GSB

Global Sustainable Bioenergy

Annotated Agenda – Summary Report – GSB Workshop on Future Sustainable Bioenergy Research

Date: June 11-13, 2013
Location: Oak Ridge National Laboratory (ORNL), Tennessee USA

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Workshop participants are listed at the end of the report and contributors include: Lee Lynd, Edgar Beauclair, Heitor Cantarella, Annie Chimphango, Luis Cortez, Virginia Dale, Andre Furtado, Luiz Horta, Shujiang Kang, Lee Lynd, 'Debo Oladosu, James Roberto, Jansle Rocha, André Santanchè, John Sheehan, Nagendra Singh, Jeremy Woods, Regis Leal, Ibrahim Mayaki, Mosad El-Missiry, Patricia Osseweijer, Emile van Zyl, Gideon Wolfaardt, Keith Kline and Maggie Davis.

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Climate Change Science Institute AT OAK RIDGE NATIONAL LABORATORY

OAK RIDGE NATIONAL LABORATORY MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

BIOEN FAPESP

Executive Summary

The development of bioenergy has become increasingly contentious, yet clean, renewable alternatives to fossil fuels are required to meet reduce greenhouse gas emissions and meet long-term human needs for energy. The Global Sustainable Bioenergy (GSB) Project http://bioenfapesp.org/gsb/ seeks to contribute to a more sustainable world by expanding, disseminating, and applying understanding of the possibility and necessity of producing bioenergy on a large scale while maintaining or improving other priority ecosystem services to society. Distinctive features of the project are its global scope and participation as well as a forward-looking approach unconstrained by current practices. The GSB project acknowledges that current trends are unsustainable and a transformation is needed to manage resources to meet the needs of society today and tomorrow.

GSB is developing tasks to test hypotheses that: (a) It is physically possible to make room for bioenergy while honoring other land use priorities and (b) A systemic approach to food and bioenergy production could positively and synergistically impact multiple urgent human needs. These issues are critical as the world strives to meet current development goals while minimizing negative effects on future generations caused by increasing use of fossil fuels. While other projects have assessed bioenergy potential from a perspective of current trends and probable outcomes, the results have been divided and contentious. This project works toward informed understanding and consensus on a vision of what is most desirable and how to achieve it.

The first goal of the workshop - to familiarize researchers with each other's activities, capabilities, and plans – was achieved and helped participants identify opportunities for mutually beneficial expansion of GSB collaborations. Fulfilling a second goal, researchers learned about a newly-initiated FAPESP-NEPAD partnership. Researchers also highlighted recent findings ranging from geospatial analysis of the uncertainties surrounding "pasture" land productivity and utilization to new global modeling and the relationship between bioenergy crop development and pasture intensification in Brazil. Other results include agreement on the plan for submission of a GSB geospatial analysis and modeling proposal. Suggestions for future GSB research were discussed, including: the need to clearly articulate the key questions, scales of analysis, and data requirements across different GSB tasks; potential to develop a hierarchical approach to modeling (linking complex local models to more nimble, simpler high-level models); and a proposal to develop an open data and modeling platform to facilitate the integration of different approaches.

The GSB Project welcomes new collaborators. Current collaborations represented at this workshop include the Sao Paulo Research Foundation (FAPESP), Oak Ridge National Laboratory (ORNL), the BE-Basic Program coordinated by Delft University of Technology (The Netherlands), the Latin America, Caribbean and Africa (LACAF) Project coordinated out of the University of Campinas (Brazil), Stellenbosch University (South Africa), and the New Partnership for African Development (NEPAD). The workshop was hosted by Oak Ridge National Laboratory (ORNL) and proceedings are posted at the Center for Bioenergy Sustainability at ORNL website: http://www.ornl.gov/sci/ees/cbes/

Workshop Summary (see Agenda posted on CBES website)

June 11, 2012: Informal Discussions and Dinner

June 12, 2013

Welcome, Introductions, Goals of Meeting. Maggie Davis

Meeting objectives with emphasis on geospatial analysis, data and modeling:

1) Familiarize ORNL and GSB researchers with each other's activities, capabilities, and plans to help identify possible future or expanded collaborations.
2) Input and discussion on the relationship between geospatial analysis and other parts of the GSB and LACAf projects, and in particular the newly-initiated FAPESP/NEPAD collaboration.
3) Final polishing of the FAPESP proposal to support geospatial analysis and modeling tasks of the GSB.

