective on Biofuels

DOE Committed to Environmentally Sound Biofuels Development

DOE Response based on contributions from Office of Biomass Program; Argonne National Lab, National Renewable Energy Lab, Oak Ridge National Lab, Pacific Northwest National Lab; USDA

Two studies posted last week on "ScienceExpress" -- an advance web version of Science Magazine -- and widely reported in the press, raise important issues but often read like conclusions looking for an underlying rationale. These two studies fundamentally misunderstand the local forces behind land use change issues and make no provision for mitigating impacts such as the slowdown in urbanization that a vibrant agricultural economy would bring. Further, these two studies somewhat conflict with one another, with one supporting cellulosic ethanol and the other one opposing it, except if produced from waste.

The Fargione, Hill, Tilman, Polasky and Hawthorne study ("Land Clearing and the Biofuel Carbon Debt") claims that biofuels production on agricultural lands is creating a "carbon debt" by initially releasing 17 to 420 times the amount of greenhouse gas emissions that it will save on an annual basis, through land conversion activities. The study is unsubstantiated by independent modeling work, and relies on many erroneous or extreme assumptions, such as stating that the US will widely use CRP land for biofuels production. In fact, most of CRP land is unsuitable for any kind of agricultural use. Further, a joint DOE/Oak Ridge National Laboratory study demonstrates that no CRP land is required to meet the new Renewable Fuel Standard requirements, as mandated by the *Energy Independence and Security Act of 2007 (EISA)*.

While many of the assumptions are flawed, a few points made by the Fargione study are irrefutable. For example, we strongly agree that clear-cutting of rainforest or other carbon-rich lands makes no sense. In fact, it doesn't make sense for any purpose, not just in the case of biofuels. An important point to remember is that EISA explicitly protects carbon-rich land by lifecycle greenhouse gas analysis that demonstrates a reduction of at least 50 percent in greenhouse gas emissions for advanced biofuels and at least a 60 percent reduction for cellulosic biofuels.

The Searchinger study ("Use of US Croplands for Biofuels Increases Greenhouse Gases through Emissions from Land Use Change") claims that biofuels production in the US, whether by corn or switchgrass, will trigger harmful land use changes elsewhere, in response to higher agricultural commodity prices, and thereby lead to huge GHG increases initially. The study claims that

no greenhouse gas benefits will occur for the first 167 years of corn ethanol production.

The Searchinger study is plagued by incorrect or unrealistic assumptions, and obsolete data. Here is a short list:

- The study assumes a corn ethanol production scenario of 30 billion gallons per year by 2015, which is double the amount established by EISA (see Figure 3). To meet the new RFS, after 15 billion gallons, biofuels must come from feedstocks other than grain, and primarily be produced from cellulosic feedstocks, such as agricultural wastes and forest residues.
- Although the text acknowledges yield increases for corn, these increases are apparently not modeled. Since 1975, average yield has grown by 2 percent per year and biotechnology is expected to enable trends to accelerate. We have also made great progress in reducing soil erosion and nitrogen use over the past decades (see figures 1 and 2). Similarly, the corn ethanol industry has also dramatically improved ethanol yields and energy use since its inception.
- The study relies on a worst-case scenario land conversion model and does not have the precision required to determine ultimate land use. The study then compounds the problem by assuming that land use and deforestation in 2015 will mirror that which occurred in the 1990s. In fact, deforestation rates have already declined through legislation in Brazil and elsewhere. China has experienced reforestation in the past 15 years because of government policies.
- The assumption that corn exports will decline by 62 percent is contradicted by historical trends. As Figure 4 shows, U.S. corn exports have remained fairly constant at around 2 billion bushels per year throughout the entire growth phase of the ethanol industry. Specifically, the 2007 exports represent a 14% increase compared to 2006 level, while US corn ethanol production has reached close to six billion gallons that same year.
- The premise that dramatic land use will result from U.S. corn ethanol use production is flawed. Figure 5 shows the dramatic increase in protein-rich U.S. Distiller Dry Grains (DDGS) exports, which is skyrocketing as U.S. corn ethanol production expands rapidly. DDGS export growth will be a growing contributor to the global food supply.
- One scenario analyzed in the study incorrectly assumes the conversion of US corn cropland to switchgrass. No farmer would convert corn acreage to switchgrass as the value of corn will always exceed that of a non-food crop. Furthermore, a DOE/Oak Ridge National Laboratory study found that more than 1 billion tons of biomass resources are available in this country (Figure 6) without displacing corn cropland.

DOE Commitment to Environmentally Sound Biofuels Development

DOE is committed to ensuring environmentally responsible growth of the biofuels sector. To that end, we are working with USDA, EPA and other agencies to examine the issue of direct and indirect land use, as well as many other sustainability challenges (water use, fertilizer use). DOE's research, development, and demonstration efforts focus on hastening the emergence of an advanced cellulosic biofuels industry, which will use primarily agricultural wastes, forest residues and energy crops not competing with food. The Department has announced more than $1 billion of investment over the past year, which include ten major cellulosic biofuels demonstration projects (which mostly use waste materials) and three Bioenergy centers led by our major research universities and national laboratories, which aim to achieve transformational breakthroughs in our nation's ability to produce sustainable, competitive biofuels.

One must keep in mind that land use is a critical issue that must be addressed as we grow our nation's biofuels production, but this issue is not unique to biofuels. Our nation needs smart land use policy to govern whatever growth and development occurs, whether we are considering biomass production or something entirely different. DOE and the recently passed EISA are calling for sustainable biofuels, not planting crops on every inch of arable land. In fact, as we move toward cellulosic biomass, these feedstocks can grow on more marginal lands. In terms of land use, we would only need about one-third of the land identified in the Billion Ton Study to produce the entire 36 billion gallons required by 2022. And, this does not even take into account increases in yields expected to become a reality over the next decade.

Just as the US must adopt and enforce land use policies that prohibit development of ecologically sensitive lands, this must be the case worldwide. To that end, DOE and the State Department are working to address global sustainability issues with international partners, including environmental organizations, industry, and others.

Assumption	Study Position[1]	DOE Position
US 2015 Corn Ethanol Production	30 Billion Gallons per Year	15 Billion Gallons per Year RFS Cap (see fig. 3)
Corn Yield Increase	None	Will double between now and 2030, enabling 33 Billion Gallons per Year of Corn Ethanol without new acreage[2]. (see fig. 1)
Land Use Change Paradigm	Additional Biofuels Acreage in one place causes harmful land use conversion elsewhere	Agriculture competes with many other land uses. Higher value of agriculture land may prevent urbanization which results into permanent loss of carbon sink.
Land Use Change - Model	Study Model use 1990s data – with high deforestation rate – leading to excessive carbon "debt" results	Deforestation rate is slowing down and forests are growing in 22 of 50 countries, led by US and China[3]
US Biomass Land Use	Corn production will be converted to switchgrass production	Neither policy nor market incentives will lead to this outcome; we have enough resources without impacting corn acreage (see fig. 6)
Brazil Biomass Land use	Brazil will use deforestation to plant biofuel crops	Sufficient pasture land is available in Brazil for biofuels without impacting Brazil rainforest; Cellulosic ethanol bagasse could double Brazil ethanol production with no additional land
Switchgrass productivity	Constant	Yield increases can be substantial – because of new domesticated varieties developed for agricultural productivity
US Corn Exports	Will decline by 62%	Inconsistent with Historical Track Record (see fig. 4)

[1] Searchinger study.
[2] Illinois Corn Growers Association.
[3] Proceedings from National Academy of Sciences, November 2006.

