Workshop on Biofuels and Food Security Interactions

Report of the Scientific Committee

19-20 November 2014
International Food Policy Research Institute
(IFPRI)

Summary

Over the dates 20-22 Nov 2014, an international workshop on the interactions of biofuels and food security was held at IFPRI headquarters, in Washington DC. The workshop brought together 61 scholars and experts representing over 30 different organizations interested in biofuel and food security across six continents. The Workshop agenda and full list of participants are included as appendices to this report. The purpose of the workshop was to explore current and future interactions between biofuels and food security, and elaborate learnings from analysis and field experience relevant for project developers, researchers and policy-makers. The workshop was organized around six discussion topics and was designed to encourage discussion among participants. The key aim was to identify where consensus lies regarding key barriers, gaps and opportunities related to (a) the assessment of biofuel-food security interactions and (b) recommendations for future research and implementation.

During the workshop, a very engaging set of discussions was had around the thematic presentations made. Although some issues of contention were still not fully resolved, the participants identified promising areas of inquiry that could be pursued further in subsequent research and collaborative publications. As the participants examined learnings from recent analyses and field experiences, general consensus emerged around the following discussion topics:

- Relationships among biofuel policies and food security are complex and defy simplification and generalization at global scales;
- Effects of biofuel policy and production are extremely context-specific and interact with food security at local scales, and therefore, projects need to be designed in response to, and assessed in light of, local conditions;
- Biofuel production could have negative, positive or no significant impacts on local security;
- “Flex-crops” that can support food security, energy security, and other local needs (feed, fiber, fodder) merit more analysis and attention;
- There has been excessive emphasis on “dedicated energy crops” without adequate review of options and implications associated with more integrated systems;
- Tools and guidelines are available to support more sustainable and responsible biofuel production, including stakeholder engagement and landscape approaches to design and monitoring;
- More attention should be given to scientific analysis: observations of actual conditions pre- and post- biofuel project implementation, and applying existing analytical tools such as causal analysis to better understand drivers of change and relationships;
- Continual learning from experiences gained and willingness to adjust policies and plans based on experience, can guide projects toward simultaneous improvements in energy and food security; and
- Clear, consistent, science-based and effective communications are a big challenge but paramount to enable stakeholders to constructively address issues, perceived and real.

Motivation and Background

I. Background

In recent years, the use of organic material (incl. agricultural crops) for transportation fuel and other energy purposes has spurred much debate about potential impacts on food security. This topic was discussed at the October 2013 meeting of the UN's Committee on World Food Security which:

- recognized that biofuels encompasses both opportunities and risks, depending on context and practices.
- acknowledged that, in some cases, current biofuel production creates competition with production of food crops.
- acknowledged that the links between biofuels and food security are multiple and complex and can occur in different ways at different geographic levels (local, national, regional, global) and time scales.
- acknowledged that further guidance is needed to minimize the risks and maximize the opportunities of biofuels in relation to food security.

In short, the interplay between biofuels and food security is much more complex than intuition might imply and there is a need for further and deeper understanding. That was one motivation for this workshop which aims to explore current and future interactions between biofuels and food security. The workshop was organized around a set of discussion topics informed by analyses and experience (case studies). The intention was not only to look back at what has been discussed in the literature, but also to look forward and generate:

1) An assessment of the current interplay between biofuels and food security
2) Recommendations for future directions relevant for researchers and decision-makers

A selection of key issues and findings of the workshop are being developed as a review paper to be submitted to a peer- reviewed journal.

The workshop agenda and outputs are at the website: http://www.ifpri.org/event/workshop-biofuels-and-food-security-interactions

II. Scope of workshop and discussion topics

Participants and speakers included representatives from:

1) Academia and research labs
2) International organizations active in the field such as FAO, IFPRI, and the World Bank
3) National government organizations, private sector and other parties that could contribute insight and experience.

Under each topic listed below, participants reviewed and discussed recent research and case studies to develop an understanding of what is known versus what is unknown or remains contentious. On this basis, conclusions and recommendations were generated to address identified research priorities. The six thematic discussion topics were:

1. Economic security and development
   How do biofuels affect rural incomes, poverty (and income distribution), employment, investment and agricultural development? How do biofuels interact with infrastructure investments? What are the implications for food security?

2. Energy security
   What are the linkages between energy security and the four dimensions of food security, and the underlying causes of food insecurity? How can biofuels interact with the energy needed for food production, processing, storage (food losses) and nutritional value? How do biofuels affect energy costs and price volatility? What are potential costs and benefits in terms of balance of payments and opportunity costs associated with energy imports?

3. Environmental security
   What are linkages between biofuels and the environmental conditions necessary for sustained provision of food and clean water? What have we learned about biofuels, land productivity, and changes in land cover and management? This topic includes opportunities to use bioenergy to improve and rehabilitate soils and manage water quality.

4. Biofuels and food price volatility
   What are linkages between biofuel policies and food price volatility? How do biofuels affect food markets and consumption – and what are the health effects?

5. Institutional aspects, innovation and consequences of inaction
   What are the key interactions among "governance" and institutional capacities, technological innovations, biofuels and food security? Are there "pre-requisite" conditions that must be considered to address food security concerns and develop biofuels? What can be learned from experience to date? What are the consequences of inaction, including interactions among food security, bioenergy and climate change mitigation and adaptation strategies?

6. Integration and cross-cutting issues
   What are the interactions among diversifying value streams, market substitutions, investment risk, and food availability? How can integration of biofuels within food supply systems beneficially impact food security? Productivity improvement (particularly relevant in Topics 1, 3, and 5)

To help bring participants to a common starting point, prior to the workshop, each discussion topic was elaborated in a topical brief (approximately 2 pages each) that was intended to provide recent research findings and key references. The briefs are in the annex of this report.

III. Organization of the workshop

A scientific committee was actively involved in the planning of the workshop. The members are listed below:

- Glaucia Souza, University of São Paolo, Brazil
- Helen Watson, University of KwaZulu Natal, South Africa
- Jeremy Woods, Imperial College London, UK
- Keith Kline, Oak Ridge National Laboratory, USA
- Lee Lynd, Dartmouth College, USA
- Navin Sharma, World Agroforestry Centre (ICRAF)
- Siwa Msangi, International Food Policy Research Institute

The workshop was made possible through funding provided by Novozymes, the Inter-American Development Bank, Imperial College, FAPESP, ClimateKIC, IFAD and in-kind contributions by IFPRI, ICRAF and other partners.

IV. Key questions of the workshop and participant input

Associated with each of the 6 topical themes of the workshop were a set of questions shown in Table 1.

Table 1: Key policy/research questions associated with thematic topics

Thematic discussion topics	Key questions
A. Economic security and development	1. How do biofuels affect rural incomes, poverty (and income distribution), employment, investment and agricultural development? 2. What is the linkage between biofuels and infrastructure investments? 3. How can bioenergy-based value chains be most responsive to the needs of developing countries?
B. Energy security	4. How can biofuels interact with the energy needed for food production, processing, storage (food losses) and nutritional value? 5. What are the linkages between energy security and the underlying causes of food insecurity? 6. What are potential costs and benefits in terms of balance of payments and opportunity costs associated with energy imports?
C. Environmental security	7. What are linkages between biofuels and the environmental conditions necessary for sustained provision of food and clean water? 8. What have we learned about biofuels and its relationship with land productivity, and changes in land cover and management?
D. Biofuels and food price volatility	9. What are linkages among bioenergy, energy costs, and price volatility for energy and foodstuffs? 10. What can be learned from current biofuel policies in the USA and Brazil in terms of impacts on food price volatility, food consumption patterns, and health? 11. How could biofuel policies be designed to contribute to food price

	stability and improved human nutrition and welfare in areas confronting food insecurity?
E. Institutions, innovation and consequences of inaction	12. What are the key interactions among "governance" and institutional capacities, technological innovations, biofuels and food security? 13. What are key innovation needs and opportunities – both technical and institutional (e.g. business models, public-private partnerships)? 14. What are the consequences of inaction, including interactions among food security, bioenergy and climate change mitigation and adaptation strategies?
F. Integrated food and biofuels production and cross-cutting issues	15. What are the interactions among diversifying value streams, market substitutions, investment risk, and food availability? 16. How can integration of biofuels within food supply systems affect food security and productivity? 17. What can be learned from experiences to date to guide future developments toward achievement of multiple goals (environmental, food and energy security) simultaneously?

The workshop participants had an opportunity to rank the importance of the 17 questions in Table 1, during the reception (by use of red sticker dots) that immediately preceded the opening of the workshop. The results of that ranking exercise are shown below (Table 2).

Table 2: Ranking of key questions by participants

Question	Topic	# Red dots
1. How do biofuels affect rural incomes, poverty (and income distribution), employment, investment and agricultural development?	A	15
16. How can integration of biofuels within food supply systems affect food security and productivity?	F	11
17. What can be learned from experiences to date to guide future developments toward achievement of multiple goals (environmental, food and energy security) simultaneously?	F	11
8. What have we learned about biofuels and its relationship with land productivity, and changes in land cover and management?	C	9
10. What can be learned from current biofuel policies in the USA and Brazil in terms of impacts on food price volatility, food consumption patterns, and health?	D	9
7. What are linkages between biofuels and the environmental conditions necessary for sustained provision of food and clean water [and biodiversity]?	C	8
5. What are the linkages between energy security and the underlying causes of food insecurity?	B	7
9. What are linkages among bioenergy, energy costs, and price volatility for energy and foodstuffs?	D	6
11. How could biofuel policies be designed to contribute to food price stability and improved human nutrition and welfare in	D	5

areas confronting food insecurity?		
3. How can bioenergy-based value chains be most responsive to the needs of developing countries?	A	4
12. What are the key interactions among "governance" and institutional capacities, technological innovations, biofuels and food security?	E	4
14. What are the consequences of inaction, including interactions among food security, bioenergy and climate change mitigation and adaptation strategies?	E	4
15. What are the interactions among diversifying value streams, market substitutions, investment risk, and food availability?	F	4
2. What is the linkage between biofuels and infrastructure investments?	A	3
4. How can biofuels interact with the energy needed for food production, processing, storage (food losses) and nutritional value?	B	2
13. What are key innovation needs and opportunities – both technical and institutional (e.g. business models, public-private partnerships)?	E	2
6. What are potential costs and benefits in terms of balance of payments and opportunity costs associated with energy imports?	B	1

The outcomes of the participant rankings are shown graphically in Figures 1 and 2, below, for the key questions and thematic topics, respectively.

Figure 1: Ranking of key questions by participants

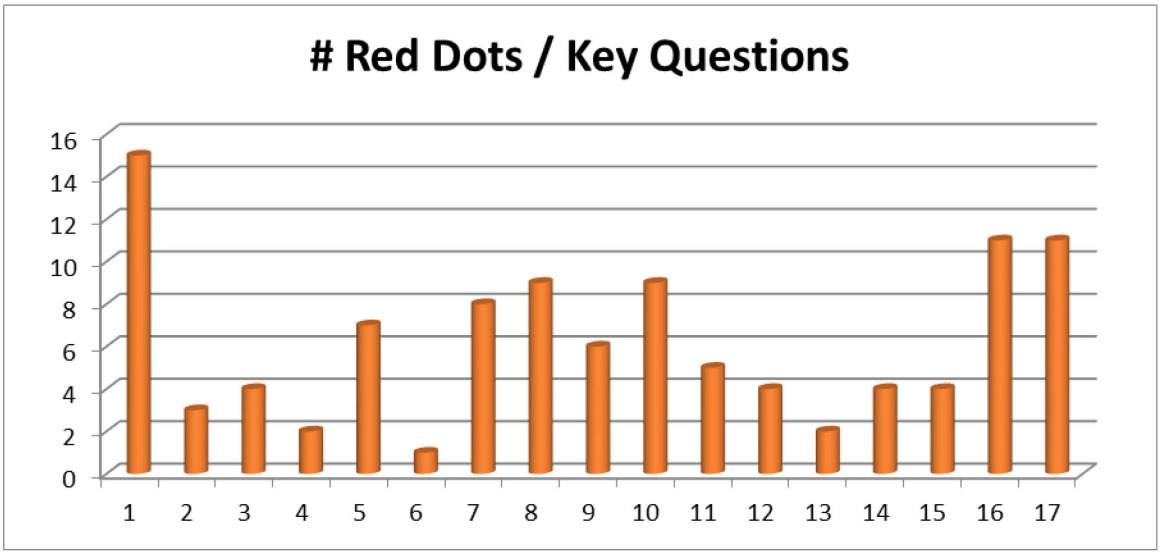
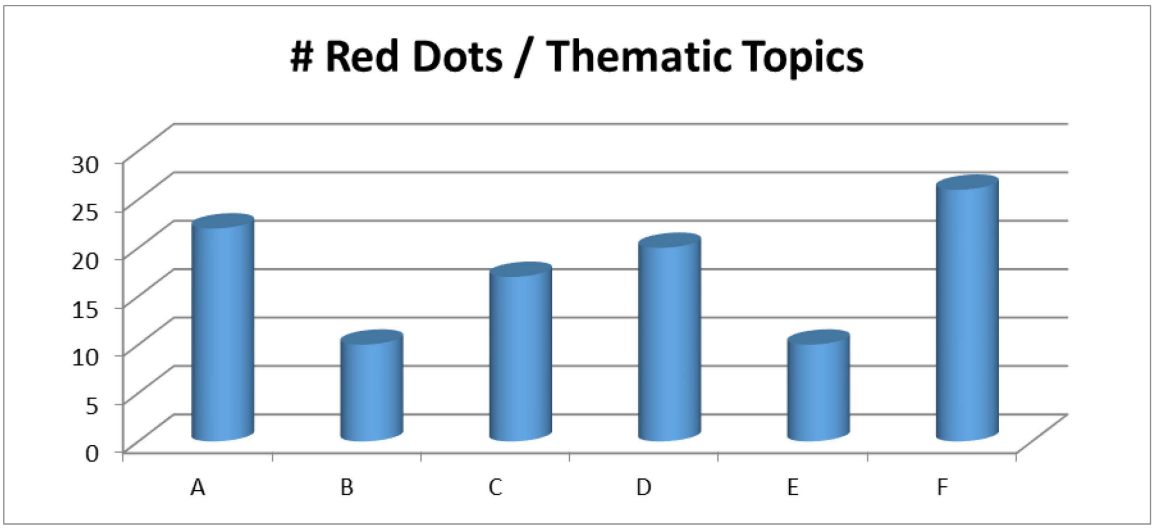


Figure 2: Ranking of thematic topics by participants



From this feedback, it appeared that the participants had the socio-economic implications of biofuels development (in terms of poverty, food security and economic development) at the top of their interests and concerns, along with the questions of how to integrate biofuels within food systems and how to assure that multi-dimensional benefits from biofuels development (i.e. environmental, energy and food security) are realized.

V. Key outputs from the workshop sessions

The presentations of the workshop were quite detailed. Below, some key points that each of the speakers made are summarized. The full presentations are available online at http://www.slideshare.net/Biofuels

Keynote presentations

What FAO Thinks and Does about Biofuels and Food Security (Olivier Dubois, FAO)

Sweeping statements on bioenergy sustainability are often over-generalizations. Bioenergy is complex, and therefore assessment of its sustainability must be evidence-based, contextualized, and integrated. Biofuels are neither good nor bad per se. What matters is the way they are managed. The tools and knowledge are available to help governments and operators reduce risks and enhance opportunities of bioenergy.

Financing Biofuels in Latin America and the Caribbean (Arnaldo de Carvalho, IDB)

IDB's goal is to support the sustainable economic and social development of its member countries. The bank sees the proper development of the biofuels sector as a viable and important strategy for achieving this goal. It has provided financing for the development of large scale ethanol plants in Latin America and the Caribbean (LAC). IDB recognizes the superiority of

biologically derived fuels relative to fossil fuels in the aviation industry and is therefore a major supporter of their development, along with other high impact opportunities in the LAC region.