Overview of relevant facilities, resources at ORNL. James B. Roberto

In support of objective 1 of the workshop, the unique capabilities at ORNL were highlighted, including the world-class capabilities for materials R&D; leading the development of ultra-scale scientific computing; and managing the DOE BioEnergy Science Center and multi-institutional teams to advance cellulosic ethanol research.

GSB overview. Lee Lynd

What makes GSB distinct? The GSB project: (a) focuses on the most desirable outcome rather than the most probable, (b) seeks to develop a new understanding and science-based consensus on the main barriers to bioenergy and a path forward that emphasizes meeting the needs for food and other ecosystem services while integrating sustainable bioenergy in productive systems whereas many other projects tend to be sharply divided into camps favoring or opposing bioenergy; and (c) the point of reference for the GSB project is a future vision of what is necessary and possible, rather than a set of limitations assumed based on current constraints.

Land and resource assessment challenges and opportunities. Keith L. Kline

Clear definitions, better measurements and data that are geospatially and temporally explicit, are needed to address concerns about changing land cover and land use. Current "Land Use" and "LUC" emission estimates are largely guesswork but are small (about 10% of global total). The LUC emission estimates have been shrinking over past decade. But the emissions from fossil fuels are well-documented, represent about 90% of the global total, and are rapidly growing. The terrestrial system can be managed to increase its value as a net sink but incentives (and financing) to invest in improved resource management are needed. Better management practices can increase above-ground productivity and the long-term capacity for below ground carbon storage. ORNL continues research on these topics and to improve systems to measure and allocate causation for observed changes. Information was also shared on integrated resource assessment capabilities, the U.S. Billion Ton biomass update, the Bioenergy Knowledge Discovery Framework (KDF) and Data Explorer.

Economic and Land Use Impacts of Biofuels. 'Debo Oladosu

Focusing on the unique ORNL capabilities in the field of LU impacts, the presenter focused on recent research with a Computable General Equilibrium (CGE) Model and the CGE-based evaluations of the economic effects of biofuels which enable improved global modeling of: (1) The links between agriculture and energy sectors involving biofuels, and (2) the interactions between biofuels and national/global economies and land cover.

Modeling Global Bioenergy Biomass Production and Environmental Effects. Shujiang Kang

Another capability of ORNL includes research and development of the Global Bioenergy Crop Model, which highlighted future plans for (a) high-resolution modeling and data management (meter-scale simulations), (b) inclusion of additional bioenergy crops (sugarcane, miscanthus, agave, trees), (c) land allocation optimization modeling capabilities – e.g., to meet growing demands for food and bioenergy simultaneously, (d) improved data sets to support land-use planning and other needs of decision-makers, and (e) support GSB and international collaboration network to improve global land modeling that integrates food, energy, fiber, and other services.

Geospatial Research Capabilities and Contributions. Nagendra Singh

ORNL's Geographic Information Science & Technology department in the Computational Sciences & Engineering Division, houses the world's 2nd fastest computer (as of 6-19-2013) "Titan," and also the Bioenergy Knowledge Discovery Framework (KDF), an extensive online collaboration toolkit for information sharing that a) brings together relevant data and helps move towards standardized datasets, assumptions, and guidelines, b) increases accessibility of data to researchers, c) provides access to analytic tools/models, and d) provides secure collaboration communities to share research, data, and in-progress publications.