Figure 1: Projected US Corn Yield Increases

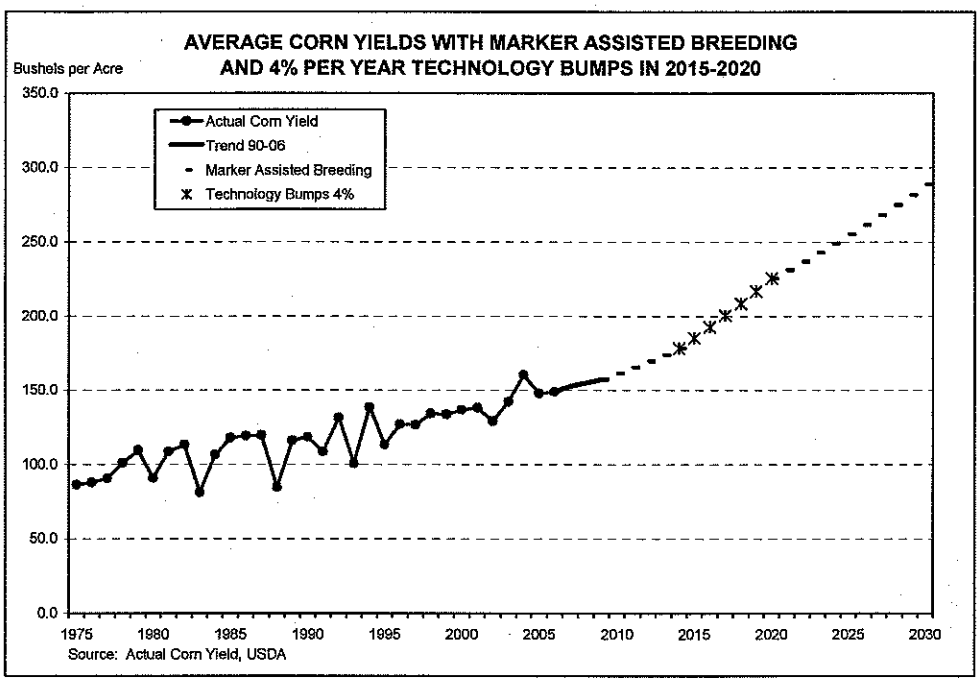


Figure 2: US Corn Nitrogen Consumption Decline

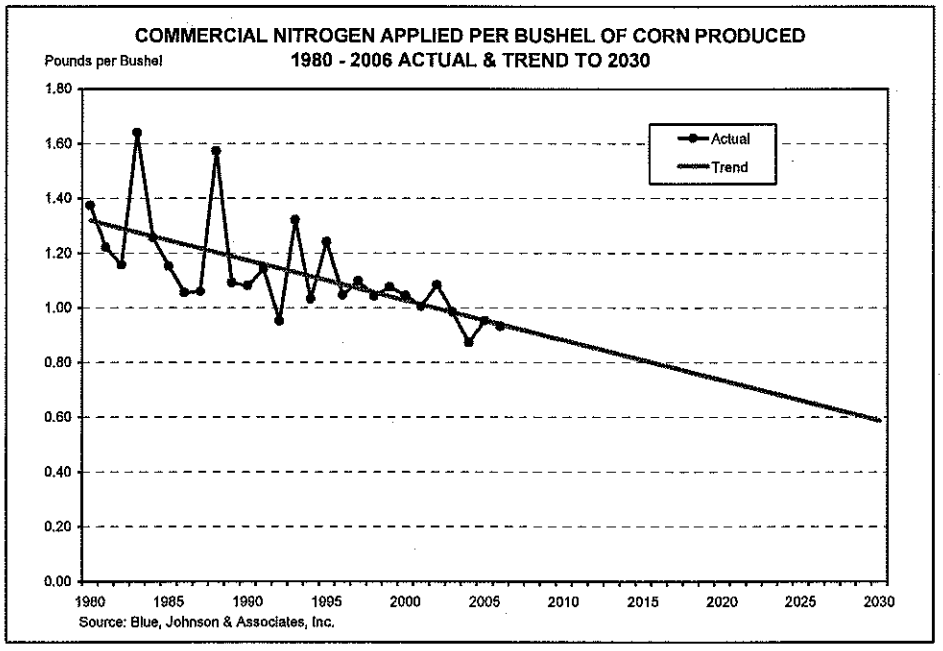
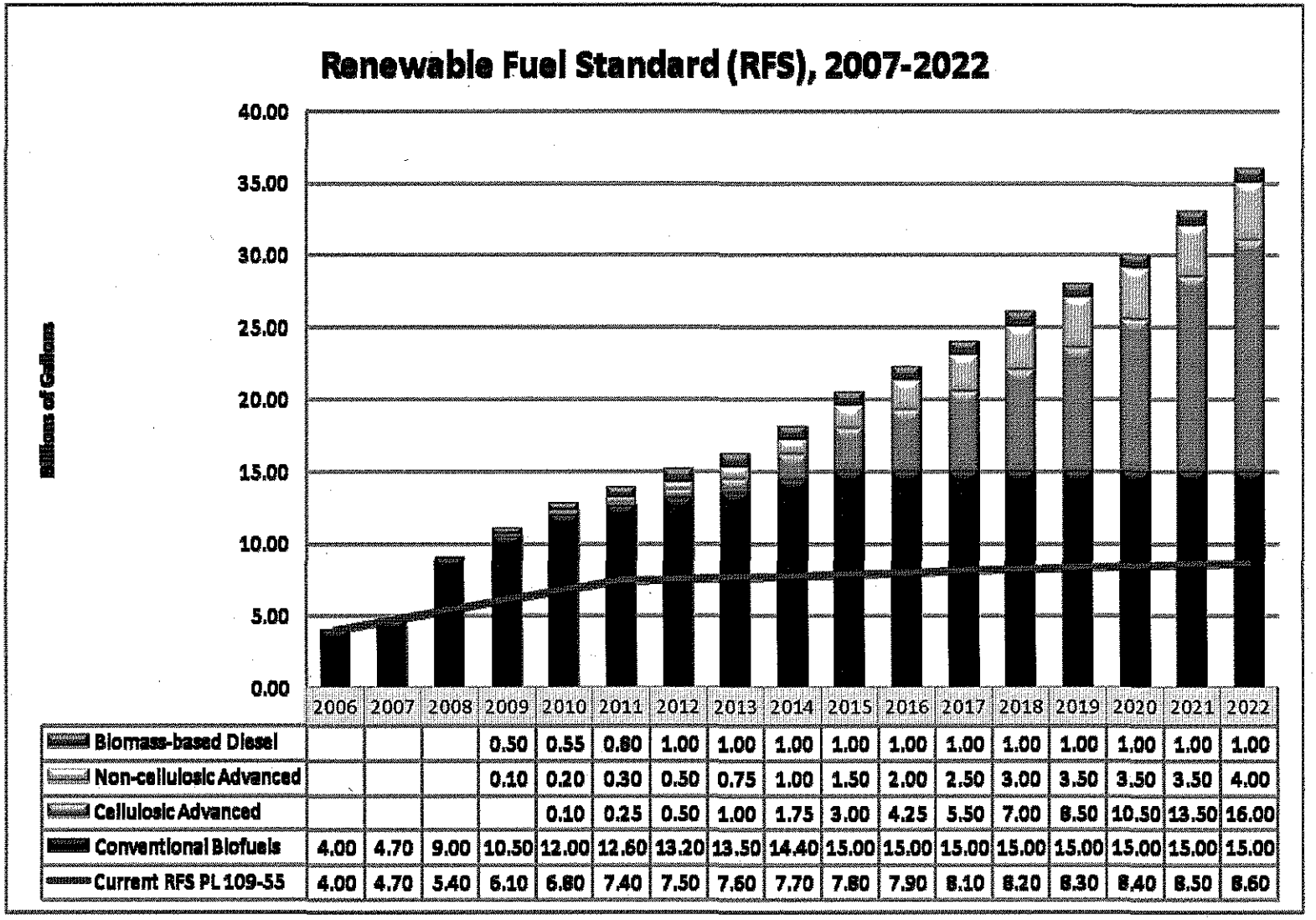


Figure 3: Renewable Fuels Standard Volume Requirements
The law establishes definitions for categories of renewable fuels identified in the RFS.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Biomass-based Diesel				0.50	0.55	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-cellulosic Advanced				0.10	0.20	0.30	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	3.50	3.50	4.00
Cellulosic Advanced					0.10	0.25	0.50	1.00	1.75	3.00	4.25	5.50	7.00	8.50	10.50	13.50	16.00
Conventional Biofuels	4.00	4.70	9.00	10.50	12.00	12.60	13.20	13.50	14.40	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Current RFS PL 109-55	4.00	4.70	5.40	6.10	6.80	7.40	7.50	7.60	7.70	7.80	7.90	8.10	8.20	8.30	8.40	8.50	8.60

Figure 4: US Corn Exports have recently Increased

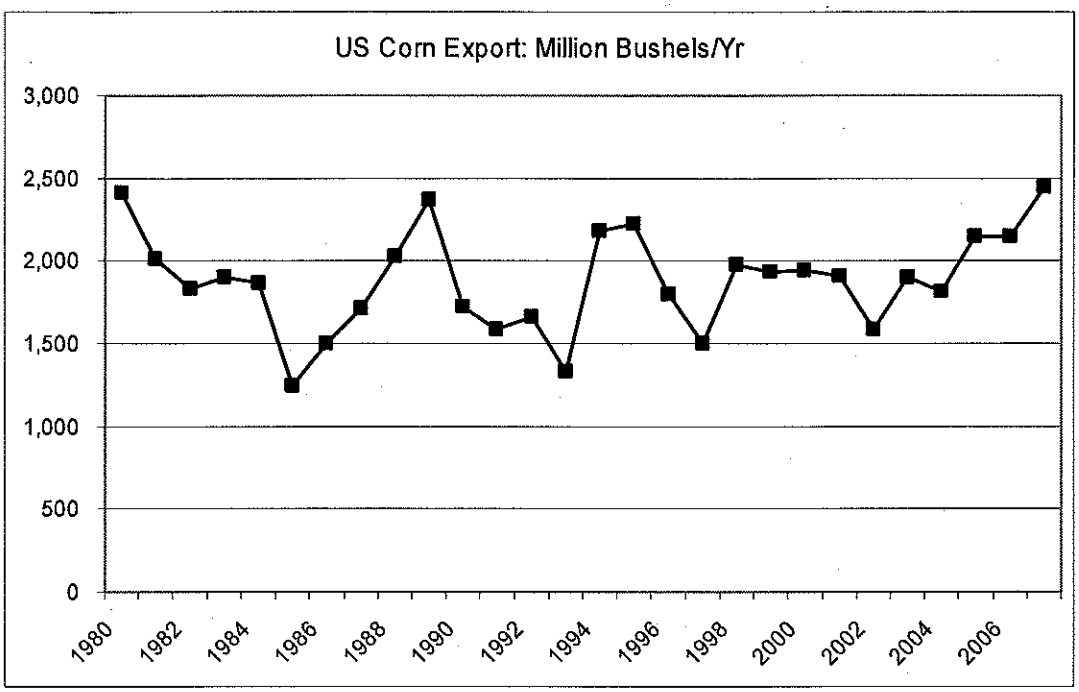


Figure 5. U.S. DGS Exports Have Increased Dramatically

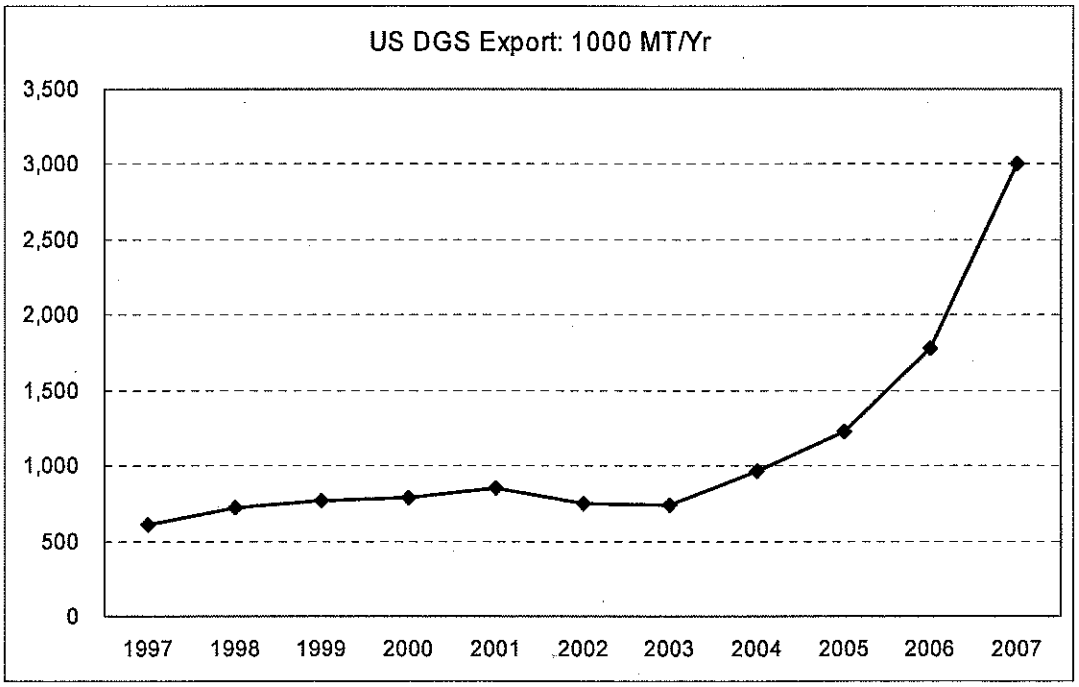
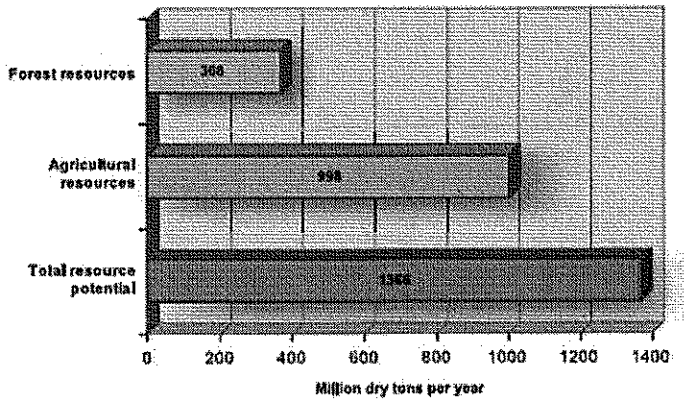


Figure 6: US Availability of Biomass Resources

Are There Sufficient Biomass Resources to Replace 1/3 of the U.S. Petroleum Requirements?