Promoting Sustainable Bioenergy via the Sustainable Energy for All Initiative (Gerard Ostheimer, SE4All Sustainable Bioenergy HIO)

More than 1 Billion people lack access to modern energy services. Many of these people live in tropical and sub-tropical parts of the world where biomass resources can be abundant and for whom modern bioenergy options could play a role in meeting their energy needs. Ironically, the same populations that lack modern energy are already highly dependent on the unsustainable biomass for cooking, heating, and lighting. Fortunately, the international community recognizes these challenges and is mobilizing to reverse these trends and manifest the potential for the sustainable production and use of bioenergy to contribute to improved landscape management, rural economic development, and social well-being through the UN Sustainable Energy for All Initiative.

Topic 1 presentations

Opening comments by topic leader (Siwa Msangi, IFPRI)

The importance of the topic to IFPRI research priorities was briefly touched upon, before introducing the speakers.

Biofuels, Economic Development and Energy Security, (Govinda Timilsina, World Bank)

Countries that have no land constraints stand to benefit economically from biofuels. Countries relying heavily on energy imports and with an abundance of land, stand to benefit in terms of energy security from biofuels. Biofuels can potentially have positive effects on the alleviation of poverty, are a cleaner alternative to fossil fuels, and have an overall positive economic impact if countries take the proper approach to their development.

Charles Jumbe, Associate Professor of Economics, Lilongwe University of Agriculture and Natural Resources, Malawi

Biofuel development presents both opportunities and risks to African countries. For energy importers (most of Africa), it can increase energy security by substituting for fossil fuels. However, if managed improperly, expansion of biofuel land can displace land allocated to food production, as well as virgin ecosystems with high carbon storage content, therefore having major implications on food security and climate change. If biofuels are developed in tandem with sustainable productivity growth in agriculture, allowing non-food by products to be allocated to bioenergy production, and allowing for the equitable distribution of the returns on investments, then both food and energy security needs can be met. It is necessary that African governments manage their domestic biofuels policies properly in order to reap these rewards and avoid the risks.

Topic 2 presentations

Opening comments by topic leader (Navin Sharma, World Agroforestry Center/ICRAF)

Biofuels have the potential to fill the energy gaps for agricultural productivity in developing countries provided smart agroforestry systems with multiple use / non edible oil bearing trees are deployed that do not compete with agriculture. Emerging science clearly points to multiple species grown together have much better NEB then monoculture. Such sustainably developed biofuels also have the potential for GHG reduction and increased resilience to climate change while enhancing the rural energy security. The success of such intervention comes down to rigorous science that can determine what species to grow and where and how to grow them.

Biofuels for Food Security, (Balakrishna Gowda, University of Agricultural Sciences, Bengaluru, India)

Agricultural products can be used for energy production in a way that is not only non-competitive with food security, but enhances productivity of traditional agricultural land. As a case in point, biofuels from native, oil seed trees can be grown on marginal/degraded land in and among agricultural land, and have the benefits of (a) preventing soil erosion, (b) facilitating water conservation, (c) improving soil fertility through biomass incorporation, and (d) managing pests and diseases through secondary metabolites, among others.

Environmental Security, (Floor van der Hilst, Copernicus Institute of Sustainable Development, Energy & Resources, the Netherlands)

The effectiveness of biofuels in promoting food security depends on the design of the biomass supply chain and the biophysical and socioeconomic context in which the supplying region lies. If biofuels displace agricultural production or virgin land, there will be negative environmental and socioeconomic consequences. If managed properly, biofuels can have both positive environmental and socioeconomic results, and can play a particularly important role in poverty alleviation (food security) in developing countries.

Topic 3 presentations

Opening comments by topic leader (Helen Watson, University of Kwa-Zulu Natal)

Drawing from the example of the South Africa Bioenergy Atlas, the application of decision support tools to identify “no-go” areas was mentioned as a means of guiding bioenergy investments and protecting environmental quality and ecosystem health. The role of the GBEP consortium in spreading knowledge was mentioned, as well as the use of rapid assessment tools provided by the FAO Bioenergy and Food Security (BEFS) team to guide decision-making in developing country settings.

Environmental Security: A South African Smallholder Perspective, (Maxwell Mapako, CSIR Enterprise Creation for Development, South Africa)

In order to reap the benefits of expansion of the biofuels sector, communities must play an active role in its planning and development. Presently, biofuels have a mixed reputation in southern Africa due to the economic and environmental consequences of the way in which their expansion has been managed.

Topic 4 presentations

Opening comments by topic leader (Keith Kline, Oak Ridge National Laboratory)

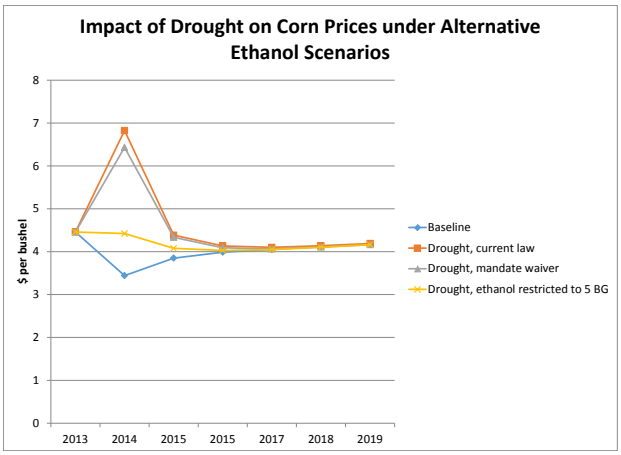
Price volatility of staple foods represents the fundamental driver of food insecurity: sudden price increases make staples inaccessible to urban poor while sudden decreases undermine small producer livelihoods and future production. More stable and predictable staple prices that create incentives for local investment in food production are desirable for enhanced food security. Relationships among price volatility in the consumer food price indices of developing nations, fossil energy prices, bioenergy policies, and food security are complex and context dependent. Important questions include: How do biofuel policies interact with staple food prices in areas at high risk to food insecurity?" Can biofuel policies be designed to reduce food price volatility and if so, what do such policies look like? Keith shared a set of slides (see IFPRI or CBES websites) and challenged presenters to address the key question: How can biofuel policies be designed to enhance food security?

Biofuels, Biofuel Policies and Agricultural Prices: Consequences on Food Security (David Laborde, IFPRI)

There is no strong link between biofuel demand and the consumer price index (CPI) for food; there are a multitude of other factors that have a larger role in determining variations in the CPI. Biofuels and biofuels policies have only a marginal effect on food prices and food price volatility. The marginal effect depends on relationships between demand and supply response (was new demand a surprise (shock) or was it foretold?). An example was provided of modeling that suggests that EU biofuels policies may translate into increased food prices and reduced welfare for some groups in some developing nations.

Impact of US Ethanol Production on Price Volatility (Bruce Babcock, Iowa State University)

What relative contribution did the U.S. biofuel policy have in relation to the major drought on corn prices in the US in 2012? The Competitive Storage Model (Zhou and Babcock, 2015) was used to simulate the effects of a repeat of the record-setting 2012 drought in 2014. The results of the simulation illustrate how U.S. ethanol production could be adjusted to off-set the price impact of a major drought; e.g., short-term restriction of US production to 5 billion gallons per year under the current policy regime (see Figure). Droughts are unpreventable but having a supply cushion could provide policy makers with flexibility and mitigating options when facing an unforeseen crisis. .



Structural change in The relationship between energy and food prices (Christopher L. Gilbert and Harriet K. Mugera). In this presentation, the increasing linkage reflected in correlations between global prices for petroleum and the prices of food commodities, particularly maize, was reviewed.

In the discussion, it was emphasized that market interventions and policy-driven price volatility should be avoided. Stable and predictable food and biofuel policies would be helpful to producers and consumers. It was also noted that questions remain about the nutritional dimension of food security given the growing global health crisis associated with eating too much of wrong foods. If the two major biofuel feedstocks in the world impact food prices, it would primarily be an impact on sugar and beef prices (e.g., ethanol in Brazil and US, respectively). Given this fact, what is the appropriate way to assess impacts on the nutrition dimension of food security?

Topic 5 presentations

Opening comments by topic leader (Lee Lynd, Dartmouth College)

When food security is viewed in terms of metrics (accessibility, availability, utility, stability), the potential impacts of bioenergy may be obscure. Consideration of the causes of food insecurity - including poverty, poorly developed infrastructure, undermined local production, and degraded land - provides a different and useful perspective. In particular, since all wealthy people have access to food and all involuntarily hungry people are poor, poverty and food insecurity are arguably more one problem than two. Some imagine bioenergy most beneficially deployed in sparsely populated areas in order to minimize interaction (often presumed negative) with people and food production. Others suggest maximizing interactions with society and agriculture in order to realize social benefits that go beyond fuel provision per se. Guidance on which of these approaches is more advantageous can be expected to come from better prospective models of the social consequences of bioenergy deployment validated by positive on-the-ground examples. Innovation is important at many levels, including institutional (e.g. innovative public private partnerships and cross-sector governmental structures), supply chains responsive to the needs of local communities (e.g. use of ethanol in farm machinery and trucks), and – we must not forget – technology (e.g, new crops, intensified or integrated land management, cellulosic and/or aviation biofuels). Considering widespread agreement that bioenergy has an important

role to play in mitigating climate change as well as the need for agricultural development in order to serve the rural poor, the risks of inaction in the bioenergy arena appear substantially greater than the risks of action.

Institutions, Innovation and Consequences of Inaction (Carlo Hamelinck, Ecofys, the Netherlands)

Biofuels offer a renewable/sustainable, cost effective, and versatile form of energy for the advancement of energy security worldwide, as well as the alleviation of poverty in the developing world. Countries that have successfully adopted (or are in the process of adopting) large scale projects in bioenergy production include Sierra Leone (Addax), Tanzania, Indonesia, and Brazil.

Bioenergy Transitions: the local and the global, (Francis X. Johnson, Senior Research Fellow Stockholm Environment Institute)

Development of the bioenergy sector provides a climate friendly means of economic development for the world's less developed economies. Agricultural and agro-industrial energy sources (especially residues) are the low hanging fruit for sustainable socioeconomic development. Significant levels of institutional development, investment/financing, facilitated trade and good governance will be necessary to achieve such pathways.

Topic 6 presentations

Opening comments by topic leader (Jeremy Woods, Imperial College, London)

The complex cross-cutting nature of the topic of biofuels and food security was brought out in this presentation, with an additional perspective of climate change and sustainable intensification. The complex interaction of agents in the market place was brought out in an example of a food market in Malawi, with a human perspective on the desperate poverty in which many households live. The idea of complexity within developing country food systems as providing both a challenge and an opportunity for bioenergy was mentioned, and the need for bringing appropriate tools and approaches to bear for addressing the various agricultural landscapes and scales of analysis (from local to global) was also emphasized.

Bioenergy and Food Security, (Patricia Osseweijer, Delft University of Technology, Netherlands)

Biofuel production can meet energy demands without competing for agricultural land, and has the potential to improve productivity of agricultural land. In particular, Africa and South America have the potential to provide much of the needed land for future production. If the global development of bioenergy is governed properly, it can enhance geopolitical stability, reduce food insecurity, while simultaneously alleviating environmental problems.

Integrating Food & Biofuels Production: Shaping New Agriculture for Bioenergy, (Luís Cortez, UNICAMP, Brazil)

In order to make bioenergy production more sustainable, there needs to be enhanced focus on research and development of the technologies related to bioenergy production. Present technology is outdated and was developed for food production in temperate climates, rather than being specifically built with bioenergy production in mind. Developing technologies specifically tailored for bioenergy production will be the key to making bioenergy a cost effective, environmentally sustainable source of energy.

Additional presentations

Glaucia Souza, Bridging the Gaps for the Sustainable Expansion of Bioenergy in the world, FAPESP, Brazil

In prominent low Carbon energy futures, bioenergy accounts for an average of 25% of global energy production. Currently, bioenergy account for only 4% of global energy production. Bioenergy is a critical factor in tomorrow's low Carbon economy. Further, bioenergy can meet the world's energy demands without compromising food security, and aiding in socioeconomic development.

Biofuels and Food production: A Systemic Approach to study the Relations and Implications in Complex Agricultureal Markets, Jorge Antonio Hilbert

> The opportunities and weaknesses of bioenergy were brought out, with the perspective that bioenergy must be considered as part of the overall food chain and that a systemic approach should be taken. The complex and multi-dimensional interactions of biofuels and food systems was mentioned, with the value-addition component of bioenergy as an important component to be considered. The perception problem of biofuels was mentioned, and the effect that it has had on policy decisions on bioenergy was brought out as a challenge that evidence and research needs to address. The example of Argentina was used as a way of illustrating how market conditions and infrastructure development contributed to the growth of the industry. The issue of food waste and measuring the environmental footprint of bioenergy through land use and indirect land use (iLUC) assessments was also discussed, with reference to recent literature.

VI. Summary

During each of the topic sessions, the participants brought up a number of ideas in reaction to each of the presentations given, and further discussion of the key questions associated with each of the themes took place during the breakout sessions of the conference. Table 3 pulls out a few selected comments that came from the participants, as they relate to the key questions and thematic topics.

Table 3: Selected comments to the key questions for each theme/topic

Thematic topics	Key questions	Discussion Notes
A. Economic security and development	1. How do biofuels affect rural incomes, poverty (and income distribution), employment, investment and agricultural development? 2. What is the linkage between biofuels and infrastructure investments? 3. How can bioenergy-based value chains be most responsive to the needs of developing countries?	1. Depends on context, project, spatial and time scale of analysis. Can be positive or negative. 2. Brazil, US and Africa offer examples of infra-investments for bioenergy also benefiting other sectors incl. agriculture. 3. Apply guidance available and principles of landscape approach involving stakeholders throughout process.
B. Energy security	4. How can biofuels interact with the energy needed for food production, processing, storage (food losses) and nutritional value? 5. What are the linkages between energy security and the underlying causes of food insecurity? 6. What are potential costs and benefits in terms of balance of payments and opportunity costs associated with energy imports?	4. Energy and food prices are interconnected in many ways; energy is critical for food production, processing and consumption, so if bioenergy offers more reliable or lower cost supply, this could benefit food security (or conversely, if bioenergy costs more and is less reliable, it could undermine food security). 5. Energy and food security share common institutional and governance issues, so improving one can help other. 6. Reducing reliance on expensive energy imports can make more funding available for food security and other social services.
C. Environmental security	7. What are linkages between biofuels and the environmental conditions necessary for sustained provision of food and clean water? 8. What have we learned about biofuels and its relationship with land productivity, and changes in land cover and management?	7. Land and water management practices require analysis on case-by-case basis. Can be positive or negative. 8. Where biofuel policies expanded production in US and Brazil, land use intensified and deforestation rates fell.
D. Biofuels and food price volatility	9. What are linkages among bioenergy, energy costs, and price volatility for energy and foodstuffs? 10. What can be learned from current biofuel policies in the USA and Brazil in terms of impacts on food price volatility, food consumption patterns, and health? 11. How could biofuel policies be designed to contribute to food price stability and improved human nutrition and welfare in areas confronting food insecurity?	9. Price volatility is a problem for food security. Should avoid interventions that increase volatility and develop policies that increase price stability and predictability. 10. No empirical evidence to support modelling of significant impacts on food prices from two major biofuel cases (Brazil and US). Long-term effects appear to moderate volatility by expanding base of production and diversifying markets and substitution options. 11. Apply available tools (see below).
E. Institutions, innovation and consequences of inaction	12. What are the key interactions among "governance" and institutional capacities, technological innovations, biofuels and food security? 13. What are key innovation needs and opportunities – both technical and institutional (e.g. business models,	12. Positive correlations between governance and institutional capacities on one hand, food security and biofuels on other. Policy uncertainties and market uncertainties are barriers to clean fuels and food security. 13. Shared goals and commitments from government, business and land owners are

	public-private partnerships)? 14. What are the consequences of inaction, including interactions among food security, bioenergy and climate change mitigation and adaptation strategies?	needed. More field-based, local needs-responsive, landscape design approach investments are required. Should build on existing skills and industries. Apply tools (see below). 14. Discussed in Lynd presentation
F. Integrated food and biofuels production and cross-cutting issues	15. What are the interactions among diversifying value streams, market substitutions, investment risk, and food availability? 16. How can integration of biofuels within food supply systems affect food security and productivity? 17. What can be learned from experiences to date to guide future developments toward achievement of multiple goals (environmental, food and energy security) simultaneously?	15. Diversification and substitution opportunities can reduce price volatility and enhance investment for production of commodities with multiple co-products. This reduces investment risk. 16. Crops for food and fuel are more successful, and preferable for food security, compared to crops for fuel alone. Expanding markets and wider base of production, reduces vulnerability to extreme events; it also creates higher incentives for investments in new technologies and more efficient production systems which lower economic and environmental costs over long term. 17. See presentations. IFPRI shared recent analyses and FAO shared Committee on World Food Security report (CFS 2013/40/2) which lists available guidance tools designed to “minimize risk and maximize the opportunities” for biofuels to benefit food security and development. The Center for International Forestry provides principles for landscape design that are relevant and complementary.