Sustainability Indictors. Virginia Dale

ORNL and researchers within the Center for Bioenergy Sustainability, led by Dr. Dale, specializes in environmental and socioeconomic indicators of bioenergy sustainability. The approach considers the need to analyze context and specific goals and to develop indicators within a system as an opportunity to design for continual improvement of service provision from landscapes. The team is also researching multi-metric optimization approaches that address the need to consider multiple sustainability objectives.

Of cows and cars: Improving pasture-based animal production. John Sheehan

In support of Workshop Objective 1, John focused on research conducting a yield gap analysis to identify opportunities for increased productivity in pasture use for livestock (the largest human use of land on the planet). Initial findings include the determination that only 57% of the land designated as pasture appears to be occupied by animals, resulting in an aggregate livestock intensification potential that is conservatively in the range of a 2-4 fold increase (compared to 1.5 to 1.7 fold increase potential for maize using similar methods). This research has led to the conclusion that mixed crop livestock systems are an untapped opportunity.

Modeling sugar cane productivity. Edgar Beauclair

Opportunities for increased productivity for sugarcane production (the "most photosynthetic efficient crop") were discussed along with limiting factors and opportunities. These variables are related to approaches for modeling productivity. Beauclair noted that in addition to other opportunities for productivity improvements, there are potentially 15-20 tons of cane-straw (trash) per hectare per year that is not considered in most current biomass estimates.

Nutrient requirements for sustainable biofuel feedstock production. Heitor Cantarella

Presentation references the Trivelin et al. (2013) analysis of nutrients in cane trash and notes that more research is needed to assess the total biomass production with a given amount of nutrients. It is also important to document the potential for recycling nutrients for selected crops and management systems. Discussions following the presentation included issues of nutrient requirements for algae

and mixed systems with crop/rotations and animals (also noted in Sheehan's presentation). Researchers noted that most agricultural production targets urban markets and as a result much of the biomass is transported from farm to urban areas where it becomes waste – offering potential for bioenergy and nutrient recycling.

Decision-making criteria for policy makers; how GSB's geospatial analysis can help. Jem Woods

Presentation notes that new investment and ways to reduce risk are priority needs. Four major agricultural problems must be addressed as bioenergy production systems are integrated in land management planning: [1) stagnating yields, 2) decreasing biodiversity, 3) decreasing carbon stocks, and 4) soil/nutrient losses [and a 5th, water impacts]. Presentation underscores the "double penalty" to remote Africa and other less developed rural areas: required inputs for production include imported energy/fertilizer but costs much more due to poor infrastructure and distances; and exporting/selling to market costs much more as well. This topic was further discussed on Day 2 in conjunction with the NEPAD program collaboration.

Integrated Analysis of biofuels production and use. Horta

This presentation focused on an integrated analysis approach to answer the main GSB questions: "Can we? Should we?" And then more importantly, "How can we do it?" The LACAF project approach was also summarized: (a) estimating potential production; (b) forecasting demand; (c) assessing institutional and political frameworks and policy options; and (d) estimating effects of bioenergy options.

E-science and Geospatial Database. André Santanchè

In order to successfully complete the GSB goals, this researcher stressed that it is imperative to think about open modeling and data management to enable sharing, comparing and connecting research tasks to maximize reproducibility. Specific concerns are: data curation with quality control; and developing a systematic approach to models being used that breaks them in to their minimum components, discreet activities, and input values to create work flows. Such an approach supports transparency and permits users to make adjustments when input values, knowledge or assumptions change (see clue.cs.washington.edu\node\1 web site).

Breakout discussions & brainstorming

Researchers participated in a brainstorming exercise related to refining what the GSB group has proposed to do under the geospatial data and modeling task. Participants were asked to consider what is missing in the proposal and to identify connections with other work underway. The topics included: (1) analytical tools, models, databases; (2) integrated analysis, multi-variant, multi-objective; (3) geospatial analysis with crop and livestock models.