- Yes, land resources can provide a sustainable supply of more than 1.3 billion dry tons annually and still continue to meet food, feed, and export demands (USDA baseline)
- Realizing this potential will require R&D, policy change, stakeholder involvement
- Required changes are reasonable given current trends and time for biorefinery scale-up and deployment



From R. Perlack of Oak Ridge National Laboratory

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Complete Letter to the Editor of *Science*
February 16, 2008

Dear Editor:

The recent papers in *Science* by Fargione, et al (1) and by Searchinger, et al, (2) connect increased demand for corn for biofuel production with large, indirect land use changes to satisfy the demand for animal feed left unfilled because of the increased demand for corn. These indirect land use changes are in turn linked to large emissions of greenhouse gases (GHGs), thereby incurring a "carbon debt" that the authors believe may take many years to repay. (No mention is made of how long it will take to repay the "carbon debt" resulting from petroleum-derived gasoline.) Both studies have major omissions and deficiencies. I will discuss only those deficiencies that relate to life cycle analysis (LCA).

LCA is an internationally-recognized procedure for determining the environmental impacts of products and processes. LCA follows specific standards (eg, the ISO 14040 series) so that the both the procedure itself and the analytical results are transparent, verifiable and credible. We use LCA in combination with biophysical agroecosystem models to better understand and improve the environmental performance of biofuels and bioproducts (3, 4, 5). LCA is data driven, but these two papers do not depend much on actual data. Instead an assumption-driven economic model is linked to land use decisions and these land use decisions are in turn linked to GHG emissions through another undifferentiated, assumption-driven model.

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In contrast, consider the following situation. Corn and ammonia are inputs used to make ethanol. One can legitimately use LCA to test the effect of different means of producing ammonia (eg, from coal vs. natural gas) on the greenhouse gas profile of corn ethanol, but only if actual data on both ammonia production routes are available. Similarly, one can legitimately test the effects of corn produced by two different means (eg, conventional tillage vs. conservation tillage) on the greenhouse gas profile of ethanol, but only given actual data on the GHG effects of these two tillage practices. There are no real, verifiable data in either of these papers on the land use changes that actually occur as more corn is processed to ethanol—hence these papers are not LCA studies. They are in fact highly speculative and uncertain scenarios for what might happen as a result of increased demand for corn grain.

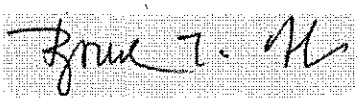
Even if there were such data connecting increased corn demand for ethanol with land use changes, ethanol produced in the United States would not be "responsible", in a strict LCA sense, for anything but its own environmental profile. "New" corn produced in Brazil by clearing savannah to satisfy animal

feed demand is responsible for its environmental profile as an animal feed, not as an ethanol feedstock. For example, plastic bottles are made from ethylene. Ethylene can also be used to make carpets. If demand for ethylene to make plastic bottles grows, then more ethylene will be needed to satisfy the unfilled demand for ethylene for carpets. But we do not make plastic bottle producers responsible for the environmental performance of carpet manufacturers. Likewise, it is arbitrary and unreasonable to make corn or switchgrass growers who are producing feedstock for biofuels responsible for the highly uncertain land use decisions of individuals thousands of miles away who are producing animal feed. We are much more likely to make environmental progress by holding individuals and corporations responsible for their own behavior rather than assigning to them responsibility for the behavior of other independent decision makers.

This is clearly different from the situation in which tropical wet lands are converted to oil palm production for the express purpose of providing oil for biodiesel production. It is also different from the situation in which Conservation Reserve Program (CRP) grasslands are actually converted to produce additional corn for ethanol production. In both of these cases, we can and should assess the biofuels produced with the environmental impacts of a specific, direct land use change. Direct land use change as a result of biofuel production is a legitimate subject for LCA and carries a reasonable level of certainty. In contrast, indirect land use change supposedly caused by biofuel production is tenuous, uncertain and highly speculative. It does not meet the standards of life cycle analysis.

Why this somewhat tedious emphasis on the arcane discipline of LCA? Because the recent U.S. legislation dealing with clean renewable fuels requires that certain "lifecycle greenhouse gas emission" standards be achieved for these fuel, including emissions caused by land use changes. Direct land use changes caused by biofuels can be studied by life cycle analysis. Indirect land use changes currently cannot. We should not make biofuel policy decisions on such an uncertain scientific foundation.

Sincerely,



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1. Fargione, J., J. Hill, D. Tilman, S. Polasky, and P. Hawthorne, 2008, "Land Cleaning and Biofuel Carbon Debt," Sciencexpress, available at www.sciencexpress.org, Feb. 7.

2. Searchinger, T., R. Heimlich, R.A. Houghton, F. Dong, A. Elobeid, J. Fabiosa, S. Tokgoz, D. Hayes, and T.H. Yu, 2008, "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases through Emissions from Land Use Change," Sciencexpress, available at www.sciencexpress.org, Feb. 7.

3. Kim, S. and Dale, B E. "Allocation Procedure in Ethanol Production System From Corn Grain I. System Expansion" *International Journal of Life Cycle Assessment* **7** (4), 237-243 (2002)

4. Kim, S.; Dale, B. E.; "Life cycle assessment of various cropping systems utilized for producing biofuels: Bioethanol and biodiesel" Biomass & Bioenergy 29, 426-439, (2005).

5. Kim, S.; Dale, B. E.; "Life cycle assessment study of biopolymers (poly-hydroxyalkanoates) derived from no-tilled corn" International Journal of Life Cycle Assessment 10, 200-210, (2005).

BRUCE DALE

MICHIGAN STATE UNIVERSITY

Multi-product systems must allocate environmental costs among all products

1. System is land use in the entire world
2. Land produces:
   - Animal feed (roughly 10x direct human food use)
   - Human food
   - Biofuels
   - Pulp, paper, lumber
   - Clothing (cotton, linen…)
   - Environmental services
3. Searchinger allocated the entire incremental land use "cost" of biofuel production to the biofuel—
4. Ignores the fact that the "replaced" agricultural production went to provide animal feed…
5. His analysis advantages animal feed production from land vs. biofuel production: animal feed is "sustainable" but biofuel production is not ("prior use trumps later claims" or "squatter's rights")

Biofuels and Sustainable Development

An Executive Session on Grand Challenges of the Sustainability Transition

San Servolo Island, Venice – May 19-20, 2008

Sustainability Science Program, Harvard Kennedy School of Government
Italian Ministry of Environment, Land & Sea
Venice International University

Summary Report

by

Henry Lee, William C. Clark, and Charan Devereaux
(On behalf of the Organizing Committee)

See page 6 re indirect land use

Grand Challenges of the Sustainability Transition:

This report emerges from the second in a series of intense workshops and study sessions on Grand Challenges of the Sustainability Transition, organized by the Sustainability Science Program at Harvard University, hosted by Venice International University, and supported by the Italian Ministry of Environment, Land and Sea.

The first session in the series addressed Grand Challenges in Sustainability Science. It was convened in October 2006 by William Clark, Co-Director, Sustainability Science Program at Harvard University; John Holdren, President, American Association for the Advancement of Science and Professor, Harvard University; and Robert Kates, Co-Chair, Initiative on Science and Technology for Sustainability. Further information is available at the workshop web site: www.cid.harvard.edu/sustsci/workshops/06sanservolo/index.html.

The Sustainability Science Program at Harvard University:

The Sustainability Science Program at Harvard's Center for International Development seeks to advance basic understanding of the dynamics of human-environment systems; to facilitate the design, implementation, and evaluation of practical interventions that promote sustainability in particular places and contexts; and to improve linkages between relevant research and innovation communities on the one hand, and relevant policy and management communities on the other.

Further information is available though the Program web site at www.cid.harvard.edu/sustsci/, or from co-Directors William C. Clark (william_clark@harvard.edu or Nancy Dickson (nancy_dickson@harvard.edu), at the Center for International Development, Harvard Kennedy School, 79 JFK Street, Cambridge, MA 02138 USA.

Environment and Natural Resources Program at Harvard University:

The Environment and Natural Resources Program at the Belfer Center for Science and International Affairs is the center of the Harvard Kennedy School's research and outreach on public policy that affects global environmental quality and natural resource management. Its mandate is to conduct policy-relevant research at the regional, national, international, and global level, and through its outreach initiatives to make its products available to decision-makers, scholars, and interested citizens.

More information can be found on ENRP's web site at www.belfercenter.org/enrp or from director Henry Lee (henry_lee@harvard.edu) or program administrator Amanda Swanson (amanda_swanson@harvard.edu), at ENRP, Harvard Kennedy School, 79 JFK Street, Cambridge, MA 02138 USA.

Venice International University:

Venice International University (VIU) is an association made up of ten universities, the Foundation of Venice, the Province of Venice, the Italian Ministry for the Environment and Territory (IMET) and the Italian National Research Council. The aim of this international center is to manage higher education and research centers on the island of San Servolo in Venice. VIU's work on sustainability is pursued through The Center for Thematic Environmental Networks (TEN).

Further information is available through the TEN web site at www.univiu.org/research/ten, or from its President, Professor Ignazio Musu (ten@univiu.org), at VIU, Isola di San Servolo 30100 Venice, Italy.

Citation:

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Copies are available on the Sustainability Science Program's web site (www.cid.harvard.edu/sustsci) and the Environment and Natural Resources web site (www.belfercenter.org/enrp). Comments should be sent to Henry Lee, Harvard Kennedy School, 79 JFK Street, Cambridge, MA 02138 USA, henry_lee@harvard.edu .

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Preface

The goals and concerns surrounding the debate over government policies related to the greater use and production of biofuels were addressed in an executive session convened by the John F. Kennedy School of Government at Harvard University and the Venice International University on May 19th and 20th, 2008. The session attracted more than 25 of the world's leading experts from the fields of policy, science, and business to San Servolo Island for an intensive two day session (see Appendix A for a list of the participants). The discussions were off-the-record, with each participant present in his or her own capacity, rather than representing an organization. The session was one in a series on Grand Challenges of the Sustainability Transition organized by the Sustainability Science Program at Harvard University with the generous support of the Italian Ministry for Environment, Land and Sea. This particular session was held as part of the Ministry's ongoing work with the Global Bioenergy Program established at the G8 Gleneagles Summit in 2005.