Appendix

A.1. Detailed Agenda of the workshop

Workshop on Biofuels and Food Security Interactions
Detailed Agenda

Overview and objectives:

The workshop will examine understanding of the interactions between bioenergy and food security, including case studies, areas of agreement and consensus, knowledge gaps, opportunities, and risks. We aim to identify activities that can address the knowledge gaps, realize opportunities, and minimize risks. Submission of a synthesis paper to a journal is planned, drawing on insights from the workshop and contributions from interested participants.

TUESDAY, NOVEMBER 18	
3:00pm *Executive Conference Room, IFPRI, 2033 K Street, NW*	**Science Committee Meeting**
6:00pm – 8:00pm *St. Gregory Hotel, 2033 M Street, NW*	**Reception** • "Key Questions" are written on colored cards and posted around the reception area. • Brief announcement is given of the purpose of the reception – a chance to meet and talk with colleagues, but also begin to think about the workshop topics. Exercise is meant to be simple, open, no pressure, but structured. Results will be shared in the morning. • Attendees are given 3 "sticky dots". They are to review the posted key questions and select the three (3) which are the most critical for understanding the linkage between Biofuels and Food Security and important to address. They then place their sticky dots on those cards. • The scientific committee will tabulate the sticky dots and prepare a chart showed the ranked order, including the number of sticky dots for each. • At the opening session, someone from the science committee will present and comment – not a scientific survey of course, but a reading of the group's thinking about these questions.
WEDNESDAY, NOVEMBER 19 *4th Floor Conference Rooms, IFPRI, 2033 K Street, NW*	
7:00am	Setup
8:00am	Registration (breakfast is available)
8:30am	Welcome – IFPRI Rep (10 min)
8:40am	Opening Remarks – Organizing Committee (10 min)

	• Include brief review of synthesis paper that will be the product of the workshop
8:50am	Objectives, Agenda, and Introduction of Participants (20 min)
9:10am	Comment on the Reception activity – Science Committee (20 min)
9:30am	Keynote IDB [Arnaldo Vieira de Carvalho]
9:50am	Keynote FAO [Olivier Dubois]
10:10am	Presentation on Sustainable Energy for All [Gerry Ostheimer]
10:30am	Keynote Q&A
10:50am	Coffee Break
11:00am *(people move to different meeting rooms)* ***Rooms: 4ABC, 5A, 7A, 7B, 8A, and executive conference room***	Breakout Session #1: Situation Analysis of the Discussion Topics • Science Committee assigns participants to one of the 6 groups • Worksheet provided to participants, with instructions; discuss the topic and complete the chart below, which is formatted on a flip chart sheet. • Groups self-select a) facilitator, b) recorder, and c) presenter • 60 minute discussion (including assignment and going to work space) **Discussion Topic 1:** **ECONOMIC SECURITY AND DEVELOPMENT** **What is Known, Supported by Evidence** — **Relevant Case Studies, Research Projects** ▪ ▪ **Key Issues and Gaps Blocking Common Understanding** — **Recommendations (to address key issues and gaps identified)** ▪ ▪ ▪ ▪
12:00 noon	*LUNCH (1 hr)*
1:10pm	Breakout groups share results (6 presentations, 10 min each)
2:10pm	Discussion Topic 1: Economic Security and Development (55 min) • **Siwa Msangi** introduces topic and speaker (10 min) • 2 – 3 10 minute presentations (30 min) [Govinda Timilsina, Charles Jumbe] • Q & A (15 min)
3:05pm	Coffee Break *(lengthened to 25 min)*
3:30pm	Discussion Topic 2: Energy Security (45 min) • **Navin Sharma** introduces topic and speaker (10 min) • Two 10 minute presentations (20 min) [Balakrishna Gowda, Madhu Khanna] • Q & A (15 min)
4:15pm	Discussion Topic 3: Environmental Security (45 min) • **Helen Watson** introduces topic and speaker (10 min)

	• Two 10 minute presentations (20 min) [Floor van de Hilst, Maxwell Mapako] • Q & A (15 min)
5:00pm	Wrap-up and Preparation for Day 2 • Participants are asked to consider questions overnight: 1. After Day 1 presentations and discussions, what are our emerging priorities for moving forward? Any changes in your thinking related to priorities? 2. Were any key issues omitted from the listed topics? and; 3. How could we, as a scientific community, get our message out there, related to these topics? • Posters will be displayed in the morning for participants to write down their comments and reflections on these two questions. This input will be helpful in preparing the Synthesis Paper. • 2 participants will be asked to start us out in the morning with their reflections on Day 1 and aspirations for Day 2. They will each have 5 – 10 minutes.
5:15pm	Closing
6:00pm *Pre-conference area, IFPRI*	Reception
THURSDAY, NOVEMBER 20 *4th Floor Conference Rooms, IFPRI, 2033 K Street, NW*	
7:00am	Setup
8:00am	Registration *(breakfast is available)*
8:30am	Participant reflections (20 mins)
8:50am	Discussion Topic 4: Biofuels and Food Price Volatility (60 min) • **Keith Kline** introduces topic and speaker (10 min) • 3 10 minute presentations (30 min) [David Laborde, Bruce Babcock, Christopher Gilbert] • Q & A (20 min)
9:50am	Coffee Break
10:20am	Discussion Topic 5: Institutions, Innovation, and Consequences of Inaction (60 min) • **Lee Lynd** introduces topic and speaker (10 min) • Two 10 minute presentations (20 min) [Francis Johnson, Carlo Hamelink] • Q & A (15 min)
11:20am	Three to five 10 minute presentations, pre-identified, topics that don't quite fit into the 6 discussion themes [Glaucia Souza, Bah Saho, Jorge Antonio Hilbert]
12:00nn	*LUNCH (1 hour)*
1:00pm	Discussion Topic 6: Integrated Food and Biofuels Production and Cross-Cutting Issues (60 min) • **Jeremy Woods** introduces topic and speaker (10 min) • 2 – 3 10 minute presentations (30 min) [Patricia Osseweijer, Luis Augusto Cortez] • Q & A (20 min)
2:00pm *(people move to different meeting rooms)* ***Rooms: 4ABC, 5A, 8A, executive, 4th floor***	Breakout Session #2: Recommendations for Moving Forward • Participants rejoin their original Discussion Topic group • Groups complete chart **Example: Discussion Topic 1:** **ECONOMIC SECURITY AND DEVELOPMENT**

multipurpose room	**Recommendations for Research Activities** ▪ ▪ **Recommendations for Deployment** ▪ ▪
3:00pm	Coffee Break
3:30pm	Break-out Groups' Reports (10 min each)
4:30pm	Wrap Up by Organizing Committee • Review of the Synthesis Paper; purpose, audience, etc. • Open questions to the group; "What are additional thoughts or suggestions as to what should be included in the Synthesis Paper?" "Volunteers to contribute to draft specific parts of the manuscript"? • Facilitator takes notes.
5:00pm	Closing
5:30-6:30pm Executive Conference Room	Authors' coordination meeting for the synthesis paper (all interested persons are welcome to join in this process)

A.2. List of Participants

	First Name	Last Name	Job Title	Organization	Country
1	Alok	Adholeya	Director	TERI	India
2	Gabriela Alejandra	Arteaga Arredondo	Intern	IICA	USA
3	Bruce	Babcock	Professor	Iowa State University	USA
4	Luis Augusto	Barbosa Cortez	Professor	UNICAMP	Brazil

5	Miroslav	Batka	Research Analyst	IFPRI	USA
6	Jorge	Bendeck	Executive President	National Biofuels Federation of Colombia	Colombia
7	Diana	Betancourt		Inter-American Development Bank	USA
8	Flynn	Bucy	Director, Business Development	Agrifood Consulting International	USA
9	Rodrigo	Ciannella	Programme Officer - Biofuels	World Agroforestry Centre (ICRAF)	Kenya
10	Joy	Clancy	Associate Professor	University of Twente	Netherlands
11	Virginia	Dale	Director, Center for Bioenergy Sustainability	Oak Ridge National Laboratory	USA
12	Amy	Davis	Government Relations	Novozymes North America Inc.	USA
13	Olivier	Dubois	Senior natural Resources Officer (Energy)	FAO	Italy
14	Manal	Eid	Associate Professor of Genetics	Suez Canal University-Faculty of Agriculture	Egypt
15	Gary	Forbes	Facilitator		USA
16	Christopher	Gilbert	Professor	SAIS Bologna Center, Johns Hopkins University	Italy
17	Elizabeth	Gooch	Economist	USDA Economic Research Service	USA
18	Balakrishna	Gowda	Professor	University of Agricultural Sciences, Bangalore	India
19	Morten	Gylling	Senior Research Advisor	IFRO-UCPH and Climate KIC - Bioeconomy	Denmark
20	Carlo	Hamelinck	Managing Consultant	Ecofys	Netherlands
21	James	Hawkins	Senior Research Assistant	IFPRI	USA
22	Jorge Antonio	Hilbert	Researcher, Advisor, and Professor	INTAUT	Argentina

23	Michael	Jacobson	Professor	Penn State	USA
24	Francis	Johnson	Senior Research Fellow	Stockholm Environment Institute	Sweden
25	Charles	Jumbe	Director of Research and Outreach	Lilongwe University of Agriculture and Natural Resources	Malawi
26	Madhu	Khanna	Professor	University of Illinois	USA
27	Keith	Kline	Global Change and Developing Countries Programs	Oak Ridge National Laboratory	USA
28	Jesper	Kløverpris	Sustainability manager	Novozymes	Denmark
29	Adam	Komarek	Research Fellow	IFPRI	USA
30	Anders Lyngaa	Kristoffersen	Manager, Public Affairs, Region Europe	Novozymes A/S	Denmark
31	David	Laborde	Senior Research Fellow	IFPRI	USA
32	Manoel Regis LV	Leal	Institutional Relations Coordinator	CTBE - Brazilian Bioethanol Science and Technology Laboratory	Brazil
33	Lee	Lynd	Paul E. and Joan H. Queneau Distinguished Professor in Environmental Engineering Design and Adjunct Professor of Biology	Darthmouth College	USA
34	Maxwell	Mapako	Senior Energy Specialist	CSIR	South Africa
35	Kandice	Marshall	Economist	USDA, Economic Research Service	USA
36	Geraldo	Martha	Coordinator, Embrapa Strategic Intelligence System	Embrapa	Brazil
37	Paul	Mason	Intern	ICRAF	Kenya
38	Patrick	McDonnell	Director for Strategy and Marketing	Bee Energy	USA

39	Lorena	Mejicanos Rios	Multilateral Investment Fund (MIF)	Inter-American Development Bank	USA
40	Siwa	Msangi	Senior Research Fellow	International Food Policy Research Institute (IFPRI)	USA
41	Harriet	Mugera	PhD Candidate	University of Trento	Italy
42*	Patricia	Osseweijer	Professor	TU delft	Netherlands
43	Gerard	Ostheimer	Global Lead	SE4All Sustainable Bioenergy HIO	USA
44	Leslie	Ovard	Bioenergy Policy Specialist (M&O Contractor from I	Dept. of Energy/Bioenergy Technologies Office	USA
45	Femi	Oye	Co-Founder and CEO	SMEFUNDS-GEBIOFUELS	Nigeria
46	Joseph	Pomerening	American Association for the Advancement of Science (AAAS) and Oak Ridge Institute for Science and Education (ORISE) Fellow	U.S. Department of Energy/Bioenergy Technologies Office	USA
47	Kuthi Thammaiah	Prasanna	Professor	University of Agricultural Sciences, Bangalore	India
48	Stephanie	Riche	Economist	USDA Economic Research Service	USA
49	Fahran	Robb	Senior Scientific and Policy Advisory for Biofuels	USDA Foreign Agricultural Service (FAS) Office of Global Analysis	USA
50	Marina	Rousset	Senior Research Officer	IMF	USA
51	Bah F.M.	Saho	Renewable Energy Expert (Bioenergy)	ECREEE	Cape Verde
52	Navin	Sharma	Programme Director - Biofuels	ICRAF (World Agroforestry Centre)	India
53	Glaucia	Souza	President	FAPESP Bioenergy Research Program BIOEN	Brazil

54	Shellye	Suttles	Agricultural Economist	USDA Economics Research Service	USA
55	Govinda	Timilsina	Senior Research Economist	The World Bank	USA
56	Wallace	Tyner	Professor	Purdue University	USA
57	Floor	van der Hilst	Assistant Professor	Copernicus Institute, Utrecht university	Netherlands
58	Reynaldo	Victoria	Professor	FAPESP	Brazil
59	Arnaldo	Vieira de Carvalho	Lead Energy Specialist	Inter-American Development Bank	USA
60	Helen	Watson	Honorary Senior Lecturer	University of KwaZulu Natal	South Africa
61	Jeremy	Woods	Lecturer	Imperial College London / Climate-KIC	UK

* Note: Prof Osseweijer participated virtually, and Jem Woods made a presentation on her behalf

A.3. Speaker biographies

BRUCE BABCOCK
Cargill Endowed Chair of Energy Economics
Iowa State University
USA
http://www.card.iastate.edu/facstaff/profile.aspx?id=13

Bruce Babcock holds the Cargill Endowed Chair of Energy Economics, directs the Biobased Industry Center and is a professor of economics at Iowa State University.

Professor Babcock's research interests include understanding US and world agricultural and energy commodity markets, the impacts of commodity policy and biofuels on U.S. and world agriculture, and the development of innovative risk management strategies for farmers.

Professor Babcock is originally from Southern California. He received his B.S. in economics of resource use and his M.S. in agricultural economics from the University of California at Davis, and his Ph.D. in agricultural and resource economics from the University of California at Berkeley.

JOY CLANCY
Associate Professor
University of Twente
Netherlands

http://www.utwente.nl/mb/cstm/staff/cv/clancy/

Joy Clancy is a Reader (Associate Professor) in Development Studies specializing in Technology Transfer. She joined the Technology and Development Group, part of which has been amalgamated into CSTM, in 1989. Dr. Clancy's research has focused, for more than 25 years, on small scale energy systems for developing countries, including the technology transfer process and the role that energy plays as an input for small businesses and the potential it offers entrepreneurs through the provision of a new infrastructure service. Gender and energy has been an important factor addressed in this research. Recently she has been working on social inclusion and exclusion in biofuel value chains and the impacts on poverty.