Report out, group discussion

Discussions from the groups resulted in the following specific suggestions and topics for further consideration by GSB collaborators:

a) Consider a hierarchical approach to modeling, where complex models feed into more nimble and simpler "high-level" models. You need simple models to allow you to think about many broader, bigger and diverse issues. These can help define what is most important for more complex models to assess.
    i. The group noted that GSB is at the global scale while LACAF is at the national scale and that there may be issues with global and local modeling interfaces. The role of

"integration" is to reinforce conclusions in order to support robust policy recommendations.

ii. The group noted that it is very critical to be able to make clear, simple arguments that lay people (and policy makers) can understand. These arguments need to be supported by simple models, and to make these robust in face of criticism.

b) The group should consider the need for common definitions of terms, scales, units of analysis, etc., and the need to clarify key questions, scales of analysis, and data requirements in clearly defined terms.

c) Researchers need to further explore how to proceed with open modeling and how to best integrate different approaches such as MatLab, common map units (5 minute grid), etc.

   i. Practical scenarios include: data sets and tools (C-program and how to run it as an open model). The general idea is to break tools used into work flows.

   ii. The "executable papers" concept (i.e. ultimate ebook is executable book where you can play with parameters and see how issues discussed in paper work) was discussed as an interesting possibility. One suggestion for the group to do is "data prospecting," where participants explain which tools and data sets they use.

   iii. This group should identify quality database and DB structures (and who will be responsible for each).

d) An additional idea was to learn from climate research community (well-represented at ORNL) and propose development of ensemble of models based on community of researchers and developing community bioenergy-sustainability assessment modeling framework

e) It may be impossible to get complete integration, but it is important that the various GSB tasks and analyses achieve some degree of comparability and compatibility in terms of input data sets and scenarios. Also, to communicate effectively and enable policy analysis, some level of integration of the various elements is essential.

   i. The group noted the difficulty (time and costs involved) in doing a fully integrated analysis at the national scale. Additionally, some of the key social acceptability issues for bioenergy are reflected by hypotheses and questions that can only be asked at a global scale.

   ii. Researchers need to demonstrate "real things in real world;" this can only happen at local level. At a national level, interactions of many different factors and policies make allocations difficult and modeling can get complicated. For an integrated assessment it might be preferable to use a tested, relatively simple model.

      i. Suggestion: Consider identifying 3 areas at scale of small hydrological catchment for a bioenergy project, or the "fuel shed" for a specific bioenergy conversion facility. This is the scale at which a real project would happen and at such scale, the impacts on environment, society, etc. can better be measured. It may make sense to add focus at different, specific scales. Multi-scale approach is necessary.

   iii. To look at the proposed "integration" question, you need to consider policies. The group noted that the history of biofuel policies in Brazil serves as a potential laboratory for testing many different policy issues related to biofuels.

f) The modeling group will prepare to have a series of calls on modeling methods related to the development of two publications targeted in the proposal.

g) It may be possible to add economic analysis to consider the probability of profitability for N-analysis and management. The power of profitability can be important, but to government, the primary consideration may be a combination of growth and <u>distribution</u> of benefits (i.e. how many, who and where are benefits distributed).

h) There is an opportunity to improve interactions with LACAF and involve LACAF countries to better define the desired products/research results. This should focus on opportunities to enhance mutual benefits among all partners while contributing to GSB goals.

June 13th, 2013

Video Conference, attended in person by Group 1, remotely by Group 2, to achieve goals 2 & 3

Welcome, overview, and objectives. Lee Lynd

On-site attendees welcomed the remotely connected attendees from Brazil (UNICAMP, CTBE), Africa (NEPAD and Stellenbosch University) and The Netherlands (BE-Basic).

Geospatial Analysis and Modeling. Jansle Rocha

This presenter stressed that the GSB project could benefit from common data set and units for geospatial analysis. A preliminary analysis of Brazil crop and pasture area, considering cattle density and other data sets in same region (social and economic analyses), found that pasture intensification was significant in areas with sugar production. Understanding how bioenergy development can help instigate, catalyze and accelerate improvements in other productive systems is a core research goal in the GSB Project. Data collection and modeling will be undertaken under the Geospatial Analysis proposal to support this goal.