This summary report of the session is our synthesis of the main points and arguments that emerged from the discussions. It does not represent a consensus document, since no effort was made at the Session to arrive at a single consensus view. Rather, we report here on what we heard to be the major themes discussed at the session. Any errors or misrepresentations remain solely our responsibility.

A session of this type is made possible by the commitment and hard work of many people. We would like to thank our organizing committee of Corrado Clini, Empedocle Mafia, Melinda Kimble, Ricardo Hausmann, and Robert Lawrence. We are deeply appreciative for the work of Elisa Carlotto and Alessandra Fornetti at Venice International University and to Nancy Dickson and Gloria Visconti for their advice and guidance throughout the process. Charan Devereaux served as the rapporteur and has helped us in the development of this report. Finally we are very grateful to Amanda Swanson, who served as the staff coordinator for the entire project and whose help was essential to the success of this session.

As this report went to press, we received word that our friend and colleague on the organizing committee, Empedocle Maffia, had died in Rome after a short illness. He was instrumental in planning this session, which embodies what Empedocle spent his life doing: bringing together passionately committed individuals separated by their individual perspectives and interests, yet united in a commitment to respectful and reasoned discourse aimed at making the world a little bit wiser and better place. We dedicate this report to his memory, hoping that he would have thought we got some of it right, and missing terribly the wry humor and firm hand he surely would have brought to improving it.

Henry Lee and William C. Clark

Executive Summary

Liquid biofuels can provide a much needed substitute for fossil fuels used in the transport sector. They can contribute to climate and other environmental goals, energy security, economic development, and offer opportunities for private companies to profit. If not implemented with care, however, biofuel production can put upward pressure on food prices, increase greenhouse gas (GHG) emissions, exacerbate degradation of land, forests, water sources, and ecosystems, and jeopardize the livelihood security of individuals immediately dependent on the natural resource base. Guiding biofuel development to realize its multiple potential benefits while guarding against its multiple risks requires the application of a similarly diverse set of tailored policy interventions. Most session participants agreed that any single rule – such as production subsidies, a simple ban on biofuel production, or the immediate revocation of existing mandates for biofuel use – is too blunt an instrument, and will almost certainly do more harm than good.

Biofuels and Sustainable Development

Biofuels have emerged as a centerpiece of the international public policy debate. All of the G8+5 countries, with the exception of Russia, have created transport biofuel targets. Some countries have mandated the use of these fuels. For example, in January of 2008 the European Union reaffirmed a goal that 10% of vehicle fuel be derived from renewable sources by 2020. And the U.S. Energy Security and Independence Act requires that 36 billion gallons of renewable fuels be blended into gasoline by 2022. Recently, however, increased food prices triggered in part by converting food crops such as maize to fuel have raised public concerns about such goals. These concerns have been reinforced by several studies which indicate that biofuels may aggravate the net emissions of greenhouse gases rather than reduce them. While the potential benefits of biofuels have induced some governments to embrace their potential, many leaders are now concerned about the costs – particularly those that impact food prices and the environment.

Biomass can be used to provide energy in many forms including electricity, heat, solid, gaseous, and liquid fuels. These bioenergy options have been actively pursued in both the developed and developing world. Further, approximately two billion of the world's poorest people use biomass directly for cooking and heating, often seriously endangering their health and their environment. This Session focused exclusively on one part of the bioenergy menu: liquid biofuels for transportation. The Session asked three principal questions. Why should countries care about biofuels? Why should they be concerned about the negative spillover effects of biofuel production? What can be done to mitigate these negative effects, while promoting the development of a sustainable biofuel industry?

1. WHY BIOFUELS?

Policymakers, business representatives, academics, and members of civil society are pushing development of biofuels for different reasons. Some see biofuels as a substitute for high priced petroleum, either to ease the burden on consumers, to diversify the sources of energy supplies, or to reduce escalating trade deficits. Some have focused on biofuels as a way to extend available energy in the context of increasing world demand for transportation fuels. Others target biofuels as a substitute for more carbon intensive energy. Still others see biofuels as an economic opportunity. This latter group can be divided into two sectors: those who see biofuels as an

economic development opportunity, and companies who see biofuels as a potential market in which to invest.

1.1. **Energy:** The world currently uses 86 million barrels of oil per day,[1] with forecasts that demand for liquid fuels will increase to 118 million barrels by 2030.[2] Most of the incremental fuel will come from OPEC and specifically from the Middle East. In the last two years the world's supply of oil has had difficulty keeping up with demand, and prices have skyrocketed to $140 per barrel and more. This has triggered economic hardship, especially among the poorest importing countries. As more and more funds are required to pay for oil products, importing countries find their current account balances eroding and the costs of producing and transporting goods and services increasing. Today, many forecasters predict that while prices will fluctuate, the era of low-cost oil is over and countries must adjust by seeking alternative energy options and strategies.

More than 60% of the oil consumed in the OECD countries is used for transportation. While there are many substitutes for oil in the heating and power sectors, this is not the case in the transportation sector. Fossil fuel based alternatives, such as oil shale and coal liquefaction, could potentially provide additional transportation fuels, but their production will have large impacts on greenhouse gas emissions and water resources. In the short term, producing liquid fuels from biomass is one of the only alternatives to petroleum-based transportation fuels. As a result, countries are looking at a menu of biofuel options to reduce their future reliance on petroleum. Since biofuels are likely to be produced in countries outside of OPEC, they may also allow oil-consuming nations to diversify the sources of their transport fuels, and hence provide energy security benefits. While some debate the significance of the energy security advantages, until alternative transportation fuels (such as hydrogen and electricity) can be produced and consumed at a competitive price, biofuels are one of the few short-term options available to national governments worried about dependence on imported oil.

1.2. **Climate:** Growing concern over global climate change has motivated growing interest in all manner of renewable energy sources, biofuels among them. With transport contributing around 25% of global carbon dioxide ($C0_2$) emissions and with very few viable alternative fuels available, biofuels have been presented as a potentially significant contributor to strategies for reducing net greenhouse gas emissions from the transportation sector. There is little question that when produced and used appropriately, biofuels can deliver substantially lower net greenhouse gas emissions than fuels derived from fossil sources. This is particularly true when considering the greenhouse gas intensive synthetic fuels produced from coal or oil shale that are one of

the principal alternatives for liquid transport fuels. But the net greenhouse gas emissions of biofuels vary significantly depending on the feedstocks and technologies used in their production and consumption. And the overall impact of biofuel development on climate is more complex still, tied up with differences in carbon stocks and solar reflectance between the biomass crops and the vegetation they replace. It seems virtually certain that biofuels will (and should) have a role in national and global strategies to address the dangers of climate change. What is the most appropriate nature, scale, and location of that role remains an open question.

1.3. **Economic Development:** Biofuels and their feedstocks could be an important source of export income for developing nations. History has shown that participating in the global economy through export activity is a crucial part of the economic development process. In some tropical countries, biofuel production can bring with it "stepping stone" effects such as the extension of transportation networks, as well as job creation. In addition to, or in some cases in lieu of, growing biofuels for export, countries can substitute domestically-produced biofuels for imported oil products, reducing the micro and macro impacts of the sharp escalation in oil prices. In addition, biofuels present an opportunity for new entrepreneurial companies and small holders to emerge while simultaneously increasing economic activity in both developed and developing countries.

2. WHAT ARE THE CONCERNS ABOUT BIOFUELS?

Just as there are multiple goals that many seek to achieve through appropriate biofuel production and use, there are also multiple concerns. Many have blamed biofuels for higher food prices. Critics have also questioned the carbon mitigation claims surrounding biofuels. Others have pointed out that some kinds of increased biofuel production may dramatically increase nitrogen flows into lakes, streams, and coastal waters. Intensive use of land to produce biofuels – just like intensive use of land to produce food and fiber – can have serious impacts on conservation and ecosystem services, and on the livelihood security of poor land users. There are economic challenges as well. Many of the poorer tropical countries identified as potential targets for future investments currently lack the transportation and agricultural infrastructure to fully realize the potential of biofuels. Furthermore, trade barriers continue to block the development of a global biofuels market. More generally, critics argue that without appropriate public policy, the potential benefits of increased biofuel production may be outweighed by the costs.

It is important to carefully characterize the concerns raised about biofuels in order to tailor effective policy. Any single policy that attempts to address every challenge simultaneously is almost certain to be ineffective and would likely foreclose the opportunity to realize the potential

benefits outlined above. In fact, it is well established that good policy generally needs as many different instruments or interventions as it has targets or objectives.[3] To address the four or five concerns noted above, good biofuel policy should generally expect to need four or five instruments, each tailored to the particular challenge at hand. Of course reality is more complex, and it will also be important to consider the interactions among such instruments, and to pick ones that are mutually supportive. The broader point remains, however, that by being specific and clear about goals and constraints on the one hand, and specific interventions to address each of them on the other, an analytical rather than ideological approach to biofuels can become possible. In this way, policymaking can isolate problems about biofuels and start down the path toward mitigating those problems so as to secure in a responsible manner the potential benefits that biofuels can almost certainly offer to society.

2.1. **Food versus Fuel:** According to the Food and Agriculture Organization of the United Nations (FAO), global food prices have increased dramatically, rising by nearly 40% in 2007 and continuing to increase at the time of this session. Nearly all agricultural commodities have been affected, including major grains such as maize, wheat and rice.[4] The causes of the price hikes include adverse weather in key production areas, higher agricultural input prices (especially oil and oil-derived products such as fertilizers), and limited elasticity in agricultural production capability. Demand for food has also grown, especially in Asia and sub-Saharan Africa. While experts differ as to the extent of its role, increased biofuel production has also clearly played a part in higher food prices, shifting land away from food production and triggering increased competition for land use.

Another major underlying factor in the increase in food prices is that agricultural practices have not kept up with changing challenges and demands. Agricultural research and development has been underfunded for several decades, as have investments in rural infrastructure such as modern irrigation technologies and roads. In addition, energy and environmental policies that have pushed biofuel development have had little interaction or coordination with agricultural policies. Thus, biofuels production has not been fully integrated or embedded in strategic agriculture policy.

2.2. **Greenhouse Gases:** When measured over the entire production chain, the production of some biofuels, such as sugarcane-based ethanol, results in significant reductions in carbon dioxide emissions compared to conventional gasoline. The production of some biofuels can lead to smaller reductions, or even increases, in net carbon emissions. In particular, Session participants identified the clearing of forests to grow energy crops as a major concern as this practice can release large amounts of carbon dioxide to the atmosphere. Other sources of greenhouse gases emissions were also a cause for concern, such as the oxidation of peat that has resulted from the clearing of swamp

forests for oil palm plantations in Indonesia. Several participants pointed out that the significance of N_2O as a greenhouse gas should not be neglected as its impacts can be exacerbated by biofuel production and use.