She is a founder member of ENERGIA, the international network on Gender. Dr. Clancy is also a co-convenor of the Gender and Development Working Group of the European Association of Development and Training Institutes (EADI). Dr Clancy is currently a technical advisor on gender and energy to the World Bank AFREA Programme. She is currently a member of the Dutch Ministry for Development Cooperation's (DGIS) knowledge panel on sustainability, climate and energy.

LUIS AUGUSTO BARBOSA CORTEZ
Professor
UNICAMP
Brazil

Luis Augusto Barbosa obtained his PhD from Texas Tech University, Lubbock, Texas in 1989. Prior to this, he obtained a degree in Agricultural Engineering from the State University of Campinas, and a Masters degree from Laval University, Canada. He has been a professor in the department of Agricultural Engineering, Feagri-Unicamp, Brazil, since 2004.

He is dedicated to research on the use of biomass from cane sugar for energy. Since 2006, he has coordinated FAPESP's Project on Ethanol for Public Policy. He has published seven books, among them "Biomass for Energy", and "Introduction to Agricultural Engineering in Brazil", and was a finalist in the 2009 Tortoise Award for "Best book in the field of Exact Sciences and Technology".

OLIVIER DUBOIS
Senior natural Resources Officer (Energy)
United Nations Food and Agriculture Organization
Italy
https://cleanenergysolutions.org/expert/dubois

Olivier Dubois is Senior Rural Institutions Officer and Coordinator of the Bioenergy Group within the Climate, Energy and Tenure Division of the Food and Agriculture Organization (FAO) of the United Nations. He has worked on land use intensification, forest management, and institutional aspects of rural development in more than 40 countries in Africa, Asia-South Pacific, Latin America, the Middle East, and the Commonwealth of Independent States, through both long-term assignments with the

Belgian Cooperation Agency, the German Consulting Company DFS (Deutsche Forest Service), the International Institute for Environment and Development (IIED), and FAO, and several short-term missions, including for the World Bank and the European Commission. An agronomist, land use and natural resource management specialist, Olivier has a Masters in Agronomy, certificates in Tropical Agriculture, Rural Economics and Sociology from the Faculty of Agronomy of Gembloux, Belgium, and a Masters in Environmental Management from the European Community Environment Programme.

CHRISTOPHER GILBERT
Adjunct Professor of Econometrics
SAIS Bologna Center, Johns Hopkins University
Italy
http://www.jhubc.it/OUR-FACULTY/profprofile.cfm/profid=342/Christopher-L.-Gilbert

Professor Gilbert has recently retired as Professor of Econometrics from the University of Trento (Italy). Previous appointments include Professor of Econometrics at Birkbeck, University of London; Professor of Finance at the Vrije Universiteit, Amsterdam; Professor of Applied Economics at Queen Mary, University of London; University Lecturer (associate equivalent) in Economics at the University of Oxford and at the University of Bristol. He has consulted extensively for the European Commission, the InterAmerican Development Bank, the IMF, UNCTAD and the World Bank mainly on issues relating to primary commodities and commodity futures markets. Professor Gilbert has extensive experience as an expert witness in U.S. futures-related litigation. Education: Oxford (M.A. and D.Phil.) and LSE (M.Sc.).

BALAKRISHNA GOWDA
Professor
University of Agricultural Sciences Bangalore
India

Balakrishna Gowda is a professor at University of Agricultural Sciences, Bangalore, India. Dr. Gowda has been
with the university for the past 35 years, working in the field of Biodiversity, conservation and management of bio-resources. He specializes in using remote sensing and GIS to identify vegetation, including non timber forest products and trees, in order to provide energy security to rural areas in India.

CARLO HAMELINCK
Managing Consultant
Ecofys
Netherlands
http://www.ecofys.com/en/experts/hamelinck/

Carlo Hamelinck PhD is senior strategic advisor to players in the biofuels arena. He advises to industry and governments to exploit opportunities and to accelerate sustainable development. Carlo supports and challenges the stakeholders, to facilitate discussions and decisions. He brings expertise to the table on different dimensions of biofuels production, international trade, policies and application. Carlo Hamelinck has almost fifteen years of biofuels expertise. He joined Ecofys in 2004 after finalising his PhD thesis on transportation fuels from biomass and international transport of biomass and biofuels, at the Utrecht University.

Within Ecofys, his workfield has broadened to other aspects of biofuels, in particular to the international market of feedstock and final products, to national and international legislations and to options for aviation and maritime biofuels. Carlo has done studies on the potential contribution of biofuels in several European countries, written a book about the European market for biofuels, and performed several due diligences and benchmark studies on biofuels initiatives for industries and private equity investors. He explores the developments in the global market in bioenergy and related commodities. In the past three years, Carlo lead a large consortium to report to the European Commission on the current status of the European biofuels market and how it impacts other markets, commodities, and socio-economic and environmental sustainability aspects. Carlo is currently also advising to the government of Tanzania on their biofuels policy, legislation and institutional framework.

JORGE ANTONIO HILBERT
Researcher, Advisor, and Professor
INTAUT
Argentina
http://www.renewableenergyworld.com/rea/u/jah1956jah

Jorge Antonio Hilbert holds a degree in Agronomical Engineering, as well as a M.Sc. degree in farm mechanization from National University of La Plata. He serves as coordinator of Argentina's National Bioenergy program, and as co-chairman of the Agriculture Committee of the Global Methane Initiative. He served as director of the Institute of Agricultural Engineering at INTA from 2004-2010. He specializes in development, education and outreach in the areas of Conventional and Non-Conventional Energy (biogas-biodiesel). He has authored over 76 research papers and 203 technical disclosure in the mainstream media of Argentina, as well as 31 technical standards and 67 specific projects. As a teacher he has taught more than 87 courses in his field and has participated in national and international consultancies. He is a reviewer for scientific journals, project evaluator and columnist for various graphics, television and radio media in Argentina.

FRANCIS JOHNSON
Senior Research Fellow
Stockholm Environment Institute (SEI)
Sweden
http://www.sei-international.org/staff?staffid=26

Francis X. Johnson conducts interdisciplinary energy/climate analyses, capacity-building and research, focusing especially on biomass energy in developing countries and including techno-economic feasibility, environmental impacts, socio-technical innovation, international market development.and the policy linkages across different scales and end-use sectors.

He has over twenty years of experience in economic and environmental analysis of biofuels, bioenergy strategies, climate mitigation, and energy efficiency. Prior to joining SEI, he was a Senior Research Associate in the Energy Analysis program at Lawrence Berkeley National Laboratory, USA: He has served as an advisor or expert for international initiatives run by UNIDO, FAO, European Commission, and the Environment Committee of the European Parliament. He has project experience in several different countries in Africa and Asia and has managed or coordinated two international boenergy networks. He has been co-editor of three books and two conference proceedings and served as Editor of the periodical *Renewable Energy for Development* for 8 years.

He holds a Bachelor of Science in Systems Science and Engineering from the University of Pennsylvania, a Master of Science in Operations Research from the George Washington University and a Master of Arts in Public Policy from the University of Wisconsin-Madison. He also completed the pre-dissertation phase of PhD studies in Geography and Environmental Engineering at The Johns Hopkins University and is now completing the PhD dissertation in cooperation with the Energy and Climate Studies Division at KTH Royal Institute of Technology in Stockholm.

MADHU KHANNA
Professor
University of Illinois
USA
http://ace.illinois.edu/directory/khanna1

Madhu Khanna has worked on diverse topics ranging from technology adoption and agro-environmental policy analysis, voluntary approaches to environmental protection and the land use, market and greenhouse gas implications of biofuels. Her work on technology adoption seeks to provide a rationale for the often-observed low rates of adoption of efficiency-enhancing technologies and shows the importance of considering heterogeneous producer characteristics, risks, uncertainty and market failures that distort prices while analyzing the incentives to adopt these technologies. She also examines the design of conservation payments to induce the adoption of improved land management practices to reduce non-point pollution from agriculture and enhance soil carbon sequestration.

My research also examines the effectiveness of environmental information disclosure policies and voluntary pollution control programs in achieving environmental protection. She has studied the motivations for corporations to undertake voluntary environmental initiatives to reduce toxic emissions to the environment. She analyzes the

design of such voluntary programs, the incentives for firms to participate and the effectiveness of voluntary efforts in improving corporate environmental performance. More recently, she has been analyzing the economic and land use implications of large scale production of biofuels from the next-generation of bioenergy crops, such as perennial grasses and crop residues, and the intended and unintended impacts of biofuels on greenhouse gas emissions. Her research often includes inter-disciplinary components and aims to be policy relevant.

KEITH KLINE
Global Change and Developing Countries Programs
Environmental Sciences Division
Oak Ridge National Laboratory
USA
http://www.esd.ornl.gov/people/kline/

Keith has worked in association with Oak Ridge National Laboratory since 1990 and since 1980 on the design, management and evaluation of international sustainable development programs and environmental analysis. Keith spent 22 years living in developing nations of Africa and Central and South America while working on programs to enhance human welfare and protect biodiversity through improved natural resource management. Keith served as Team Leader for a variety of USAID regional and bilateral projects, the most recent being the multi-national program for biodiversity conservation and water management in the Okavango Basin of Angola, Namibia and Botswana. Keith helped design and initiate the Central American Regional Natural Resources Management Project, the Maya Biosphere Project (Guatemala) and the Integrated River Basin Management Project in Southern Africa. Projects under his guidance have incorporated community-based forestry concessions, protected area management, and conflict resolution addressing issues related to land tenure, commercial agriculture and extractive industries such as mining and petroleum in sensitive ecological areas. Keith served as a Peace Corps Volunteer in Ecuador and holds degrees from the University of Michigan School of Natural Resources and Framingham State College, Massachusetts.

In addition to international development work, Keith has authored or co-authored reports on energy issues ranging from fuelwood and small hydro to combined heat and power and enhanced-use leasing. Recent research has focused on indicators and assessments of the sustainability of production systems, land-use change, biomass resource assessments and biofuel feedstock supply potentials around the world.

DAVID LABORDE
Senior Research Fellow, Markets, Trade and Institutions
IFPRI
USA

http://www.ifpri.org/staffprofile/david-laborde-debucquet

Dr. David Laborde Debucquet joined IFPRI, Washington DC, in 2007. He is a Senior Research Fellow and leader of the "Globalization and Markets" research program in the Markets, Trade and Institutions Division.

His research interests include international trade, measurement and modeling of protectionism, multilateral and regional trade liberalization as well as environmental issues (climate change, biofuels). He has developed the MAcMapHS6 and the ADEPTA databases on tariffs as well as the TASTE software. He is a contributor to the GTAP database and a GTAP research fellow since 2005.

Beyond his work on databases, he has developed several partial and general equilibrium models applied to trade policy and environmental issues, including the MIRAGE model and its extensions.

He has participated and organized training sessions for researchers and policy makers in several developing countries, with a special focus on sub-Saharan Africa.

Prior to joining IFPRI, he was an Economist at the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII), Paris between 2003 and 2007 and lecturer at the University of Pau (France). He received his PhD from the University of Pau in 2008. He has also worked as consultant for the European Commission, the Economic Commission for West Africa, the World Bank, USAID, and various UN agencies.

LEE LYND

Paul E. and Joan H. Queneau Distinguished Professor in
Environmental Engineering Design and Adjunct Professor of Biology
Dartmouth College
USA
http://engineering.dartmouth.edu/people/faculty/lee-lynd/

Professor Lynd is an expert on the production of energy from plant biomass and conducts leading research on microbial cellulose utilization. Professor Lynd's H-Index of 51 (Google Scholar) is among the highest of researchers with primary activity in the bioenergy field, and Lynd was among the top 5 academic researchers listed in Biofuel Digest's Top 100 People in Bioenergy in both 2011-12 and 2012-13. Lynd has authored over 150 papers, book chapters, and reviews spanning both laboratory research and visionary analysis. In addition to leading his research group, Lynd's activities at Thayer School include teaching the undergraduate Systems course as well as graduate courses in Metabolic Engineering and Energy Systems, and curriculum development and strategic planning in the energy area. He also chairs the Executive Committee of the Global Sustainable Bioenergy Project, is a Management Team member and Biomass Deconstruction and Conversion Focus Area Leader for the Department of Energy Bioenergy Science Center, and is Chief Scientific Officer, Director, and Co-Founder of Mascoma Corporation. A frequent presenter on technical and strategic aspects of biomass energy, Lynd has testified three times before the United States Senate, and his work has been featured in both national and international media such as Wired, Forbes, and Nova.

MAXWELL MAPAKO
Senior Energy Specialist
Council for Scientific and Industrial Research (CSIR)
South Africa
http://www.csir.co.za/nre/energy_futures/staff_max.html

Maxwell Mapako is senior energy specialist and a PhD candidate at the Energy Research Centre, University of Cape Town. His main research interest is policies and approaches for more successful implementation of modern energy services for poverty reduction.

This stems from his long experience with the challenges around dissemination of modern energy services among poor communities. He was a principal researcher with the Nairobi-based African Energy Policy Research Network and authored two book chapters and edited one book.

In a current project, Maxwell is a lead author for the *IPCC Special report of renewable energy and climate change mitigation* (2009-2010), and current reviewer and guest editor for *Energy Policy* as well as several World Development Journals.

HARRIET MUGERA
PhD Candidate
University of Trento
Italy

Harriet Mugera is a PhD candidate in Economics and Management at the School of Social Sciences at the University of Trento (Italy). She holds a MSc. in Economics and Finance from the University of Trento. She worked as an Economist and Econometrician at the Food and Agricultural Organization (U.N.) in the Trade and Markets and in the Agricultural Development Economics Divisions. Her research interests are in international, agricultural and monetary economics, financial and commodity markets, development economics, poverty and vulnerability.

SIWA MSANGI
Senior Research Fellow, Environment and Production Technology
International Food Policy Research Institute
USA
http://www.ifpri.org/staffprofile/siwa-msangi

Siwa Msangi is a Senior Research Fellow in the Environment and Production Technology Division, and co-leads IFPRI's research theme 1, which focuses on the major socio-economic and bio-physical drivers affecting agricultural production and trade, and their impacts on nutrition, poverty and the environment. While a great deal of his current research activity focuses on the economic and environmental impacts of biofuels, Siwa has a broader research background in natural resource management -- especially that of surface and groundwater management policy. Siwa also has

interests in quantitative dynamic economics and the application of dynamic game theory to the study of user behavior in natural resource settings.

A Tanzanian national, Siwa joined IFPRI in August 2004 as a post-doctoral fellow, after obtaining his degree in Agricultural & Resource Economics at the University of California at Davis. He earned a Master's degree in International Development Policy at the Food Policy Research Institute at Stanford University, where he also received an undergraduate degree in Chemical Engineering.

PATRICIA OSSEWEIJER
Professor
Delft University of Technology
Netherlands
http://www.tnw.tudelft.nl/en/about-faculty/departments/biotechnology/people/biotechnologie-en-samenleving/profdr-p-osseweijer/

Patricia Osseweijer is a Professor in the Department of Biotechnology at Delft University of Technology (The Netherlands). Her research interests include the social responsibility of scientists in public interaction and public opinion forming, novel forms of public communication, ethical aspects of industrial biotechnology, and the development of trans disciplinary action research methdology. She has published her research in a number of peer reviewed academic journals, including Sustainable Growth and Economic Success, Biotechnology Journal, Science and Engineering Ethics, and Nature.

GERARD OSTHEIMER
Global Lead
SE4All Sustainable Bioenergy HIO
USA

Gerard Ostheimer obtained his PhD in molecular biology from the University of Oregon in 2003. He worked as a Post-Doctoral Fellow in the department of molecular biology at MIT from 2005-2010. He was the technical lead to the Global Bioenergy Partnership for the USDA from 2010 to 2013. Beginning in 2013, he has been the sustainable bio-energy lead for the UN Sustainable Energy for All (SE4ALL) initiative.