Strategic partnerships to unlock the potential of bioenergy production in Africa – with presentations, comments and discussions with WH (Emile) Van Zyl, Annie FA Chimphango, Ibrahim Mayaki, and Mosad Elmissiry

Stellenbosch University has partnered with NEPAD to develop a project for coherent mapping of the current status of biomass resources in Africa. The researchers are exploring how to *unlock the bioenergy potential* and how this potential can be used as a stimulant for rural development in Africa. Currently, they are "limited by inefficiencies in the value chain." The presenters also discussed the "double penalty" in Africa (i.e. high input costs; high costs to reach markets) and higher risks from market volatility (susceptibility and intensity of effects). The team discussed ideas for unlocking the bioenergy potential as an essential step in integration of resource management for food/energy supply systems. The presenters also stated that they are developing a "vision" and also trying to meet political needs to address social and economic dimensions of development in Africa.

African Transformation & Bioenergy. Lee Lynd

This presentation highlighted the GSB Africa Convention report and underscored the same "vision" concept noted by NEPAD. Lee discussed a framework for moving forward that would build on national assessments now underway in Africa on food security and similar issues. The presenter suggested that the GSB project complement these by doing analysis at the scale of feedstock catchment areas for potential individual bioenergy production facilities. In addition, a new "business model" was presented which aims to simultaneously realize (i) sustainable and widely-distributed social benefits and (ii) commercial viability of a bioenergy production system. A key feature of this business model was to seek rather than avoid social engagement and to make land available for bioenergy by first increasing the yield of food production.

BE-Basic Flagship 9 Societal Embedding of a BBE. Patricia Osseweijer

The presenter discussed the four new program areas in the BE-BASIC Program's international collaborations: innovation, macro-economic, sustainability in wood use for energy, and public knowledge and perceptions. The public knowledge and perceptions study ("Microsociety2030: a public qualitative study") found that (a) the general public does not understand the idea of a Bio-based Energy Economy (BBE); (b) people dislike "biofuels" primarily due to perceptions of food

security; (c) people do not accept or believe in the idea of "limited oil" and they do not want to pay more for alternatives to fossil fuels; and (d) people do believe in recycling (circular economy) but have skepticism about making a difference with personal choices. The public is also skeptical about the ability of government to make a difference in developing a BBE. There is a need for better communications and a "common framework" to study society's footprint (e.g., sustainability indicators).

Brainstorm and discussion day 2 – Geospatial analysis and the FAPESP/NEPAD collaboration

a) Concerns about perceptions and potential conflicts with other external investments and "land grabbing" were discussed. While broad concerns and suspicions about external investment (and foreign motives) persist in many nations, investment is essential to make improvements. It is expected that many NGO groups could oppose anything labeled "bioenergy" but may be supportive of efforts to improve and develop local production and local markets. Local community involvement in any project "on the ground" is essential. It was noted that the typical partners and corporate investors this project would identify, would prefer to be supplied by locals rather than buy land.
b) Researchers also discussed how farmers are too vulnerable with single crops or basic food production alone. The hedging effect of diversification, including potential bioenergy markets, is essential to reduce inevitable volatility caused by forces outside the control of local producers. The discussions noted the need to develop a project road map that responds to the GSB Africa Convention declaration and addresses local needs and sensitivities.
c) Researchers also recognized that the food security issue can depend on location. For example, in West Africa there are cyclical issues of large amounts of food waste and a need for better utilization of waste when products cannot reach viable markets.
d) A business outline combines "short term" and "long term" and the need to look at how short term can feed into long term. (e.g., increasing yields near term, leading to new markets in longer term). Researchers noted that resilience in the system is really important.
    a. This is one aspect of Brazil's experience that GSB will want to bring to the project, under "lessons from Brazil."
e) The link with BE-Basic and the need for good examples of socially beneficial bioenergy was also discussed. Researchers stressed the value of examples that highlight real projects costs and benefits. While many examples of showstoppers exist, more examples of successful development would be helpful.
f) Other discussions were on scale and a spatially explicit vision. There may be a difference between the vision and scale for the GSB from a short term perspective and that of a longer term perspective. Researchers noted that where you place things on land should be done thoughtfully and begin with provision of food and basic services (i.e. "think spatially about choices").