Biofuel development that results in an increase in greenhouse gas emissions, rather than a reduction, erodes climate goals. Polices are needed to ensure forest protection and to encourage changes in agricultural practices to reduce net greenhouse gas. There is presently a lack of consistent methodologies for carbon emissions accounting that would allow society to precisely assess the impact of different agricultural and forestry practices. The absence of an agreed methodology is a major barrier to the development and implementation of a sustainable biofuels industry and associated policies. This barrier is being addressed by several international organizations including the Global Bioenergy Partnership.

2.3. **Ecosystems:** While greenhouse gas emissions were a major focus of the Session, they were not the only environmental concern voiced about an expanding biofuel industry. Air pollution, water pollution (especially nitrogen run-off), deforestation, loss of biodiversity, and overuse of water for irrigation in countries that are likely to face increased water shortages over the next several decades are all issues that require close attention in the development of agriculture for both increased food and biofuel production. The extent to which mixed-model development, including production from small holders, might balance ecosystem protection with economic development should be examined more closely.

2.4. **Market Concerns:** A free and open market for biofuels in which products, technologies, and producers can freely compete on relevant terms will encourage product improvement, capacity growth, and cost reductions. But clearly the environmental land use and economic costs will require regulatory intervention to set minimum standards and create a level playing field. Concerns about the market can be grouped into three areas: trade, incentives, and infrastructure.

2.4.1. **Trade:** Currently, a world market for biofuels does not exist. Import tariffs and non-tariff trade barriers erected by potential biofuel-consuming nations constrain the emergence of a functioning global market and eliminate economic opportunities for a number of developing countries. Such policies also reduce access to lower-priced biofuels in consuming countries. However, direct competition should be avoided where possible between western farmers intent on protecting their domestic markets and food and fuel suppliers from developing regions intent on identifying and accessing new markets.

2.4.2. **Incentives:** Session participants raised concerns about the inadequate design of existing incentives and mandates for biofuel production. Many were uncomfortable with mandates, arguing that they often target the wrong goals, and therefore serve as an ineffective instrument for achieving the full potential benefit from biofuels. However, as a recent UNCTAD study pointed out, no country has ever established a biofuels market without the use of mandates and subsidies. Prematurely removing existing mandates would have a chilling effect on the nascent biofuel industry, as investors who have committed funds in response to these mandates might walk away, stranding established production capacity. Uncertainty about policy and programmatic consistency was identified as a major constraint on future investment.

Several participants argued that if a second generation of biofuels is to emerge, financial rewards should be linked to reductions in greenhouse gas emissions at all stages of the production chain. Simply relying on prohibitions and other negative incentives to achieve these ends would not be sufficient.

Much discussion centered on biofuel certification processes, and on how to design them to ensure that environmental and developmental goals were addressed. The common sentiment was that these processes, if poorly designed, could severely restrain the market without appreciably improving sustainability or reducing greenhouse gas emissions. Several participants suggested that the principles embodied in the Roundtable on Sustainable Biofuels should be generally supported.

2.4.3. **Infrastructure:** An additional market challenge is that many of the poorer potential biofuel-producing nations lack the transportation, institutional, regulatory, and service infrastructures to support a biofuel industry.

It is unlikely that investments in this infrastructure will precede investments in biofuel production since development banks will not provide financing unless the demand for the product is clearly identifiable. For example, if the World Bank is to finance a road in the Congo to support a burgeoning biofuels industry, it must have assurances that there will be an industry present to use the road or it will not take on the demand risk. However, unless there is a reasonable probability that adequate infrastructure will exist to transport their products, investors will not put up their money. Significant investments in infrastructure are required, but they must be sequenced in a manner that is reasonable both for the investors and the banks.

Many poorer developing countries lack the regulatory, institutional, and legal systems necessary to induce investors to take the financial risks inherent in building a nascent industry. Their governments are struggling to develop and implement such systems and need technical, and in some instances financial, assistance to design appropriate governance frameworks.

2.4.4. **Land Use:** The biofuel debate is about how countries use their land. As food and fuel prices increase, competition for the world's land, especially for forests – will become more fierce. Many countries, including those in the developed world, lack the institutional capacity to tailor policies and programs that integrate agriculture, energy and environmental policies into a coherent land use policy. Governments will be under increased pressures to play the role of facilitator between local communities, businesses, and interest groups. They presently lack a coherent menu of institutions and policies to fill this new responsibility. For many governments, this would be a particularly challenging and unfamiliar task for which technical assistance and external policy advice may be required.

3. WHAT'S TO BE DONE?

What are the most important actions that could be taken to overcome the barriers impeding the use of biofuels for sustainable development? Who should be responsible for those actions?

As noted in earlier sections, many at the Session agreed that a necessary though insufficient step to realize the potential of a sustainable biofuel industry in developing countries is the emergence of an international market to couple supply, demand, and the incentives for investment and innovation at the largest possible scale. Ideally, such an international market would encourage the production of biofuels in locations where they can be grown most efficiently and where undesirable impacts are the smallest, and the consumption of biofuels in locations where the need for them is greatest. There was a strong feeling among the participants that the potential benefits of an international market in biofuels could be outweighed by risks of damage to food and environment systems unless adequate protective measures were simultaneously introduced. These protective measures will likely include the explicit recognition that sustainable production of biofuels cannot be expanded indefinitely. There are intrinsic limits on the productive capacity of ecosystems, constraining yields per unit of available area, and the amount of area that can be dedicated to sustainable biofuels production.

3.1. **Industry Development:** Support for infrastructure and vastly expanded R&D are essential for the development of any global biofuel industry. If that industry is to be sustainable, governments must also put into place a portfolio of incentives aimed at

minimizing the collateral impacts, including environmental damage, increased food prices, and additional greenhouse gas emissions. *Responsibility for action in this arena lies largely with national governments and multi-national firms.*

3.2. **Infrastructure Development:** Biofuel production is infrastructure intensive. At the national level, many poorer countries will find it difficult, especially in the early years, to develop the physical and institutional infrastructure needed to exploit their potential for sustainable production of biofuels unless provided with substantial outside support. Without the means to transport and store both the feedstock and the final product, biofuel companies in poorer developing countries will not be able to attract significant investment.

3.2.1. **Public Good Infrastructure:** Much of the needed support is of a public good variety that can generally be provided only by international, bilateral, and private aid programs. Such assistance should be directed to traditional development infrastructure projects such as roads to connect production areas with refining facilities and markets. (Such projects, wherever possible, should be "dual use," providing infrastructure needed for biofuel development that can also support agricultural and other development.)

Additional assistance for public good infrastructure is also needed to support the development of biofuel-related public goods such as research (see below) and production processes that help to reduce environmental impacts that would otherwise be externalized (e.g., highly efficient irrigation and fertilization; low-impact harvest). *Responsibility for action in this arena lies primarily with development banks; international, bilateral, and private aid programs; and developing country governments.*

3.2.2. **Private Good Infrastructure:** Some of the infrastructure support needed for biofuel development can generate returns to investors and is thus a potential opportunity for loans or direct foreign investment. Examples include investments in production, refinery/processing, and product distribution facilities. *Responsibility for action in this arena lies with banks and multi-national firms seeking to develop operations in the producing countries.*

3.3. **Standards and Certification:** Session participants expressed broad agreement with the view that creation of appropriate standards and certification protocols is essential for the sustainable development of biofuels. Certification or standards should be treated as means to advancing sustainable development of biofuels, not as an end in themselves. They need to balance the complexity desired to cover all concerns with the simplicity needed to promote practical and timely development and implementation. Actions are

needed to stimulate the development of an efficient market for biofuels while simultaneously guiding that development in sustainable directions. There was support at the Session for the idea that while standards or certification protocols may be needed to realize many of the major goals for the sustainable development of biofuels, efforts to control or regulate biofuels through any single global certification process or standard are likely to fail. Instead certification processes should be targeted towards specific, clearly defined problems that are not, or cannot be, addressed by other regulatory or policy mechanism. A "one measure for all problems" approach relies on an overly blunt instrument and is not likely to succeed.

3.3.1. **Basic Product Standards:** "Plain vanilla" product standards are needed to facilitate the emergence of a biofuel market by helping buyers and sellers to share an understanding of just what they are bargaining about. (For example, oil traders can specify an interest in "Arabian light crude oil" with the reasonable expectation that the kind of product the buyer expects to get will be the kind of product that the seller actually provides.) To encourage competition and improvements, biofuel product standards should be developed for categories of fuels (such as fuel for spark-ignition engines) rather than particular products (such as ethanol). Such product standards are generally most useful if developed and promulgated under international auspices with engagement of both producers and consumers in their design. *Responsibility for action in this arena lies with multi-national, multi-stakeholder partnerships.*

3.3.2. **Greenhouse Gas Standards or Certification:** Depending upon the methods used to produce them, biofuels may have net impacts on the global carbon cycle and on emissions of other critical greenhouse gases that are either positive (releasing less carbon dioxide and other greenhouse gases than fossil fuel alternatives), or negative (releasing more carbon dioxide and other greenhouse gases than fossil fuel alternatives). Several Session participants pointed out that in this respect, biofuels are similar to other uses of land resources, such as food production. They argued that it could unduly constrain realization of the potential benefits of biofuel development to impose different certification requirements for specific emissions on land used to produce fuel than on land used to produce food and fiber. The direct and indirect impacts on land resources from increased demand for biofuels are intrinsically no different than the impacts from increased demand for food.

If, however, biofuel development projects claim that they should receive special treatment or financing because of their supposed contribution to

solving the climate problem, then they need to be able to document that contribution for buyers, investors, and regulators. Similar needs exist if land-use interventions generally (e.g. forestry, food, and fiber production) are called upon under future climate agreements to account for their net contribution to greenhouse gas emissions. To provide such documentation, it seemed essential to most Session participants that reliable and standardized life-cycle-accounting (LCA) methods be developed to assess the net carbon budgets associated with particular biofuel and other land use projects. More generally, assessment frameworks need to be developed and applied that will allow us to address the impacts of alternative biofuel strategies not only on greenhouse gas emissions, but also on other determinants of climate change (e.g. surface reflectivity). *Responsibility for this area of work lies most appropriately in cooperative action involving the international science community*[5] *and the countries/firms involved in biofuel production.*

3.3.3. **Standards or Certification Relevant to Food and Ecosystem Service Concerns:** Should standards or certification similar to those discussed for greenhouse gases be developed to trace the impact of biofuel development on food production or other ecosystem services? For example, some participants argued that biofuels ought to be grown only on soils that do not support forests, are degraded, or are otherwise unable to support food crops. Those who shared this view were primarily motivated by concerns about the impact of biofuel development on greenhouse gas emissions, the loss of biodiversity, and a host of other environmental consequences, and thus focused their attention on designing a carbon certification process. Still others argued for feedstock-based standards, designed to document which biofuels are produced from non-food feedstocks. There were also concerns that any substantial additions of fertilizer use due to biofuel development could further exacerbate existing problems of eutrophication and "dead zones" in coastal seas.