BAH F.M. SAHO
Renewable Energy Expert (Bioenergy)
ECREEE
Cape Verde
http://www.ecreee.org/staff

Until his appointment with ECREEE in 2010, Mr. Saho served as the Director of Energy in The Gambia from December 2000. He was responsible for the overall national energy policy planning, formulation and implementation of programmes and projects, including renewable energy and energy efficiency programmes.

Some of Mr. Saho's accomplishments include development of a National Energy Policy (NEP) document, formulation and enactment of Electricity Act, drafting of petroleum legislation, establishment of a framework condition for funding for renewable energy legislation and elaboration of a Household Energy Strategy document. Mr. Saho holds a master's degree (M.Sc.) in Renewable Energy and the Environment.

NAVIN SHARMA
Biofuel Programme Manager
World Agroforestry Centre (ICRAF)
Kenya
http://worldagroforestry.org/sites/default/files/Navin%20Sharma.pdf

Navin has over 23 years of experience in industrial R&D working with two major FMCG companies such as Unilever and ITC. At Unilever, Navin was responsible for the development of technologies for their tea brands and was involved in 3 major re launches in Beverages category and led some international projects with countries such as Kenya, Japan and Pakistan. He has 10 patents from the work carried out at Unilever and ITC. Was a science area leader in Biochemistry / Biotechnology working on metabolic engineering of tea. Navin was the chief scientist with ITC Ltd in India and was responsible for setting up their Corporate R&D. Several R&D findings have been taken to POC level under his leadership.

Navin joined World Agroforestry Centre in the month of January 2013 as and now leading IFAD – World Agroforestry initiative on Biofuels. This programme is hosted from India and has global mandates. The programme will be implemented in South Asia, Latin America and Africa.

Navin is a PhD from the University of Cambridge (UK) and has carried out his Postdoctoral work at the University of York (UK).

GLAUCIA SOUZA
President
FAPESP Bioenergy Research Program (BIOEN)
Brazil
http://glauciasouza.com/index.php/glaucia-mendes-souza

Dr. Glaucia Souza is a professor at the University of São Paulo, coordinator of several initiatives in sugarcane genomics in Brazil and the Coordinator of FAPESP Bioenergy Program (BIOEN). BIOEN aims at articulating public and private R&D, using academic and industrial laboratories to advance and apply knowledge in fields related to bioenergy. Research ranges from biomass production and processing to biofuel technologies, biorefineries, sustainability and impacts.

Dr. Souza is the Chairperson of the SCOPE Bioenergy & Sustainability project, a global assessment of current status and latest developments for the sustainable expansion of bioenergy

in the world (http://bioenfapesp.org/scopebioenergy/index.php) (Souza, G., Victoria, R., Joly, C., & Verdade, L. (Eds.). (2015). *Bioenergy & Sustainability: Bridging the gaps* (Vol. 72, p. 779). Paris: SCOPE. ISBN 978-2-9545557-0-6). Her research also aims to develop biotechnological tools to improve sugarcane. Since 2003 she works with the private sector to develop innovative research on sugarcane carbohydrate metabolism and stress responses. She is an Einsenhower Fellow, a member of the International Society of Cane Technologists Biology Committee, Vice-Director of the National Institute of Science and Technology of Bioethanol and a founding member of the Bioenergy Society. She has a PhD in Biochemistry and Molecular Biology obtained at USP and post-doctoral trainments in molecular genetics and signal transduction at La Jolla Cancer Research Foundation and Baylor College of Medicine.

GOVINDA TIMILSINA
Senior Research Economist, Development Research Group
World Bank
USA

Govinda Timilsina is a Senior Research Economist in the Development Research Group. He has more than 15 years experience across a board range of energy and climate change economics at the international level. His key expertise includes general equilibrium and input-output modeling; project based mechanisms under the Kyoto Protocol; climate change science, impacts and mitigation; GHG market; energy sector modeling and electricity economics & planning. Prior to joining the World Bank, Mr. Timilsina was a Senior Research Director at the Canadian Energy Research Institute, Calgary, Canada where he was engaged mainly on climate change policy analysis, economic impacts assessment and electricity issues. Mr. Timilsina served as a member of the Small-scale CDM Panel and the Registration and Issuance Team (RIT) of the Clean Development Mechanism Executive Board (CDM-EB) under the United Nations Framework Convention on Climate Change (UNFCCC). He holds a masters and a doctoral degree in energy economics from the Asian Institute of Technology, Bangkok.

FLOOR VAN DER HILST
Assistant Professor
Copernicus Institute, Utrecht University
Netherlands
http://www.uu.nl/staff/cv.aspx?Medewerker=FvanderHilst&Lng=EN

Floortje van der Hilst is an Assistant Professor in the Department of Energy and Resources, Copernicus Institute, at Utrecht University (Netherlands). She attained a PhD in 2012 from the Copernicus Institute and Wageningen University. Her thesis is entitled: "Shades of Green: Spatial Variation in Sustainability of Economic Viability and Bioenergy Potentials". She has published her research in a number of peer-reviewed, international academic journals, including Agricultural Systems, Renewable and Sustainable Energy Reviews, Bioenergy, Global Change Biology, and Environmental Modelling and Software.

ARNALDO VIEIRA DE CARVALHO
Lead Energy Specialist
Inter-American Development Bank (IADB)
USA
http://www.iadb.org/en/topics/energy/arnaldo-vieira-de-carvalho,2779.html

Mr. Arnaldo Vieira de Carvalho is Senior Energy Specialist at the Energy Division of the Inter-American Development Bank (IDB) in Washington, DC. Mr. Vieira de Carvalho has been working for the IDB since 1997 on financing and implementing sustainable energy projects. He was Director of the Latin American Energy Organization - OLADE in Quito, Ecuador and General Manager of Promon Engenharia, a leading Brazilian consulting firm in Rio de Janeiro and São Paulo, acting internationally. He has also worked as an independent energy consultant in several Latin American countries for power utilities and international organizations such as The World Bank, UN agencies and the Organization of American States (OAS). Mr. Vieira de Carvalho holds a Mechanical Engineering degree from the Aeronautical Institute of Technology (ITA) in São José dos Campos, Brazil and a M.S. degree from Kansas State University.

HELEN WATSON
Honorary Senior Lecturer
University of KwaZulu Natal
South Africa

Helen Watson is an honorary senior lecturer at the University of KwaZulu-Natal (UKZN), South Africa. She obtained her BSc, BSc Honours and MSc degrees from the former University of Natal (UN), and her PhD from the former University of Durban-Westville (UDW). Helen taught Biogeography, Geographic Information Systems, Pedology, and Natural Resource Management from first to Masters levels at these institutions from 1980 to 2013. Helen also served on the South African National Forestry Advisory Council for six years after the transition to democracy when new policies and legislation for managing this diverse resource were developed. Helen has also led work packages on the following EU INCO research contracts: (1) Southern African Savannas Network, (2) Cane Resources Network for Southern Africa and (3) Competence Platform on Energy Crop and Agroforestry Systems – Africa. Helen is currently involved in identifying land available and suitable for food crop and/or bioenergy feedstock production, and biomass harvesting in east and southern Africa.

JEREMY WOODS
Lecturer in Bioenergy
Faculty of Natural Sciences, Centre for Environmental Policy
http://www.imperial.ac.uk/people/jeremy.woods

Jeremy Woods is a Lecturer in bioenergy at Imperial College London working on the interplay between development, land-use and the sustainable use of natural resources. Becoming a co-

director of Imperial College's Porter Institute in 2010, which is dedicated to the development of advanced biorenewables. He has been a member of the Royal Society working groups including the working group on GHG emissions from agriculture and in 2008 its working group on Biofuels. Prior to this he was on the advisory board of the UK Government's Gallagher Review which assessed the indirect land use change impacts of biofuels within the context of the UK Renewable Transport Fuels Obligation. He has carried out assessments of advanced bioenergy systems for a number of UK, national and international bodies, including on carbon / greenhouse gas assurance and certification accreditation and in developing the framework for an international bioenergy programme in collaboration with the UN-FAO and the Global Environment Fund (GEF). He chairs the UK working group of the Scientific Committee on Problems of the Environment, is Chair of a voluntary community-based carbon offsetting charity, Plan Vivo (www.planvivo.org) and a trustee of the Environmental Law Foundation (www.elflaw.org). His research focuses on accessing the development opportunities that arise from advanced bioenergy and biorenewables including African development and food security linkages with bioenergy production. He lectures on Sustainable Energy Futures and Environmental Technologies in Imperial College London.

A.4. Summary Briefs on the 6 main themes of the conference

Synthesis of Topic 1: Economic Security & Development

Siwa Msangi
International Food Policy Research Institute, 2033 K Street NW, Washington, DC, 20006.
Email contact: s.msangi@cgiar.org

Key issues

Biofuels (and bioenergy more widely) has been recognized as a potential driver of growth in agriculture, as well as a source of sustainable energy for an expanding global economy. For those countries which have already made significant investments in first-generation biofuels technologies, the economic gains to their rural economies has already been realized, and the returns to these investments are accruing to those early investors. For those still developing their domestic renewable energy and biofuel programs, there is still some uncertainty as to whether there is still an equal potential for value-addition, employment generation, and additional investments into the rural economies of those countries.

While some studies have looked at the poverty reduction potential that biofuels can have in developing countries – others have focused on the price effects that biofuel production growth could have on feedstock commodity prices, and their implication for food prices and household expenditure and consumption. The poverty-reducing effect of biofuels, in some economic studies, depends upon the configuration of production (centralized vs outgrower) and the potential for involving smallholders and generating beneficial technological spillovers from them. The effect that biofuels production can have on labor demand, wages (and therefore household income) is also a factor that some try to consider. Whether the household in question is a net consumer or producer of the commodity facing the price increase is a key determinant as to whether the household-level welfare effects would be positive or negative.

The distributional consequences of biofuels expansion depends upon a number of factors, which a detailed analysis must take into account. One key factor is the distribution of skills and human capital within the economy. Depending on the type of feedstock and technology – or the degree to which the biofuel is actually made in the country (rather than exported as raw feedstock) -- the demand for semi-skilled or un-skilled labor may vary, and have different consequences for the households that possess laborers and wage-earners with those skills. The distributional effects might also come from the fact that crop feedstock producers might benefit from a higher price that is brought by increased biofuels production – whereas a livestock producer might suffer negative effects, if it has consequences for the prices of feed going to the animals. In some countries where biofuel co-products, such as dried distillers grains and solubles (DDGS) can be produced – this impact on feed is offset (or at least lessened) compared to those regions in which such co-products are not available.

The importance of infrastructure becomes apparent when one considers the degree to which its presence – in the form of good roads, efficient & cost-effective processing and storage, and adequate packing and shipping facilities for export – can enhance price competitiveness and boost market access. Where public investments have already been made in key sectors, such as transport, irrigation, power and communications – the start-up costs of an enterprise are much lower, and the prospects for a successful biofuels sector is potentially greater.

Each of the issues raised above has its own implications for the economic security and development of a country pursuing a vigorous biofuels program. The linkage to food security comes from the ultimate impact of biofuels or bioenergy growth upon household incomes and expenditures, and how this can be traced through one of the four pillars of food security – availability, access, stability, and utilization.

The issues for which there is still some need for research to clarify, are included in (but not exhaustive of) the following:

- Is biofuels the most important aspect of bioenergy to consider, when trying to promote the economic and energy security of a country through renewable energy policies?
- Under what circumstances are biofuels either good for or potentially adverse towards the alleviation of poverty?
- Are biofuels appropriate for countries across all levels of development – or are there some basic elements that need to be in place for a country to benefit and expand from biofuels?

Some interesting case studies that have been examined in the literature looking at the impact of biofuels on poverty and economic growth are those of Tanzania (Arndt et al. 2010a), Mozambique (Arndt et al. 2010b, 2011), Peru (Khwaja, 2010) – as well as a number of case studies mentioned by Clancy (2012) and Mitchell (2011).
These are useful points of reference for further study, and illustrate a variety of techniques that can be useful in the examination of this important issue.

Discussion topics

In preparation for the workshop on biofuels and food security interrelations, a number of discussion topics were prepared. Those considered most relevant for theme 1 have been listed below.

- <u>Biofuels and rural incomes (food security)</u>: Hunger and starvation are caused by a number of factors, incl. poverty and failure in some food markets. The question is therefore whether biofuels can be a source of income for rural communities in the developing world and thereby reduce poverty and, consequently, food insecurity – or whether these potential benefits are counteracted by other implications of bioenergy production (keeping in mind context, practices, geographic levels, and time scales).

- Biofuels and agricultural development in Less Developed Nations: Large parts of the developing world suffer from substantial yield gaps. This is to a high degree caused by decades of no or low investments in agriculture, which in turn is related to lack of access to international markets and/or inability to compete with subsidized agricultural production in other parts of the world. The question is therefore whether an increased demand for conventional biofuel feedstocks could be a driver for much needed agricultural investments in the developing world and, as a result, could have positive spill-over effects on crop production for food – or whether such investments would not impact the yield of food crops produced in the developing world.

- Biofuels and unemployment: In many countries (both developed and developing), rural unemployment rates are high. In some countries, this leads to urbanization. The question is therefore if biofuel policies can reduce rural unemployment and the urbanization trend and thereby have positive socioeconomic effects that are possibly not fully captured by economic equilibrium models – or whether the potential effect on rural unemployment is irrelevant for food security in developed and developing countries.

References

Arndt, C., Pauw, K., Thurlow, J., 2010a. Biofuels and economic development in Tanzania. Discussion paper 966, International Food Policy Research Institute, Washington, DC.

Arndt C, R Benfica, F Tarp, J Thurlow, R Uaiene. 2010b. "Biofuels, poverty, and growth: a computable general equilibrium analysis of Mozambique," *Environment and Development Economics*, 15(01): 81-105.

Arndt C, R Benfica, J Thurlow. 2011. Gender Implications of Biofuels Expansion in Africa: The Case of Mozambique. *World Development,* 39(9):1649-1662. doi:10.1016/j.worlddev.2011.02.012

Clancy, J. 2012. Biofuels and Rural Poverty. Routledge.

Dixon J, A Gulliver, D Gibbon. 2001. Farming Systems and Poverty: Improving farmers' livelihoods in a chaging world. . Food and Agriculture Organization & World Bank, Rome & Washington.

Khwaja, Y (ed). 2010. Bioenergy and Food Security: The BEFS Analysis for Peru: Supporting the policy machinery in Peru. Environment and Natural Resources Management Working Paper no. 40. Food and Agricultural Organization of the United Nations, Rome.

Langeveld, JWA, J Dixon, H van Keulen (eds). 2014. *Biofuel Cropping Systems: Carbon, Land and Food*. Earthscan.

Mitchell, D., 2011. *Biofuels in Africa: Opportunities, Prospects and Challenges*. The World Bank, Washington, DC.
Gasparatos A, P Stromberg (eds). 2012. *Socioeconomic and Environmental Impacts of Biofuels: Evidence from Developing Nations*. Cambridge University Press.

Synthesis of Topic 2: Energy & Food security

Navin Sharma
World Agroforestry Centre, C Block, NASC Complex, DPS Marg, Pusa Campus, New Delhi 110012
Email contact: navin.sharma@cgiar.org

Key issues

Improving the productivity of agriculture is important to reducing poverty and achieving food security objectives. As per one estimate, to feed the 9 Billion people by 2050, the food production needs to increase by 70% with added burden on the land which is becoming scarce.

Modern agriculture requires energy inputs at all stages of agricultural production such as direct use of energy in farm machinery, water management, irrigation, cultivation and harvesting. Post-harvest energy use includes energy for food processing, storage and in transport to markets. In addition, there are many indirect or sequestered energy inputs used in agriculture in the form of mineral fertilizers and chemical pesticides, insecticides and herbicides. Globally, food and agriculture consume 30% of the world's available energy, but produce about 20% of the world's GHG emissions.