Concluding remarks: trying to solve everything with bioenergy is not possible. Popular media and many studies have focused on some of the real shortcomings and many perceived problems with bioenergy projects. But trying to meet all needs, and build a more sustainable world focusing on bioenergy alone is illogical and impossible. Bioenergy can make contributions as one part of a more integrated and efficient system of land management and production. Needs and solutions need to be holistic, and bioenergy is one part of the whole. Participants recognize the multiple opportunities for bioenergy production to improve some key basic needs such as food security. Bioenergy will succeed in Africa only if it is a part of an approach designed to improve existing crop production systems.

Related Research Overviews and Updates (narrative only – no presentations posted)

LACAF-I. Cortez & Horta

Two partners will be contracted to help with diagnostic information: CTC and ICONE. E. Beauclair (ESALQ-USP) will apply an energy crop model to estimate supply potential. Regis Leal (CTBE) will work with counterparts in Africa to propose production models that can simultaneously realize goals for food and bioenergy. The goal is to have a model adapted to African needs and the process is to propose new ideas and then have discussion. LACAF-I will get going after contracts are signed and a group of post-docs have been hired (5 positions open, deadline for applications is June 30th, 2013).

LACAF-II. Andre Furtado

Since November 2012, LACAF-II has worked to merge tasks on food security and social-economic impacts. There are now 3 sub-groups: (1) Jem Woods on bioethanol and food security; (2) Marcia Azanha on social impacts; (3) Andre Furtado on scenarios. Group (1) includes food production, land etc. Group (2) will look at labor markets, traditional land use, etc. and group (3) will consider science and technology, investment, energy and trade to develop scenarios for analysis. The 3 groups will examine complementary aspects of the relationship between bioenergy and social-economic outcomes including food security.

LACAF-III. Lee Lynd to lead discussion in Luiz Martinelli's absence

At the SCOPE meeting kick-off involving several GSB researchers, the pasture intensification topic was mentioned and the first question was, "Do you plan to evaluate the environmental implications of these land changes?" GSB research partners (e.g., PSU and ORNL) have much to offer to help answer these questions and could submit a proposal to FAPESP as a complimentary GSB project to address environmental aspects considering 3 dimensions: (a) further study of effects of bioenergy in Brazil, (b) developing best practice recommendations for LACAF nations, (c) study environmental implications of LUC examined elsewhere in GSB (e.g. pasture intensification).

General Discussion/ Other Opportunities

1. Participants from Penn State note that the AFRICAP grant is focusing on marginal lands in northeast USA. The project involves a large group of Penn State (PSU) faculty and students looking at alternative landscapes for agriculture. Hydrologic modeling is also big part of that project. The GSB group identified potential opportunities for post docs from Brazil to visit PSU and to consider the possibility for researchers from PSU to visit Brazil partners with mutual benefits. PSU researchers will consider what role they might want to have in GSB work on pasture analysis and intensification. It may be possible for students from the US and other countries to get a scholarship to study in Brazil; there are many opportunities for interaction and tangible action items.
2. There may also be an opportunity to help examine issues related to the new Forest Code in Brazil and for GSB research to contribute constructively to that important analysis and discussion.
3. The Partnership with BE-Basic is a very important component of GSB and the group needs to explore how to make the best use of this cooperation. Research leaders would like to see the possibility of supporting mobility of researchers under the LACAF project – e.g. exchanging researchers with LACAF nations. These and other activities involve costs that are not easy for FAPESP to cover.

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Group 2. Video-conference participants, June 13

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