Others made a case for not stifling biofuel development with requirements that would not be made for other land use projects, e.g. those taking land out of food crop production and into use for fiber crops or for lumber used in building homes. The Session did not come to closure on this issue. There was, however, a general consensus that the best way to handle concerns about the impacts of biofuels beyond greenhouse gases was to build comprehensive plans for assuring food security and the conservation of ecosystem services, and to hold biofuel projects accountable to standards comparable to those imposed on other proposals for land use change (see later section on Governance). Such standards should be developed in a transparent,

independent, and participatory manner. Work on such standards has begun in a number of forums, including the Roundtable on Sustainable Biofuels.

3.4. **Mandates and Incentives:** Targets for biofuel use and incentives for biofuel production have had a major impact on the rate and pattern of biofuel development. Few would argue that these impacts have been optimal. Unintended consequences have emerged because mandates and incentives have often targeted the means (i.e. specific technologies or volumes of use) rather than the ultimate goals of biofuel development. For example, volume mandates have almost certainly pushed producers to use crop feedstocks, since crops tend to have the best developed production technologies and are therefore usually the cheapest way to produce volume. The resulting competition between fuel and food has been a major source of tension. Better incentives should target goals, such as focusing biofuel development on non-food biomass, low net carbon life cycles, or approaches that protect ecosystem services. At the enterprise level, second generation biofuel production is often more expensive than fossil fuel production. Hence companies will seek greater financial rewards and subsidies for developing these fuels. Any such rewards or subsidies should be clearly linked to greenhouse gas reductions and the attainment of sustainability goals.

The shortcomings of many existing mandates and incentives notwithstanding, there was a belief among many Session participants that precipitous roll-backs or moratoria on existing mandates or incentives should be avoided. As mentioned in section 2.4, such actions may have serious impacts on biofuel investment, undermining confidence, stranding assets, and generally setting back the development of sustainable biofuels. Needed instead is careful analysis of the mandates, with targeted adjustments only where necessary for sustainability. This should include a limit to extensions of existing mandates or incentives that are not carefully targeted on the ultimate goals of biofuel development discussed in section 1. In addition, governments should begin an orderly, innovation-sustaining transition toward incentives that are targeted on such multi-dimensional goals such as reduction of net GHG emissions, increasing utilization of non-food feedstocks, the attainment of sustainability targets, the conservation of biodiversity, etc. *Responsibility for this action arena lies primarily with national and regional governments in the United States, European Union, and other powerful markets. Important assistance could come, however, from the international community of scholars and policy experts who should help develop "model incentives" for nations to consider when designing incentive packages appropriate for their own particular contexts.*

3.5. **Research and Development:** Advancing a strategy for sustainable development of biofuels that meets concerns for availability, cost effectiveness, greenhouse gas

reductions, food competition, and ecosystem protection will be a knowledge-intensive activity. A great deal of R&D is currently focused on the engineering and molecular biology of biofuel production. Some R&D resources are directed towards the relevant aspects of the global carbon cycle and some into biofuel production processes. Very little is going into research on the agricultural and natural resource systems needed to sustainably "scale up" a significant biofuel production system, into the limits of sustainable expansion, or into the ways that biofuel production interacts with the environment at global, regional, and local scales.[6] Indeed, for years, the international system has neglected research and development in the agriculture and natural resource sectors. Even the most basic food and fiber crops have suffered from underinvestment. For the complex, multi-use landscapes[7] that will almost certainly be an essential component of a strategy for sustainable development of biofuels, only the very beginnings of the necessary knowledge base exist. Along with a lack of investment in biotechnology, irrigation, and roads, this underinvestment in knowledge has resulted in a long-term decline in land productivity. Food, fiber, and fuel production could be stimulated by increasing investment in research and supporting reforms targeted at increased production of multiple crops to serve multiple uses. The interactions among agriculture, energy, and the environment require that more of the research should be interdisciplinary in nature and should focus on the boundaries between these three fields. Some Session participants recommended doubling the public agriculture budget to revitalize the system, including support to the relevant research centers of the Consultative Group on International Agricultural Research (CGIAR). Such a reinvigoration of the CGIAR system, and its collaboration with other public and private sector experts in engineering and molecular biology, could begin to grow the necessary research capacity for sustainable development of biofuels. *Responsibility for action in this area resides jointly with the international scientific community (which needs to develop a strategic science plan on sustainable biofuels), the national and international funders of the CGIAR, related public goods research institutions, and large private-sector actors active in the biofuels arena.*

3.6. **Governance:** The increased demand for food and the emerging interest in biofuels has created a new challenge for governments at all levels. Biofuels are not only an energy issue, but also have major land use implications and thus must be approached from energy, agriculture, and conservation perspectives; all of which come together in land use. Most national governments separate agricultural, energy and environmental policy and natural resources planning into separate agencies. Too often the decision processes are stove piped with each agency focusing primarily on its own mandate and embracing the needs and demands of its own constituencies. In addition, the coordination between national governments and local and regional governance institutions where most of the land use decisions are made, is poor, or in some cases, non-existent.

Participants felt that it was important that biofuels not be the primary driver of land use policy. National governments should embrace the principles of integrated planning, but to do this they must be able to tap into and coordinate the interests of the many diverse stakeholders. This coordination can best be achieved at the local or regional level, which means that the role of the national governments becomes more that of a facilitator, providing guidance, financial assistance, and technical support to local and regional institutions. Local governments will often not have the technical capacity to design and develop the matrices to measure the impacts of land use changes. Thus national governments should provide technical guidelines and implementation training to sub-national governments. It also means that the relevant national agencies must develop coordinating mechanism, both among each other and with local entities. *Responsibility for this action arena should lie primarily with national governments, but guidance and information should be supplied by international institutions including the multilateral development banks. The best way to develop such internationally recognized guidance and information is almost certainly through multi-stakeholder mechanisms such as the Roundtable on Sustainable Biofuels and the Global Bioenergy Partnership.*

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[1] BP, *Statistical Review of World Energy 2008*. Available at http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622, visited June 2008.

[2] US Energy Information Administration, *International Energy Outlook*, 2007. Available at http://www.eia.doe.gov/oiaf/ieo/oil.html, visited June 2008.

[3] These relationships were first articulated by Jan Tinbergen, *On the Theory of Economic Policy*, Amsterdam: North Holland Publishing, 1952, and subsequently elaborated by many others, e.g. A.J. Hughes Hallett, "Econometrics and the Theory of Economic Policy: The Tinbergen-Theil Contributions 40 Years On," *Oxford Economic Papers*, vol. 41, 1989, pg. 189-214.

[4] Mark W. Rosegrant, "Biofuels and Grain Prices: Impacts and Policy Responses," Testimony before the U.S. Senate Committee on Homeland Security and Governmental Affairs Committee, May 7, 2008.

[5] For example, the International Agricultural Research Centers, International Council for Science, the International Academies of Science. See also the section on Research and Development.

[6] See, for example, the recent review of biofuels research in the US Federal system published by the National Research Council, *Transitioning to Sustainability Through Research and Development on Ecosystem Services and Biofuels: Workshop Summary*, Washington DC, 2008. Available at http://www.nap.edu/catalog/12195.html

[7] Landscapes that we know can simultaneously generate incomes and food and fuel and other ecosystem services.

Appendix A: Participants

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Roundtable on Sustainable Biofuels

An initiative of the EPFL Energy Center
Ensuring that biofuels deliver on their promise of sustainability

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Global principles and criteria for sustainable biofuels production
Version Zero

Preamble

In June 2007, the Steering Board of the Roundtable on Sustainable Biofuels (RSB) published draft principles for sustainable biofuels production, as the basis for a global stakeholder discussion around requirements for sustainable biofuels. Interested stakeholders were invited to join Working Groups and suggest criteria for achieving these principles, as well as rewording for the draft principles themselves. Over the past twelve months, stakeholders have discussed the criteria in about fifty Working Group and Expert Group teleconferences; four in-person stakeholder meetings in Brazil, China, South Africa, and India (totalling 200 participants); on-line via the Bioenergy Wiki; and via direct e-mails and phone calls to the Secretariat at the Swiss Federal Institute of Technology in Lausanne (EPFL).

The resulting draft standard – principles and criteria, along with key elements of the guidance for implementation – is presented in the following pages. While not every potentially interested stakeholder has been consulted on its content, the RSB Steering Board feels that a wide variety of stakeholder input has been gathered, such that interested parties could consider this a good first draft, or 'Version Zero' of a globally-applicable standard for sustainable biofuels. Throughout this feedback process, the RSB has remained **committed to an equitable, open and transparent standards-setting process,** following the ISEAL Code of Good Practice for Standards-Setting and involving various stakeholder interests from many different countries and from all parts of the supply chain.

The standard was drafted largely based on work already conducted by the Forest Stewardship Council, the Dutch Cramer Commission, the Low Carbon Vehicle Partnership in the UK, the Roundtable on Sustainable Palm Oil, the ILO's Decent Work agenda, the Sustainable Agriculture Network, the Better Sugarcane Initiative, and other sustainable agriculture initiatives. The RSB remains committed to incorporating and recognizing other sustainability standards work, and to harmonizing and reducing any eventual reporting burdens as much as possible.

The standard below includes *principles* – general tenets of sustainable production – and *criteria* – conditions to be met to achieve these tenets. We have not yet developed *indicators*, the elements which enable evaluation as to whether a farm, producer, or company is meeting a particular criterion, but many of the Working Group discussions did start to develop the guidance for indicators and implementation. Due to space requirements of this overview document, we could not include all of the detailed guidance, nor the definitions of key terms, the good practices identified by stakeholders, or the exact scope/focus of responsibilities (farm, factory, etc.) for each criterion. We have only highlighted a few elements of the guidance which we thought essential to understanding the direction of the standard. Please refer to the http://EnergyCenter.epfl.ch/Biofuels website for the background documents with the full draft of each principle for the full guidance, scope, and the lists of terms to be defined. In general, we aim to be as practical as possible and focus responsibility for compliance with each criterion on the steps in the chain with the most potential impacts.

Finally, the standard does not attempt to quantify an amount of biofuels which could be consumed globally or whether, *as a whole,* biofuels are sustainable. Biofuels cannot replace all of our transport fuel consumption without significant changes in lifestyle and efficiency of use. We hope that these standards will be used in conjunction with new, sustainable consumption patterns for all the planet's energy needs.