Developed countries have benefited in agricultural productivity from scientific advances and easy availability of energy. On the contrary, developing countries have lagged behind in modernizing their energy and technological inputs into agriculture. It is all the more important from a rural development perspective as the access to energy is fundamental for the provision of goods and services that can improve agricultural productivity and bring new opportunities for generating income (Practical Action, 2009). Affordable and reliable energy availability can augment agricultural development by increasing productivity, e.g. through irrigation, and improving crop processing and storage. Renewable energy such as biofuels have the potential to bridge the energy gaps in developing countries by providing local energy sources that can be used to run farm machineries and also providing clean energy sources for cooking. Indeed there are some exciting case studies have emerged in recent past on these area.

However, care must be taken that biofuels and the income they generate are additional to that from existing food production rather than hindering it, and that they do not increase the pressure for land use change. Sustainable and productive feed stocks and systems are needed to ensure that overall farm productivity is sustainably increased, enabling biofuels to be produced over and above the current baseline of food production. To address the issue of LUC and the 'fuel vs. food' debate, it is important that marginal land that is unfit for intense agriculture or the land that is not being used in current agriculture and is additional such as farm boundaries, is considered for

production of biofuels to avoid displacing less commercially attractive food crops from their most suited agro ecologies. It is estimated that there is enough potential from these marginal land to meet the global demand (Ghallagher, 2008).

There is a need to rethink national and global biofuel strategies, especially within the context of smallholder agriculture, so as to focus on livelihood options which biofuels can provide. In this view, biofuels must have positive effects on food security, provide the new sources of income and employment, and also provide alternative sources of energy for rural communities to enable them to step forward in their quest for sustainably intensifying their agricultural practices.

Challenges that need to be addressed:

- How to select suites of species for biofuel development that avoid land use changes.
- Development of biofuels must be pro-poor, support local livelihoods and the environment, promote gender equality and women's empowerment, and contribute to food security. Biofuels production in this view is part of a comprehensive approach to stimulating rural development to reduce poverty and boost food security, a means to an end, and not an end in itself.
- Encourage the diversification into biofuel production without compromising the delivery of other, key ecosystem services: food security, water and nutrient flows and quality, carbon sequestration and biodiversity.
- Understanding the complex relationships between biofuels production and the rest of the functions of the ecosystem: competition and complementarity, short and long term.
- Shaping the policy environment in such a way that the societal benefits are maximised. As everything else in life, these policies will create winners and losers; we need to understand who they are, how they are affected and how equitable solutions can be developed.
- Transform smallholder agriculture into successful agribusiness. The provision of energy is an important part of this effort; corporate private sector investment is a key to achieve this along the value chain.
- Ensuring business models are really inclusive out-grower models; fairness in sharing risks and rewards along the value chain

Discussion topics

In preparation for the workshop on biofuels and food security interrelations, a number of discussion topics were prepared. Those considered most relevant for theme 2 have been listed below.

<u>Energy security and food security</u>: Energy security and food security are connected. Every year, enormous amounts of food are lost, partly due to lack of energy (for cooling/storage and processing). The question is therefore whether bioenergy in the developing world could help reduce food loss and thereby contribute to improved food security – or whether innovation and new business models in this area are unattractive in a food security perspective. Besides, food

losses also occur due to poor of infrastructure. Could biofuels be a driver for improvements in this area with positive spill-over effects on food security?

Synthesis of Topic 3: Environmental Security

Helen Watson
Environmental Sciences, University of KwaZulu-Natal, Westville Campus, South Africa
Email: watsonh@ukzn.ac.za or Lewson2012@gmail.com

Key Issues

Land use changes associated with the preparation for and production of **ALL**[1] crops potentially have very significant direct and indirect, short and long term, positive and negative effects on all earth systems:-

Atmosphere: removing natural vegetation and existing crop cover may result in more greenhouse gases (GHG)[2] being admitted to the atmosphere from both above and below ground stocks than the replacement crop is able to sequester from the atmosphere. With bioenergy crops, sequestration of carbon and fossil fuel substitution will "pay back" the carbon emitted to the atmosphere over a number of years. This payback period is termed "the carbon debt". Land preparation that involves burning or exposing plant litter and soil organic matter to rapid decomposition creates a high carbon debt. The carbon debt is lowest when planting up carbon poor, sparsely covered, abandoned, and/or degraded lands. It is higher when converting inherently carbon rich land covers like forests as compared to grasslands or croplands. It is highest when converting "carbon sink" land types like peatlands, lower river plains and deltas (FAO/UNEP/UN-Energy, 2011).

Lithosphere: burning and exposing soil organic matter to rapid decomposition destroys the aggregate structure of soils resulting in surface compaction and sealing. The net consequences of which, are decreased infiltration of water, increased runoff and aridification of the soil on-site, and increased erosion off-site. Intensive, long- term, monoculture cultivation depletes soil nutrients resulting in increased chemical fertilizer application. These fertilizers acidify the soil, leach through it and get carried away in runoff. Ultimately, they enrich and accelerate the euthrophication of wetlands, rivers, dams, lakes and estuaries. Irrigating with brackish water and/or irrigating areas with very high evaporation rates results in soil salinization. Planting up sparsely covered, abandoned, and/or degraded lands with bioenergy crops can improve soil quality and productivity restoring the ability of these lands to support food crops. UNEP (2009) describe the ability of (a) switchgrass to substantially enhance the soil's organic matter content, (b) leguminous nitrogen-fixing bioenergy crops to improve soil fertility, (c) halophytic bioenergy crops to thriving in saline soils while reducing their salt content, and (d) willow thriving in soils polluted with heavy metals while reducing the content of these contaminants. Jatropha is planted in rows in fields under food and cash crops to

[1] Human food and/or animal feedstock crops, cash crops, industrial forests, bioenergy feedstocks and fuelwood plantations.
[2] GHG e.g. carbon, methane, and nitrogen oxides

reduce soil erosion by wind and surface runoff. This biodiesel plant is capable of growing in semi-arid regions where high wind speeds and crusting of the soil surface are prevalent (Boccanfus *et al*., 2013).
Hydrosphere: soil erosion associated with land preparation and crop production, and fertilizer use decrease water quality and the storage capacity of water bodies. Irrigation can decrease the quantity of water available for other particularly down-stream, users.
Biosphere: the nature, intensity, and temporal and spatial scale of the detrimental effects on the biosphere of **ALL** crops are dependent on:-
(a) the habitat or the crop being removed, of particular concern are habitats (i) containing keystone, rare, endangered or endemic species, (ii) critical to regulating ecosystem services, and (iii) that provide livelihood products[3] for indigenous communities,
(b) removal methods e.g. machines used to pull out tree roots and transport away tree trunks, burning branches and leaf litter, etc.,
(c) land preparation for the replacement crop e.g. use of machines to terrace slopes and create contour bunds, the extent to which the natural habitat is fragmented into isolated pockets, and the margin of riparian vegetation left undisturbed,
(d) what crop/s is/are grown, and
(e) how the crop/s is/are grown.
Flora and fauna not directly affected by habitat removal may be subsequently affected by increased inter and intra species competition by displaced species, habitat fragmentation and increased conflict with humans. Campbell and Doswald (2009) note that particular concerns regarding bioenergy crops are that they may become invasive, and/or cause a decline in bee populations needed to pollinate food and other crops in the vicinity.

Addressing Key Issues

Given that **ALL** crops potentially have detrimental effects on environmental security, the first step in combating them is to ensure that “good” agricultural practices are in place. These vary dependent on the climatic, edaphic and terrain characteristics of a particular locality and the crop grown. They include use of landscape ecology principles in leaving natural habitat corridors linking larger areas of natural habitat; using improved breeds; agroforestry and intercropping; minimum tillage; integrated pest management; and many others. The efficiency of these good practices has been verified over decades at research institutes in many parts of the world. Their implementation has been recommended and demonstrated by government extension services and companies associated with farmers supplying specific crop/s throughout the world. The fact that “bad” agricultural practices persist today is more often a function of land tenure insecurity than lack of knowledge. While policies and legislation to combat “bad” agricultural practices exist in all countries, the efficacy of their enforcement varies. In South East Asia for example, poor enforcement encourages palm oil producers to clear forests rather than use abandoned agricultural land because in doing so they use less fertilizer and hence have higher profits.

[3] Fuelwood, construction materials, traditional medicines, fruit, bushmeat, honey, etc.

The following have been developed to specifically ameliorate the potential detrimental environmental effects of bioenergy feedstock production:-

(a) FAO/UNEP/UN-Energy's (2011) Bioenergy Decision Support Tool. This Tool employs Geographic Information Systems (GIS) to interrogate climatic, edaphic, terrain and potential natural vegetation cover to identify where it is suitable to plant a particular bioenergy feedstock. The GIS is then used filter out "no-go" areas i.e. protected, High Conservation Value (HCV), in use for food and/or cash crops, and to interrogate data on infrastructure, settlements, historic sites, sites of cultural significance, animal migration corridors, routes used by pastoralists and areas of inherent animal-human and human-human conflict. The areas identified as suitable and available for particular bioenergy feedstock/s then need to be verified in the field. IRENA[4] and GBEP[5] aim to complete the Bioenergy Component of The Global Atlas for Renewable Energy this year, which will show these areas.

(b) Bioenergy policies and strategies e.g. certification, to implement them. [6]They mandate the use of "good" agricultural practices. They discourage the use of irrigation and arable land, while encouraging the use of abandoned, marginal and degraded lands. They additionally encourage integrating energy and food crops, better use of co-products, and increased cropping intensity. Sedjo *et.al*. (2013) describe how large amounts of industrial forest and fuelwood plantation biomass can be economically produced on sub-marginal lands. Langeveld *et.al.* (2013) detail the by-products of biofuel production processes used as animal feed and the increases in cropping intensity, and conclude that expansion of biofuel between 2000 and 2010 in the major biofuel producing countries was not associated with a decline in net harvested area available for food crop production.

Contemporary Constraints to Addressing Key Issues

In developing countries the wider use of the Bioenergy Decision Support Tool is constrained by (a) poor resolution GIS data, (b) the concern that the only available "old" protected area data may not be valid, and (c) the fact that many HCV areas are still in the process of being delimited and validated. It is uncertain whether the Bioenergy Component of The Global Atlas for Renewable Energy will be able to address these concerns in the near future. There remains a great deal of controversy over the definition of and merits of using non-arable, degraded and abandoned land. The controversy essentially focuses on two aspects. The first, being the need for investors to have incentives to use these non- economically viable lands. The second, being that degraded and abandoned land left alone may develop a rich biodiversity more efficient in GHG sequestration than the bioenergy feedstock. While certification is active and widespread, criticism that standards do not focus enough on how bioenergy crops are grown, persist.

Discussion topics

[4] International Renewable Energy Agency

[5] Global Bioenergy Partnership

[6] In most countries these policies have been revised to not only focus on fuelwood, charcoal, woodlots, and woodland and forest management, but to include biofuel feedstocks production, and use of crop residues and waste, as well.

In preparation for the workshop on biofuels and food security interrelations, a number of discussion topics were prepared. Those considered most relevant for theme 3 have been listed below.

- Integrated food and biofuels projects: The idea of integrated food and energy systems (IFES) is to produce food and energy together. The question is whether food systems with a biofuels or, more generally, a bioenergy component can help to improve food security above current levels, e.g. by diversifying value streams, reducing market vulnerability of the system, de-risking investments, and ultimately increasing food availability (and energy production) above the baseline – or whether such synergies are unattainable.

References and Suggested Readings

1. Boccanfuso, D., Coulibaly, M., Timilsina, G.R., and Savard, L., 2013: Macroeconomic and Distributional Impacts of Jatropha-based Biodiesel in Mali, June Policy Research Working Paper 6500, Environment and Energy Team, Development Research Group, The World Bank, pgs 1-39.
2. Campbell, A. and Doswald, N. (2009) The impacts of biofuel production on biodiversity: A review of the current literature. UNEP-WCMC, Cambridge, UK.
3. FAO/UNEP/UN-Energy, (2011) Bioenergy Decision Support Tool: Land Resources – Module 5, http://www.bioenergydecisiontool.org
4. Langeveld, J.W.A., Dixon, J., van Keulen, H. and Quist-Wessel, P.M.F. (2013) Analyzing the effect of biofuel expansion on land use in major producing countries: evidence of increased multiple cropping, *Journal of Biofuels, Bioproducts and Biorefining.* DOI: 10.1002/bbb.1432.
5. Sedjo, R.A., Sohngen, B. and Riddle, A. (2013) Wood bioenergy and land use: A challenge to the Searchinger hypothesis, *Journal of Industrial Biotechnology*, 9, 6, 319-327.
6. UNEP, 2009. Towards sustainable production and use of resources: Assessing Biofuels, UNEP, Paris.

Synthesis of Topic 4: Biofuels and Food Price Volatility

Keith Kline
Oak Ridge National Laboratory
Please send comments to: klinekl@ornl.gov

Key Questions:

1. Why be concerned about price volatility? How does crop price volatility affect food security in developing nations?

2. What are the linkages between domestic biofuel policies, crop prices and food price volatility?

3. What interactions and feedbacks among energy markets (with and without biofuels), biofuel feedstock commodity markets, and food prices are most important for food security?

4. What do analyses suggest about the effects of current biofuel policies in US and Brazil on food markets, food consumption patterns, and health?

5. How could biofuel policies be designed to contribute to price stability, food security and improved human nutrition and welfare in other parts of the world?

Issues, including linkages with food security: Food price volatility, *defined as large, sudden changes in market prices of staple foods*, may contribute to food insecurity in several ways. Sudden increases in prices make food less affordable for non-producers such as urban poor but may improve livelihoods in rural economies that depend on agriculture. Sudden declines in prices may be more detrimental in the long run, as they undermine local production capacity and investment in local food production supply chains. Price crashes also catalyze rural to urban migration and increase rural poverty and food insecurity. More stable and predictable food prices that support local investment in food production are desirable for enhanced food security.

One hypothesis among policy makers, modelers and the general public is that government programs to support biofuels cause higher food prices, contribute to greater price volatility, and impact human welfare by increasing food insecurity. The United Nations Committee on Food Security has proposed that large bioenergy programs such as the Renewable Fuel Standard in the U.S. be studied to determine if temporary suspension during times of upward price shocks could alleviate food price crises.

Relevant questions and dimensions: What are the relationships among price volatility for staple foods in developing nations, fossil energy prices, bioenergy policies, and food security? What are the key linkages and mechanisms that allow bioenergy policies in one place to influence food prices, fossil energy prices and food security in other places? How would relationships change if future bioenergy is primarily derived from advanced processes (e.g., wastes and cellulosic resources)? How does the food-biofuel price debate affect investment and development of socially and environmentally responsible energy sources to meet human needs? How sensitive are the answers to the scale (local, national, or global), type of analysis (economic model, statistical analysis, etc.) and choice of data? What conclusions can be drawn from the analysis of historic data from the US and Brazil, the worlds' two largest biofuel producing nations? What evidence is there from smaller nations with established biofuel blending policies (e.g. Malawi)? What factors, contexts and policy attributes tend contribute to volatility versus price stability?