Next steps

The Steering Board is proposing a **further six-month round of global stakeholder feedback** on Version Zero of this draft standard, to ensure that producers, workers, farmers, financial institutions, NGOs, governments, and traders have been given ample opportunities to input into the process. The RSB will be organizing or co-organizing a series of stakeholder workshops around the world through February 2009, and encourages any stakeholder to collect feedback from colleagues, organize group discussions, and send any suggestions to the RSB Secretariat (e-mail: rsb@epfl.ch or telephone: +41 21 693 0079) during this time. All of the suggestions received by the Secretariat and resulting from stakeholder workshops will be synthesized by the Secretariat and will form the basis for the Steering Board's re-drafting of 'Version One' of the standard, to be published in April, 2009.

The RSB will also develop generic protocols and processes to guide companies and farmers so that they can field test the draft standard in their own supply chains in cooperation with third parties. Lessons learnt from these pilot and field tests will be shared in the Implementation Working Group, which will then make recommendations to modify the standard based on these lessons.

These six months will certainly not be the last round of feedback - as the science and understanding of biofuels progress, our understanding of biofuels' sustainability must be updated and the standard adapted periodically, at announced intervals so that business can plan accordingly. Similarly, the full indicators and definitions will need to be developed by the respective Working Groups, including perhaps national-level interpretations through a process yet to be determined by the Steering Board.

Finally, while continuous improvement and the eventual adoption of good agricultural practices is the goal of many stakeholders in the RSB, there is a recognition that small producers may have difficulties complying with some criteria. When discussing the implementation of the standard over the next months, there will be a need to balance some of the aspirational elements of the standard with practical business realities on the ground. Similarly, as part of a new and expanding sector subject to highly variable agricultural pricing, biofuels projects require significant investments that might limit their initial capacity to invest substantially in sustainability measures. Depending on the feedstock and on the level of development of the country of production, the investment required to comply with the RSB standard might vary significantly, especially where producers do not benefit from public support and where capital is scarce and expensive. For these reasons, the RSB's approach will favor gradual and balanced improvements in compliance with the standard.

A note on economic sustainability

According to the triple bottom line approach of sustainability, biofuels shall be environmentally sound, socially fair, and economically viable. While some aspects of the economic sustainability of biofuel projects can be assessed at the production unit level, others depend on national macro-economic policies. To ensure a level playing field for global biofuel production, domestic use and trade, macro-economic policies such as trade barriers and distortive subsidies that disrupt global food and biofuel markets should also be addressed by the appropriate authorities. If produced sustainably, biofuels can create opportunities for developing countries with a comparative advantage in their production to, in some cases, even export biofuels to countries that need them.

A note on direct vs. indirect impacts

Throughout the course of this first year of standards development, it became clear that many of the concerns about the sustainability of biofuels' production can be addressed by direct behaviours of farmers, traders, and processors. However, potentially large impacts can result from off-farm, macroeconomic interactions amongst food, fodder, fuel, and fiber markets. Complying with Principle 3 on greenhouse gas emissions and Principle 7 on conservation is compromised if converting currently productive land into biofuel production results in other lands with high amounts of stored carbon and/or High Conservation Values being converted into productive activities for food, fodder, fuelwood, or other markets. Complying with Principle 6 on food security can also be beyond the control of the producer, if increased demand for biofuels results in higher

global market prices for feedstocks and increased vulnerability for people who spend large amounts of their income on food.

As awareness about these potential impacts is only just developing, there is little consensus about their magnitude and what might be done to mitigate them. Recent agricultural commodity price increases can, for the most part, be attributed to factors unrelated to biofuel production, such as increasing food and fodder demand, speculation on international food markets, and incidental poor harvests due to extreme weather events. High oil prices and related high costs of fertilizers also have an impact on the price of agricultural commodities. Deforestation and loss of biodiversity had already reached unsustainable levels before the recent surges in biofuel demand, and it is difficult to link direct causality of land use changes in one region or country to biofuel production in another. Nevertheless, the potential for negative indirect impacts is high, and within the spirit of the Precautionary Principle, sustainable biofuel supporters should be assured that their good intentions do not have unintended consequences.

Unfortunately, there is to date no scientific consensus as to how to quantify the amount of land use change or food price increases attributable to biofuel production. As stated in the Sustainable Biofuel Consensus[1] reached by a group of biofuels experts who met in Bellagio, Italy in April 2008, "addressing indirect impacts explicitly requires:

- continued global research to identify and quantify links between biofuels and land use change;
- mechanisms to promote biofuels that do not have negative land use change impacts;
- mechanisms that mitigate these negative impacts but do not unduly increase transaction costs for producers; and
- social safeguards at the national level, that ensure that vulnerable people are not further disadvantaged through food and energy price increases and other potential negative economic side effects."

The criteria below aim to address the *direct* activities that farmers and producers can undertake to prevent some of these unintended consequences. However, the Steering Board recognizes that many efforts to minimize these risks must be taken by governments in their policies that affect land use, land protection, biofuel promotion, and food security even in countries far away. Over the next year, the RSB shall collaborate with governments, international organizations, inter-governmental agencies, and concerned stakeholders to better understand the nature of these impacts and achieve consensus on how to measure and mitigate them.

Roundtable on Sustainable Biofuels – Standard for Sustainable Biofuels
'Version Zero' for global stakeholder feedback

Legality

1. Biofuel production shall follow all applicable laws of the country in which they occur, and shall endeavour to follow all international treaties relevant to biofuels' production to which the relevant country is a party.

Key guidance: Includes laws and treaties relating to air quality, water resources, soil conservation, protected areas, biodiversity, labor conditions, agricultural practices, and land rights, including for instance ILO, CBD, UNFCCC, and the Universal Declaration of Human Rights. This standard can go beyond national law, but cannot contradict or contravene national law.

[1] *Available at :* http://EnergyCenter.epfl.ch/Biofuels - Further reading

Consultation, planning, and monitoring

2. Biofuels projects shall be designed and operated under appropriate, comprehensive, transparent, consultative, and participatory processes that involve all relevant stakeholders.

Key guidance: 'Biofuel projects' refers to farms and factories producing biofuels. The intent of this principle is to diffuse conflict situations through an open, transparent process of stakeholder consultation and acceptance, with the scale of consultation proportionate to the scale, scope, and stage of the project, and any potential conflicts. The RSB will develop a scoping process to help determine the extent of the stakeholder consultation based on key criteria. Where many farmers are engaging in the same activity in the same area, there should be flexibility for a group of farmers to combine their work.

2.a For new large-scale projects, an environmental and social impact assessment, strategy, and impact mitigation plan (ESIA) covering the full lifespan of the project shall arise through a consultative process to establish rights and obligations and ensure implementation of a long-term plan that results in sustainability for all partners and interested communities. The ESIA shall cover all of the social, environmental, and economic principles outlined in this standard.

Key guidance: The ESIA shall include the identification of High Conservation Value areas, biodiversity corridors, buffer zones, and ecosystem services; shall evaluate soil health; shall identify potential sources of air, water and soil pollution; shall evaluate potential impacts on water availability; shall cover a baseline social indicator assessment; shall include an economic feasibility study for all key stakeholders; shall identify potential positive and negative social impacts including job creation and potential loss of livelihoods; shall establish any existing water and land rights.

Small-scale producers or cooperatives unable to perform ESIAs will need support and/or modified ESIAs.

'Large-scale producers' and 'relevant stakeholders' will be defined in the indicators.

2.b For existing projects, periodic monitoring of environmental and social impacts outlined in this standard is required.

2.c The scope, length, participation and extent of the consultation and monitoring shall be reasonable and proportionate to the scale, intensity, and stage of the project and the interests at stake.

Key guidance: The focus of this principle shall be on mitigating any potential negative impacts of large-scale projects in regions where stakeholder conflict is potentially high.

2.d Stakeholder engagement shall be active, engaging and participatory, enabling local, indigenous, and tribal peoples and other stakeholders to engage meaningfully.

2.e Stakeholder consultation shall demonstrate best efforts to reach consensus through free prior and informed consent. The outcome of such consensus-seeking must have an overall benefit to all parties, and shall not violate other principles in this standard.

Key guidance: 'Free prior and informed consent' and 'consensus' will be carefully defined. Consensus-seeking will be used to find the best solutions and iron out any potential problems that may arise over the lifetime of the project. Consensus can be sought from a group selected from stakeholders, to prevent decision-blocking by any one group or individual.

2.f Processes linked to this principle shall be open and transparent and all information required for input and decision-making shall be readily available to stakeholders.

Key guidance: Good practices for stakeholder consultation will be developed. Smallholders will need support for complying.

Greenhouse gas emissions

3. Biofuels shall contribute to climate change mitigation by significantly reducing GHG emissions as compared to fossil fuels.

Key guidance: The aim of this principle is to establish an acceptable standard methodology for comparing the GHG benefits of different biofuels in a way that can be written into regulations and enforced in standards. The overriding requirement is therefore a methodology that is not susceptible to subjective assumptions or manipulation.

The fossil fuel reference shall be global, based on IEA projections of fossil fuel mixes.

3.a Producers and processors shall reduce GHG emissions from biofuel production over time.

Key guidance: The RSB shall investigate incentive mechanisms to promote those biofuels with significantly higher reductions than others, for instance by introducing performance categories based on percentage reductions as compared to fossil fuels.

3.b Emissions shall be estimated via a consistent approach to lifecycle assessment, with system boundaries from land to tank.

Key guidance: The scope shall include carbon embedded in the fuel but exclude vehicle technology. Carbon sequestered in the soil and plant matter and carbon emissions from direct and indirect land use change shall all be accounted for whenever accepted methodologies are available – per 3d and 3e. Lifecycle assessment tools that go beyond this scope (for instance that include vehicle technology) shall be recognized as long as any extra elements can be isolated to facilitate comparisons.

3.c At the point of verification, measured or default values shall be provided for the major steps in the biofuel production chain.

Key guidance: The RSB will develop criteria for the quality of acceptable default values and measurements, and work with other institutions to develop default values for typical supply chains in different regions to help small producers comply with this criterion.

3.d GHG emissions from **direct land use change** shall be estimated using IPCC Tier 1 methodology and values. Better performance than IPCC default values can be proven through models or field experiments.

3.e GHG emissions from **indirect land use change**, i.e. that arise through macroeconomic effects of biofuels production, shall be minimized. There is no broadly-accepted methodology to determine them. Practical steps that shall be taken to minimize these indirect effects will include:

- Maximising use of waste and residues as feedstocks; marginal, degraded or previously cleared land; improvements to yields; and efficient crops;
- International collaboration to prevent detrimental land use changes; and
- Avoiding the use of land or crops that are likely to induce land conversions resulting in emissions of stored carbon.

Key guidance: The use of residues and waste shall not violate Principle 8 on Soil. Careful definitions and guidelines for identifying preferred land (marginal, degraded, underutilized, etc.) will be needed. The RSB will work with key international and national agencies and experts to try to provide a methodology to measure the indirect impacts of biofuels production for inclusion in the assessment of compliance with this standard, and to give guidance to producers.

3.f The preferred methodology for GHG lifecycle assessment is as such:

- The functional unit shall be CO2 equivalent (in kg) per Giga Joule [kgCO2equ/GJ].
- The greenhouse gases covered shall include CO2, N2O and CH4. The most recent 100-year time horizon Global Warming Potential values and lifetimes from the IPCC shall be used.

Key guidance: The RSB will develop guidelines for how substitution, allocation by energy content, and allocation by market value should be used, as there is a risk of mistakes and variability in results. Waste products (defined by the IPCC as having no economic value) will have zero allocation of historical emissions. It is possible that the definition of 'waste' will be expanded beyond the IPCC definition.

Human and labour rights

4. Biofuel production shall not violate human rights or labor rights, and shall ensure decent work and the well-being of workers.

Key guidance: Key international conventions such as the ILO's core labor conventions and the UN Declaration on Human Rights shall form the basis for this principle. Employees, contracted labour, small outgrowers, and employees of outgrowers shall all be accorded the rights described below. 'Decent work', as defined by the ILO, will be the aspirational goal for this principle.

4.a Workers will enjoy freedom of association, the right to organise, and the right to collectively bargain.

Key guidance: In countries where the law prevents collective bargaining or unionisation, special measures must be developed within the framework of the project implementation plan to ensure that workers can engage with the project owners or partners while being protected from breaking the law.

4.b No slave labour or forced labour shall occur.

4.c No child labour shall occur, except on family farms and then only when work does not interfere with the child's schooling.

4.d Workers shall be free of discrimination of any kind, whether in employment or opportunity, with respect to wages, working conditions, and social benefits.

4.e Workers' wages and working conditions shall respect all applicable laws and international conventions, as well as all relevant collective agreements. They shall also be determined by reference to, at a minimum, the conditions established for work of the same character or offered by comparable employers in the country concerned.

4.f Conditions of occupational safety and health for workers and communities shall follow internationally-recognised standards.

Key guidance: Applicable standards will be referenced by the RSB in the full guidance.

Rural and social development

5. Biofuel production shall contribute to the social and economic development of local, rural and indigenous peoples and communities.

5.a The ESIA carried out under 2a and monitoring required under 2b shall result in a baseline social assessment of existing social and economic conditions and a business plan that shall ensure sustainability, local economic development, equity for partners, and social and rural upliftment through all aspects of the value chain.

Key guidance: Small producers will need support or reduced requirements for this criterion. Large producers and processors shall work with local governmental and non-governmental agencies to ensure the proper application of this criterion. There should be measured improvements in the social and economic indicators as set against the baseline and targets, in proportion to the scale and extent of the project and the region in which it is located. The ILO's Decent Work Agenda is a recommended tool for assessing local impacts. The following best practices should be aimed for in the projects: Local ownership, local employment and livelihood opportunities, opportunities for the labour force in the off-season to ensure stable local communities, diversification of crops if shown to improve local economic conditions of communities, training, value added products, credit facilities for local communities and small outgrowers (e.g. through micro credit schemes supported by buyers and/or financial institutions), and/or provision of biofuel or bioenergy to local communities to promote energy security. Appropriate institutional structures should be developed, such as co-operatives that encourage and maximize local involvement and management.

5.b Special measures that benefit women, youth, indigenous communities and the vulnerable in the affected and interested communities shall be designed and implemented, where applicable.

Key guidance: Large producers and processors shall work with local governmental and non-governmental agencies to ensure the proper application of this criterion in proportion to the scale of the project.

Food security

6. Biofuel production shall not impair food security.

6.a Biofuel production shall minimize negative impacts on food security by giving particular preference to waste and residues as input (once economically viable), to degraded/marginal/underutilized lands as sources, and to yield improvements that maintain existing food supplies.

Key guidance: Clear definitions are needed for waste, residues, and degraded/marginal/underutilized land. ESIA should ensure that these lands were not used for livelihoods support, or that benefits of use for biofuels outweigh any loss of livelihoods. All of these definitions are time-dependent; unused land might come into production anyway given climate change as well as population and wealth growth. These criteria and definitions should be periodically re-assessed.

The RSB will examine different tools for incenting the use of these preferred sources of biofuels.

6.b Biofuel producers implementing new large-scale projects shall assess the status of local food security and shall not replace staple crops if there are indications of local food insecurity.

Key guidance: The RSB will work with other actors to develop tools for assessing local food insecurity. To mitigate local food security impacts, the biofuel project could, for instance: take the maximum food value from the crop and use the remainder as an energy stock, offset impacts via economic instruments, and/or intercrop food and fuel.

Conservation

7. Biofuel production shall avoid negative impacts on biodiversity, ecosystems, and areas of High Conservation Value.

Key guidance: HCV areas, native ecosystems, ecological corridors and public and private biological conservation areas can only be exploited as far as conservation values are left intact and can in no case be converted. Definitions of these terms and an appropriate cut-off date will be developed by the RSB.

7.a High Conservation Value areas, native ecosystems, ecological corridors and other public and private biological conservation areas shall be identified and protected.

Key guidance: Identification and mapping of HCV areas should be undertaken by governmental, inter-governmental, and conservation organizations, as part of larger processes involving non-biofuel sectors. Where such mapping is occurring, the results shall be respected by producers. Where such maps do not exist, large-scale producers shall use existing recognized toolkits such as the HCV toolkit or the IBAT. Producers or cooperatives unable to perform an environmental impact assessment and/or a land management plan will need support. The use of native crops shall be preferred. Hunting, fishing, ensnaring, poisoning and exploitation of endangered and legally protected species are prohibited on the production site.

7.b Ecosystem functions and services shall be preserved.

Key guidance: Ecosystem (ecological) functions are described in other systems, for instance FSC criterion 6.3. Ecosystem services are provisioning, regulating, cultural and supporting services obtained by people from ecosystems, as described in the Millennium Ecosystem Assessment. Specific ecosystem functions and services relevant to an area of production shall be locally defined.

7.c Buffer zones shall be protected or created.

7.d Ecological corridors shall be protected or restored.

Soil

8. Biofuel production shall promote practices that seek to improve soil health and minimize degradation.

8.a Soil organic matter content shall be maintained at or enhanced to its optimal level under local conditions.

Key guidance: The optimal level of organic matter is to be defined through the consultation of local experts, communities and producers, taking into account local climatic, geologic and ecologic conditions. Realistic targets should be set, in accordance with the producers' capacities and on a reasonable timeline. Follow-up indicators should focus on the implementation of recognized good practices. The use of agrarian residual products, including lignocellulosic material, must not be at the expense of other essential functions for the maintenance of soil organic matter (e.g. compost, mulch).

8.b The physical, chemical, and biological health of the soil shall be maintained at or enhanced to its optimal level under local conditions.

Key guidance: Soil erosion must be minimized through the design of the plantation or production site and use of sustainable practices (where possible: use of perennial crops, no till, vegetative ground cover, side-hedges of trees, etc.) in order to enhance soil physical health on a watershed scale. WHO class Ia and Ib pesticides are prohibited. Risks to health related to the application of pesticides are covered under 4.f.

8.c Wastes and byproducts from processing units shall be managed such that soil health is not damaged.

Water

9. Biofuel production shall optimize surface and groundwater resource use, including minimizing contamination or depletion of these resources, and shall not violate existing formal and customary water rights.

9.a The ESIA outlined in 2a shall identify existing water rights, both formal and customary, as potential impacts of the project on water availability within the watershed where the project occurs.

9.b Biofuel production shall include a water management plan appropriate to the scale and intensity of production.

9.c Biofuel production shall not deplete surface or groundwater resources.

Key guidance: The use of water for biofuel production must not be at the expense of the daily basic water needs of local communities. Water-intensive biofuel crops and biofuel production systems must not be established in water-stressed areas. The most efficient use of water must be sought through the use of crops that fit the local conditions.

9.d The quality of surface and groundwater resources shall be maintained at or enhanced to their optimal level under local conditions.

Key guidance: Adequate precautions must be taken to avoid run-off and contamination of surface and ground water resources, in particular from chemicals. Waste water must be adequately managed.

Air

10. Air pollution from biofuel production and processing shall be minimized along the supply chain.

10.a Air pollution from agrochemicals, biofuel processing units, and machinery shall be minimized.

Key guidance: the use of ground or aerial pesticides must comply with the FAO's codes of conduct.

10.b Open-air burning shall be avoided in biofuel production.

Key guidance: Open-air burning of leaves, straw and other agricultural residues must be minimized, with the aim of ultimately eliminating burning practices. In specific situations such as those described in the ASEAN guidelines and other appropriate policies, or if workers' health and safety is at stake, limited open-air burning practices may occur.

Economic efficiency, technology, and continuous improvement

11. Biofuels shall be produced in the most cost-effective way. The use of technology must improve production efficiency and social and environmental performance in all stages of the biofuel value chain.

11.a Biofuel projects shall implement a business plan that reflects a commitment to economic viability.

Key guidance: Biofuel projects should seek to be economically viable without distortive public support (for instance, tariffs and production subsidies).

11.b Biofuel projects shall demonstrate a commitment to continuous improvement in energy balance, productivity per hectare, and input use.

11.c Information on the use of technologies along the biofuel value chain must be fully available, unless limited by national law or international agreements on intellectual property.

Key guidance. The focus shall be on technologies that might pose a hazard to people or the environment.

11.d The choice of technologies used along the biofuel value chain shall minimize the risk of damages to environment and people, and continuously improve environmental and/or social performance.

11.e The use of genetically modified: plants, micro-organisms, and algae for biofuel production must improve productivity and maintain or improve social and environmental performance, as compared to common practices and materials under local conditions. Adequate monitoring and preventative measures must be taken to prevent gene migration.

11.f Micro-organisms used in biofuel processing must be used in contained systems only.

Land rights

12. Biofuel production shall not violate land rights.

12.a Under the ESIA described under criterion 2a, land use rights for the land earmarked for the biofuel project shall be clearly defined and established, and not be legitimately contested by local communities with demonstrable rights, whether formal or customary.

Key guidance: The term 'land use' means any land use, whether it be for commercial, industrial, agricultural, customary, leisure use, right of way, or any land rights. Methods for establishing ownership and land use should include advertising, communication with local leaders, and locally-established methods of data collection. Lack of a legal deed shall not hinder the inclusion of local communities in biofuel projects.

12.b Local people shall be fairly and equitably compensated for any agreed land acquisitions and relinquishments of rights. Free prior and informed consent and negotiated agreements shall always be applied in such cases.

Key guidance: Coercion by investors or authorities to change or adapt land use is not allowed. Compensation should be at the value of the land for the community or household, based on existing land uses and livelihood needs.

12.c Appropriate mechanisms shall be developed as part of the ESIA to resolve disputes over tenure claims and use rights.