- What we (think we) know:

a) Food price volatility is caused by unexpected events and combinations of events which lead markets to react with sudden buying or selling.
    i. Volatility can be exacerbated by "crisis mentalities" in governments and markets (e.g., simultaneous efforts in futures markets to buy/stockpile to profit from or mitigate exposure to expected future supply shortage, or rapid selling to reduce losses due to expected future excess supply).

ii. Good data on current and projected stocks and supply-to-demand ratios reduces price volatility and provides producers and consumers with more certainty for investment planning. Some speculation in futures markets, such as that based on accurate data projections, can be a mechanism that dampens volatility by providing advance price signals to producers.

iii. Government intervention in markets, inaccurate or manipulated data (e.g., unreported hoarding, storage, or new production), and sudden, unforeseen changes in policies that affect supply or demand, tend to increase price volatility.

b) Food price volatility nearly always involves or is made worse by weather variations in food producing regions.

c) Food price volatility consistently follows sudden price shocks in world oil markets (along with most other globally-traded commodities).

d) Food price volatility increases when national policies change suddenly, e.g., to "protect local interests" by restricting exports or changing tariff/tax/trade terms.

e) Some dimensions of food security – consistent access and availability to local produce and investment in local production capacity – are undermined if food prices are held artificially low. [Persistent "food aid" and food subsidies reduce investment and the ability of local farmers to compete in the marketplace].

f) Nearly 90% of global biofuel production is based on feed grains (mostly maize) and sugarcane. Predominant uses for these feedstock commodities are production of beef (with maize) and sweeteners (sugar and high-fructose corn syrup-HFCS from maize).

g) Global population suffering from undernourishment has been declining over past decade of biofuel expansion and is now 0.8 billion (FAO 2014), while global population suffering from inappropriate consumption including too much beef/sugar in diets is estimated to exceed 1 billion and is increasing (WHO 2013).

- Contentious issues obstructing common understanding:

1. The degree to which biofuel policies increase, decrease or have no effect on price volatility in staple food and energy markets.
2. Lack of understanding of causes of food insecurity in part due to the lack of consistent definition and measurement of "food insecurity" and "food price crisis."
3. Understanding of what factors are most important in causing human suffering associated with food price volatility.
4. Understanding of most effective mechanisms to relieve suffering from food price volatility.
5. Understanding the differences between industrial commodities such as "yellow corn #2" and food staples. Rice (staple for 50% of humanity and 85% of regions suffering food insecurity) along with wheat, millet, cassava, sorghum and white maize – are primary staples for regions with food insecurity.

6. Lack of careful analysis of the amount of productive land available for agriculture in the world and the belief that land is the limiting factor affecting food price volatility.
7. Understanding the capacity of national agricultural sectors and their abilities to respond to market signals.
8. Representation of national biofuel policies in model simulations and analyses. For example: Contrary to common modeling approaches, if a policy sets long term goals for incremental increases in biofuels and is transparent, the policy does not create a market demand "shock" because producers foresee the demand. And if the policy includes flexibilities to adjust to extraneous market shocks (e.g., drought), then the biofuel policy can serve as a "shock absorber." The effects of biofuel policy are distinct from the effects from an unexpected drought, or sudden changes in import/export policies in major supplier/consumer nations, or sudden changes in global stock estimates due to unreported stores/hoarding, etc.

Recommended actions: Test selected hypotheses and address research priorities defined in workshop.

Suggested readings and References:

- Arezki et al. 2014. Understanding international commodity price fluctuations. Journal of International Money and Finance 42 (2014) 1–8
- Babcock, B. A. (2011 June). The impact of US biofuel policies on agricultural price levels and volatility. . International Centre for Trade and Sustainable Development (35)
- Charles, C. (2012 April). Should we be concerned about competition between food and fuel? International Institute for Sustainable Development.
- Defra 2010 The 2007/08 Agricultural Price Spikes: Causes and Policy Implications. HM Government, United Kingdom.
- de Gorter, H., & Just, D. R. (2010). The social costs and benefits of biofuels: The intersection of environmental, energy and agricultural policy. Applied Economic Perspectives and Policy.
- Economic Research Service, Amber Waves, 10(2 (June)), 2012.
- Durham, C., Davies, G., & Bhattacharyya, T. (2012, June). Can biofuels policy work for food security? Department for Environment Food and Rural Affairs.

- FAO, IFAD, IMF, OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI, and the UN HLTF. (2011, June 2). Price volatility in food and agricultural markets: Policy responses. Policy Report for the G-20 .
- Fischer, G., van Velthuizen, H. & Nachtergaele, F. 2011. GAEZ v3.0 – Global Agro-ecological Zones Model documentation, (mimeo). IIASA, Luxemburg.
- King R (Oxfam), Kelbert A (IDS), Chisholm N (University College Cork), Hossain N (IDS). 2014. Help Yourself - Food Rights and Responsibilities: Year 2 findings from Life in a Time of Food Price Volatility. Joint Agency Research Report. www.ids.ac.uk and www.oxfam.org
- Langeveld, H., Dixon, J., and van Keulen, H. 2014. Biofuel cropping systems: carbon, land and food. Routledge Earthscan, Abingdon, UK. ISBN13: 978-0-415-53953-1
- Locke, A., Wiggins, S., Henley, G., & Keats, S. (2013 April). Diverting grain from animal feed and biofuels. London : Overseas Development Institute.
- McPhail, Lihong Lu, & Du, X. (2012). Ethanol Strengthens the Link Between Agriculture and Energy Markets.
- Peterka, A. (2012 31-July). Livestock groups urge EPA to waive ethanol mandate. Governors' Biofuels Coalition.
- Schafer, E. (2012 8-March). Proposed RFS changes spark food vs. fuel debate. Feed & Grain.
- Strassburg BBN, Latwiec AE, et al., 2014. When enough should be enough. Improving the use of current agricultural lands could spare natural habitats in Brazil. Glob.Env.Change 28 84-97.
- Tyner, W. E., Taheripour, F., & Hurt, C. (2012 16-August). Potential impacts of a partial waiver of the ethanol blending rules. Farm Foundation and Purdue University.
- Wright, B. (2011, February). Biofuels and food security: Time to consider safety valves? . IPC Policy Focus, International Food and Agricultural Trade Policy Council.
- Alexandratos, N. and J. Bruinsma. 2012. *World agriculture towards 2030/2050: the 2012 revision.* ESA Working paper No. 12-03. Rome, FAO
- CBES. 2009. *Land-use change and bioenergy*. Report from the 2009 workshop, ORNL/CBES-001, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy and Oak Ridge National Laboratory. http://www.ornl.gov/sci/besd/cbes.shtml .

- Dale VH, KL Kline, LL Wright, RD Perlack, M Downing, RL Graham. 2011. Interactions among bioenergy feedstock choices, landscape dynamics and land use. *Ecological Applications* 21(4):1039-1054.
- FAO and IIASA. 2007. Mapping biophysical factors that influence agricultural production and rural vulnerability. Food and Agriculture Organization and International Institute for Applied Systems Analysis, Rome, Italy.

Synthesis of Topic 5: Institutions, innovation and consequences of inaction

Lee Lynd
Dartmouth College, USA
Email: Lee.R.Lynd@Dartmouth.edu

Key questions: What are the key interactions among "governance" and institutional capacities, technological innovations, biofuels and food security? Are there "pre-requisite" conditions that must be considered to address food security concerns and develop biofuels? What can be learned from experiences to date? What are the consequences of inaction, including interactions among food security, bioenergy and climate change mitigation and adaptation strategies?

Scope. In light of multiple demands on finite land resources combined with the complexities of adding large-scale bioenergy to already complex land use choices and challenges, it is common to take an "other renewables first" approach to bioenergy. Yet the complexity and diverse interactions that motivate caution with respect to bioenergy also give rise potential benefits in terms of energy supply, the environment, and social development. There is increasing recognition that bioenergy will be needed in order to sustainably provide fuel for long distance travel and some industrial applications (1,2). Consistent with this, bioenergy provides on average 25% of primary energy supply in five prominent low-carbon energy scenarios for 2050 (3). Although social consequences of bioenergy development have often been an afterthought rather than an integral part of project planning, impacts of bioenergy on food security and economic development have in some cases been demonstrably positive, with Brazil providing a prominent example (4). Looking forward, and in particular imagining that development objectives become an integral component of project planning, modern bioenergy has potential to contribute to social transformation in developing countries (5). The future course of bioenergy, including its sustainability impacts in all dimensions, will depend to a significant extent on institutional aspects and innovation. As well, it is instructive to compare the risks and challenges of action in the bioenergy domain with the risks and challenges of inaction.

Institutional. Good governance is widely recognized as critical in order to maximize sustainable bioenergy outcomes, and yet is lacking in many areas of the world where bioenergy could be most beneficial (6). Since both positive and negative impacts of bioenergy cut across sectors, institutionally-inclusive multi-sector legislative structures

will be more effective at maximizing the social benefits of bioenergy as compared to institutionally exclusive, single sector structures (5). Given the desirability of melding commercial and social objectives, and in some cases compensating for absent governance structures, there appears to be considerable scope for innovative public-private partnerships.

Innovation. In addition to the institutional innovations considered in the prior paragraph, most scenarios for a sustainable energy future involve substantial technical innovation. This is true for bioenergy, as well as other energy technologies, with conversion of "2nd generation" cellulosic feedstocks being a prominent example although by no means the only one. Technological innovation can be at several levels – e.g. unit operation, in-process integration, and integration of bioenergy processes with other material and energy flows in the economy – and also involves somewhat different considerations at village and industrial scales.

Risks of Inaction. Looking back over the past decade, much of the world saw a period of great optimism about bioenergy in the 2005 to 2008 timeframe, when unprecedented public and private sector investments were made around the world and expectations were very high. Since then, the pendulum has swung rather decisively toward a more sober if not critical assessment. While these sober assessments have tended to emphasize the risks of action with respect to bioenergy, it is relevant also to consider risks of inaction – which some argue are greater today. A middle path that minimizes both risks is likely possible and certainly desirable.

Discussion topics. In preparation for the workshop on biofuels and food security interrelations, a number of discussion topics were prepared. Those considered most relevant for theme 5 have been listed below.

- The consequences of inaction: Climate change is a serious problem that can or will have substantial adverse effects on toady's food production system. Biofuels hold the potential to partly mitigate climate change and thereby reduce these adverse effects. The question is what the net effect will be.

- Agricultural productivity: Crop and agribusiness product research has focused on traditional crops and traditional food, fiber, and feed products producing substantial improvements in the past, but forecasts of further improvements are more modest. Forecasts of the ability of agriculture to meet the increasing demands placed on it are primarily based on these estimates of the low rate of improvements in genetic yield potential, implemented through local agricultural managers. Biofuels change the mix of crop characteristics being desired for a broader use for agriculture. This has led to investigations of entirely new crops (i.e. Jathropa and Arundo donax) and entirely new mixes of features in existing crops (e.g. sugarcane high in both sugar and fiber). The potential from underexploited traits in these new crops and existing crops has not yet been fully explored. Can the presence of this new market open up an opportunity to increase agricultural productivity from the same agricultural footprint sufficiently

to reduce forecast land requirements in the future? Alternatively, is the productive potential of crops sufficiently limited to make bioenergy more like a zero sum game, effectively further reducing the productive potential of agriculture for meeting food, fiber, and feed markets.

References.

1) The Energy Report: 100% Renewable Energy by 2050. http://www.ecofys.com/files/files/ecofys-wwf-2011-the-energy-report.pdf.

2) Fulton, L., L. R. Lynd, N. Greene, Alexander Körner, Luke R. Tonachel. The need for biofuels as part of a low carbon energy future. Submitted.

3) Dale, B.E. et al. (14 coauthors). Take a closer look: Biofuels can support environmental, economics, and social goals. Env. Sci. Technol. (in press).

4) Assato MM, deMoraes MAFD: *Impactos sócio-econômicos da expansão do setor bioenergético no Estado do Mato Grosso do Sul: os casos dos municípios de Nova Alvorada do Sul e Rio Brilhante.* Corecon, São Paulo; 2011. Summarized in English in reference 5), below.

5) Lynd, L.R. et al. (11 coauthors including several Africans and Brazilians). Bioenergy and African transformation. Submitted.

6) Practical Action Consulting: Liquid Biofuels Strategies and Policies in Selected African Countries. Policy Innovation Systems for Clean Energy Security. *Edinburgh,* 2011.

Synthesis of Theme 6
Integrating Food & Biofuels Production
Issues on land use improvement, choice of food and feedstocks, yields, soil fertility, technologies, economics, trade and social development evaluated under food&fuels integration

Jeremy Wood
Center for Environmental Policy, Imperial College, London
Email: jeremy.woods@imperial.ac.uk

Glaucia Souza
Dept. of Biochemistry, University of São Paulo
Email: glmsouza@iq.usp.br

Key issues

Among the renewable energy options bioenergy is the one whose benefits spread across most sectors of society. When bioenergy is produced using the correct practices it can contribute to food security, environmental and climate security, sustainable development and innovation. Like most and likely all modern technologies, bioenergy can lead to negative impacts if misused and monitoring and good governance is required to ensure positive outcomes. In its interactions with our food production systems it is not possible to treat bioenergy and agricultural problems as separate problems. Food and bioenergy sinergies can make an enourmous difference for developing countries to achieve food security. Bioenergy in rural regions can improve energy access and water acces that can impinge positively in food security (i.e. transportation, stability) and poverty reduction as well as human health. There is an urgent need to move away from the traditional use of bioenergy (burning wood for cooking and heat) that kills millions of lives due to indoor pollution and is a cause of deforestation. The desire to create stronger synergies between the production of bioenergy and food within the bioeconomy is an objective that exists both at the level of policy and within the commercial objectives of private sector entrepreneurs and an argument can be made to include also in the discussion our current ethics on providing for food for people in a time of climate change without accounting for agricultural impacts on the environment and ecosystem services.

In this topical theme, we raise a number of important questions that need to be addressed by research and technology development which are indicative of the cross-cutting interactions between bioenergy, our environment and food production that need to be understood.

- What are the sinergies that can arise when food and energy crops cultivation is integrated? Agriculture modernization is paramount to decreasing impacts? How can we improve land use?
- Can food production improve bioenergy production and vice versa? How can we translate the positive synergies into economical activities across the globe that contribute to our urgent need for sustainable food and energy?
- How do we construct soil fertility? What is the role of soil carbon? Can input use be optimized in food-energy-integrated systems?
- How can bioenergy and agriculture integration resolve local infrastructure issues? And capacity issues?
- What are the issues in food and energy trade systems? Tariffs, subsidies, commoditization.
- Are CO_2 accounting mechanisms adequate in food and bioenergy systems?
- What role do productivity improvements play in creating stronger synergies?
- How do technologies facilitate full biomass utililization and use of agricultural residues in a way that benefit the environment?
- Can bioenergy transform agriculture into a fully renewable process?
- Can agro-forestry integration be a tool to improve soils and ecosystem services?
- What are the important policy issues regarding food-feed-energy integration?

- How can we disseminate knowledge of emerging sustainable practices? Which are the organizations that can address knowledge dissemination in an integrated manner?

Each of the points raised above has its own implications for how a strong knowledge-based, global bioeconomy might develop in the future, which has synergistic links between biofuels and food production.

Case studies: Short presentations of case studies are encouraged to address questions and issues
above, and to help build understanding among workshop participants about: what is known, what requires more analysis, what guidance can be provided to assure synergies in the future projects, and what can be done to overcome current barriers to biofuel developments that reduce food price volatility for at-risk nations.

Recommended actions: Identify cases that help illuminate strategies and approaches that integrate biofuels to simultaneously improve welfare, energy security and food security. We hope to identify specific opportunities to address research priorities defined in workshop.

A.5. Outputs from breakout sessions

Synthesis of discussions from Day 1 and 2 on Topic 1: Economic Security & Development

Session 1

Economic Security & Development

THEMATIC DISCUSSION TOPIC

WHAT IS KNOWN, SUPPORTED BY EVIDENCE

- **Ag. sector and value chain development (R&D) – bioenergy sector growth (Brazil, CTC, Embrapa)**
- **Market-driven impacts (Malaysia)**
- **Mixed industrial and small-holder (Malawi, sugar-based ethanol)**
- **Infrastructure and human capacity is a key element (worked – Central and South Brazil, hasn't worked – Mozambique and Angola)**
- **Critical combination of political will, economy and enforcement (Brazil, US (RFS/LCFS), Sweden)**

Session 1

Economic Security & Development
THEMATIC DISCUSSION TOPIC

KEY ISSUES and GAPS BLOCKING UNDERSTANDING

- Public / political perception of "fuel vs. food"
- Micro-level evidence from the field (sub-regional picture)
- How to couple bioenergy to rural development in LDC context (gasification, mini-grids, etc.)

FUTURE RESEARCH POSSIBILITIES

- Accounting of externalities in pricing of conventional / renewable fuels
- Understanding how to break the vicious cycle to a virtuous cycle (better ag. food and bioenergy production)
- More in-depth analysis at regional and local scale

Session 2

Economic Security & Developement
THEMATIC DISCUSSION TOPIC

RECOMMENDATIONS for FUTURE RESEARCH ACTIVITIES (what, how, who, where)

- **Find quantifiable targets for sustainability of energy-food systems at local/practical scale**
- **More research on all food & feedstock crops that are regionally-relevant (understanding co-products) [focus on energy traits)**
- **Socio-economic dimensions of bioenergy impacts – looking at the local-scale effects (labor, hhold characteristics)**

RECOMMENDATIONS for DEPLOYMENT (what, how, who, where)

- **Training/capacity-building programs at all levels (scientists, policy/govt, business/commercial)**
- **Knowledge-sharing (proven technologies)**
- **Making better use of analytical tools that are out there at local-level prior to initiating projects (BEFS, land tenure analysis, spatially-explicit impact assessment)**

Synthesis of discussions from Day 1 and 2 on Topic 2: Energy Security

Session 1

Energy Security

THEMATIC DISCUSSION TOPIC

WHAT IS KNOWN, SUPPORTED BY EVIDENCE

- Depending on development status: developed countries, developing countries
  Political: Mandates, subsidies, local energy provision
- Economic Local Energy for Smallholder Farmers: Biofuels for farm machinery, assured market
- Trade-offs between fossil fuels and bio-fuels.
  -Current fossil fuel cost and availability

  -Local energy offsets imports

Session 1

Energy Security
THEMATIC DISCUSSION TOPIC

KEY ISSUES and GAPS BLOCKING UNDERSTANDING

- Value Chains
- Not at expense of Food Security
- Policy
- Land Tenure
- Trade off examples
- Capacity Building & Information

FUTURE RESEARCH POSSIBILITIES

- Assess potential of sustainable bioenergy development
- Local Knowledge, scaling up
- Regional Planning
- Socio-economics
- Adaptation of successful model from small holders
- How to avoid Land Use Change (make LUC "sustainable")
- Look for areas of mutual support

Session 2

Energy Security
THEMATIC DISCUSSION TOPIC

RECOMMENDATIONS for FUTURE RESEARCH ACTIVITIES (what, how, who, where)

- **Do the developments in developed countries really affect food security in developing countries**
- **Development of standard methodology for forecasting (models)**
- **What is the best biofuel production system for developing countries: whether existing models of developed countries or whether there is need for an alternative system specifically for small holder farmers**

RECOMMENDATIONS for DEPLOYMENT (what, how, who, where)

- **Value chain analysis – country/context specific**
- **Policies**
- **Market development**
- **Capacity building**

Synthesis of discussions from Day 1 and 2 on Topic 3: Environmental Security

Session 1

Environmental Security
THEMATIC DISCUSSION TOPIC

WHAT IS KNOWN, SUPPORTED BY EVIDENCE

- **Can have detrimental impacts in growing feedstocks under certain conditions (Synthesis points) Can have beneficial effects of production system; both are context specific, so management practices need to be context specific and is influences by prior land use.**
- **Farm production – impact is same regardless where crop goes, so with flex crops, analyze the final environmental impacts and transforming chain (entire supply chain). What we know: water contamination potential (I.e., vinasse – liquid biproduct from sugar fermentation process. Can be used for soil amendment but past practices have disposed in waterways. Can enrich DDS for animal feed.**
- **Certification needs to support systemic rotation schemes - certification need to look at whole farm management system rather than annual crops. (Case study in Argentina – soy bean certification requires planting every year to keep certification.)**
- **Environmental effects occur across the supply chain. When we analyze food and energy**

use, we need to include alternative energy uses that would be employed without the use of biofuel. A tradeoff analysis.

- Detrimental or beneficial effects of growing biofuels on waste/marginal land. Ecosystem services (global are important) but local ecosystem services get lost. Stakeholder engagement for identification of local environmental, social, economic services…
- Abengoa and POET-DSM both have plans in place to make sure too much residue is not removed. Gap for replicability is lack of consistent, site-specific data in other countries.
- Gap – where is the benefit for the farmer. Africa-specific extension/education about successes in other areas of Africa where it makes a real difference in their lives. Mali has cotton fields surrounded by jatropha hedges. (Research possibilities – outreach and education of small-scale successes.)
- Consider all generations of biofuels and their individual requirements (also across entire supply chain).
- Apply feed production practices of intensification of production and combination of feeds to minimize negative effects to land. Problem with that is that we don't know ecosystem services that unused pasture is providing. Also, it may actually be used in a less recognized way.

Session 1

Environmental Security
THEMATIC DISCUSSION TOPIC

KEY ISSUES and GAPS BLOCKING UNDERSTANDING

- Misleading studies (e.g., LCAs), especially on second generation
- Allocation factors applied when different type of products are produced
- Lack of knowledge regarding use of marginal lands
- Lack of knowledge on residue management and use – effect on soil organic content and productivity
- Data gap – better case studies (farm residue use and the implications on the variety of environmental effects)

FUTURE RESEARCH POSSIBILITIES

- **GHG emission on farm and broader scales. Regions and subregions. Soils, biodiversity, air quality, jobs, in an integrated perspective. There integrated with food production. Stakeholder engagement in analyzing these benefits and costs (tradeoff).**
- **Second gen biofuels GHG balance**
- **Abandoned lands – isolation may make it "marginal" but once you put in a road, it is no longer marginal.**
- **Public scare of indirect LU is cutting down rain forests – intensification driven by gov't policy is actually what occurs – do analysis and see if this scare is validated. Where does this cross over with communication science? (This area needs some myth-busting – economic models told an incomplete story.)**
- **Integration between different biofuels – co-generation and use within plant. See what the impacts are of integrating these.**
- **Models need to be adjusted at field level re water erosion, wind, etc.**
- **When LU changes, we need studies of what really happened**
- **Confusion of terminology in literature – can we drive towards**

Session 2

Environmental Security

THEMATIC DISCUSSION TOPIC

RECOMMENDATIONS for FUTURE RESEARCH ACTIVITIES (what, how, who, where)

- **DO AGRICULTURE DIFFERENTLY – INNOVATIVE SUSTAINABLE INDUSTRIAL AGRICULTURAL CONCEPTS AND PRACTICES**
- **INTENSIVE WHOLE VALUE CHAIN RESEARCH – WHOLE TRANSFORMING CHAIN REGARDING LCA (INCLUDES ALL PRODUCTS [FOOD, FEED, FIBER, AND FUEL])**
    - Validate model outcomes with field studies to help decision makers
- **SOCIAL AND ENVIRONMENTAL APPROPRIATENESS FOR DIFFERENT BIOCLIMATIC REGIONS**
    - CONSIDER ALL PRODUCTS, TECHNOLOGIES, AND EXTERNALITIES
    - RESEARCH HOW TO IMPLEMENT CHANGE IN PUBLIC PERCEPTION

RECOMMENDATIONS for DEPLOYMENT (what, how, who, where)

- **Agriculture and energy segments in governance integrate better**
- **Facilitate stakeholder engagement with those who are producing food and bioenergy products**
- **Develop and implement communications strategy to educate public about potential food security and environmental benefits**

Session 1

Biofuels & Food Price Volatility
THEMATIC DISCUSSION TOPIC

WHAT IS KNOWN, SUPPORTED BY EVIDENCE

- **Can have detrimental impacts in growing feedstocks under certain conditions (Synthesis**

Session 1

Biofuels & Food Price Volatility
THEMATIC DISCUSSION TOPIC

KEY ISSUES and GAPS BLOCKING UNDERSTANDING

- **Misleading studies (e.g., LCAs), especially on second generation**

FUTURE RESEARCH POSSIBILITIES

- GHG emission on farm and broader scales. Regions and subregions. Soils, biodiversity, air quality, jobs, in an integrated perspective. There integrated with food production. Stakeholder engagement in analyzing these benefits and costs (tradeoff).

Session 2

Biofuels & Food Price Volatility

THEMATIC DISCUSSION TOPIC

RECOMMENDATIONS for FUTURE RESEARCH ACTIVITIES (what is most important?)

- **Differentiate between effects on food security in the developing world, food security in developed world, and other common measures (global CPI and commodity prices).**
- **Document the effects of diversification and multiple feedstocks for multiple markets. Brazil example as case study.**
- **More analysis of the empirical evidence/case studies on transmission mechanisms from international commodity markets to local ones in underdeveloped countries.**
- **Develop public (global) knowledge sharing mechanisms and make more case studies available to consider price transmission mechanisms and policies to address them.**
- **Develop country-specific monitoring and analysis capacity (knowledge base) on commodity price transmission.**

RECOMMENDATIONS for DEPLOYMENT (what, how, who, where)

- **Make sure policy objective is clear first, then design the most efficient policy.**
- **Note the differences between food security and coping mechanisms at household level versus national policies and national scale data (CFPI) related to food security.**
- **If you are going to have a policy, make it flexible. Don't pick "winners and losers."**
- **Direct support towards feedstock-flexible plants (in order to increase resilience and options for substitution)**
- **Integrate data collection and analysis on energy sources/use and fuels at the household level and increase access to it (as complement to the World Bank household surveys).**
- **Communicate the differences between commodity volatility (e.g., national and global commodity price indices) and food price volatility (e.g., particularly volatility in prices for staple foods for more vulnerable, low-income populations).**

Synthesis of discussions from Day 1 and 2 on Topic 5: Institutions, Innovation and Consequences of Inaction

Session 1

Institutions, Innovations, Consequences of Inaction

THEMATIC DISCUSSION TOPIC

WHAT IS KNOWN, SUPPORTED BY EVIDENCE	CASE STUDIES/RESEARCH PROJECTS
❖ Tout role in energy security at smallholder level.	Sweden/Finland
Cross cutting role of government.	Ecowas in Africa
Bioenergy has cross sector impacts.	Malawi for ethanol
	Brazil: mixed role for government

- Need for innovation in technology and institutions. Need to imagine possibilities beyond current reality. Learn from models.

  Public private partnerships – government catalyzes innovations, invests resources.

  Poet DSM
  Abergoa

- Continuing decline in R&D spending limits innovation
  Gap of private profitability of new technologies and costs

  Risk of inaction – Climate, Energy Security, and economic Development

  Aviation Biofuels
  UNDP, 2nd gen Biofuels
  Sri Lanka - biomass
  (woodlots, shortrotation)

Session 1

Institutions, Innovation, and Consequences of Inaction

THEMATIC DISCUSSION TOPIC

KEY ISSUES and GAPS BLOCKING UNDERSTANDING

- Availability of land (determination of land). How to make land available – increasing efficiency of existing land use
- How to develop integrated landscapes – requires infrastructure
- Showing economic viability of sustainable bioenergy production
- ILUC
- Impact of bioenergy on water, biodiversity
- Role of certification
- Relationship between bioenergy and social benefits and economic development (where would US/Brazil be without biofuels?)

FUTURE RESEARCH POSSIBILITIES

- Understanding potential ways for intensifying
- Land Use: Pasture intensification, integrated agricultural production
- How to use models & results appropriately
- Making the case to the farmer or bioenergy producer
- Vision of a beneficial bioenergy future
- Can we scale up small scale bioenergy production to large scale use and new markets

Session 2

THEMATIC DISCUSSION TOPIC

RECOMMENDATIONS for FUTURE RESEARCH ACTIVITIES (what, how, who, where)

- **Better understand opportunities for beneficial impacts of bioenergy on agricultural and economic development, and resilient food production (research sponsors)**
- **Accelerate R&D on technical innovation.**
    - **New/better crops**
    - **Integrated bioenergy feedstock production systems,**
    - **Conversion processes, including co-products**
- **Develop better ability to envision, model, and evaluate counterfactual cases, future scenarios, and the risks of inaction.**

RECOMMENDATIONS for DEPLOYMENT (what, how, who, where)

- **Create necessity and opportunity concurrently – policy and financial support (Governments, banks and private sector, aid agencies)**
    - **Innovation and improvements are driven by need**
    - **Develop demand, market structure and logistics**
- **Establish nodes of excellence – exemplary, locally-responsive, multiply-beneficial projects (same players as above).**
    - **In both developing and developed countries, with more technology risk and innovation in the latter and more institutional risk and innovation in the former.**
    - **Should be done by public-private partnerships so that commercial viability and social objectives both have a sponsor and stakeholder.**
    - **Human resource development as well as demonstration. Learn by doing.**
    - **Decentralized bioenergy applications in rural areas through agro-industrial development**
- **Create cross-sector, multi-level governance structures spanning the multiple dimensions of bioenergy**

Synthesis of discussions from Day 1 and 2 on Topic 6: Integrated Food and Biofuels Production and cross-cutting issues

Session 1

Integrated Food & Biofuels Production and cross-cutting issues
THEMATIC DISCUSSION TOPIC

WHAT IS KNOWN, SUPPORTED BY EVIDENCE

- **Land availability is not a significant constraint on the global scale**
- **Flexibility is key (co-products but also multiple use of land and crop) which aids local development**
- **'lower the beta' – lower income volatility**
- **Integration = no trade-offs (in the longer term)**

RELEVANT CASE STUDIES OR RESEARCH OPPORTUNITIES

- **Colombia – driven by poverty alleviation = political stabilization**
- **Brazil – sugar cane co-generation; soy and sugar cane rotation**
- **U.S. – corn ethanol**
- **UK – wheat ethanol**
- **West Africa – jatropha and cotton as a non-food cash crop development blueprint**

Session 1

____Integrated Food and Biofuels Production and cross-cutting issues
THEMATIC DISCUSSION TOPIC

KEY ISSUES and GAPS BLOCKING UNDERSTANDING

- **Complexity**
- **Volatility (supply, demand and price)**
- **Heterogeneity (diversity of potential bioenergy systems)**
- **Uncertainty e.g. climate**
- **Local context**

FUTURE RESEARCH POSSIBILITIES

- **What is needed to stimulate the multiple uses of systems, given the local circumstances?**
- **Local context for investment**
- **What fraction of wastes and residues can be used? Sustainable use of residues?**
- **Water, food and energy nexus**
- **Time dynamics of bioenergy systems development**

Session 2

Integrated Food and Biofuels Production & Cross-cutting issues
THEMATIC DISCUSSION TOPIC

RECOMMENDATIONS for FUTURE RESEARCH ACTIVITIES (what, how, who, where)

- **Research into integrated food and energy systems**
- **Linked research into social, economic, environment, governance and institutional components of bioenergy systems**
- **Research on constraints and experiences in closing yield gaps and in how biofuels can contribute**
- **Research on potential bioenergy production and use for a given country**
- **Other alternative innovations (technical and knowledge) that could be deployed *de novo***
- **What is specific and what is generic that can be transferred to other countries (e.g. sugarcane – India, Mauritius, Brazil)**
- **Water-soil-energy-food-land nexus**

RECOMMENDATIONS for POLICY DEVELOPMENT EFFORTS (what, how, who, where)

- **Don't search for miracle solutions, preferably build on existing agri-business systems**
- **Assess potential at national level and develop national strategies (supply/value chain, capacity and infrastructure need assessment)**
- **Support research on integrated food and energy systems**
- **Assessment framework, public policies and finance must work together**
- **Communication and re-framing the discussion away from the either-or (food vs. fuel)**