PART I: WORKSHOP OUTLINE

China-US Workshop
"Bioenergy Consequences for Global Environmental Change"
(October 15-18, 2008, Beijing, China)

1. INTRODUCTION

On July 20, 2006, in Beijing, representatives of the University of Tennessee-Oak Ridge National Laboratory's (UT-ORNL) Joint Institute for Biological Sciences (JIBS) and UT's Institute for a Secure and Sustainable Environment (ISSE), and representatives from two institutes of the Chinese Academy of Science (CAS): the Institute of Geographic Sciences and Natural Resources Research (IGSNRR) and the Research Center for Eco-Environmental Science (RCEES) signed a framework agreement for the establishment of a China-US Joint Research Center for Ecosystem and Environmental Change (http://isse.utk.edu/jrceec/). The focus of this agreement is to promote research collaboration, academic exchange, student education, and technology training and transfer in the areas of ecosystem and environmental sciences. The center's primary collaborative themes include:

(1) Ecosystem processes and management;

(2) Environmental sustainability of bioenergy production;

(3) Ecological fundamentals of water resources and quality;

(4) Technologies for improvement of eco-environmental systems.

Since the establishment of the Joint Center, bioenergy and its environmental sustainability theme has been the topic of several reciprocal visits and joint workshops in Beijing as well as in Knoxville, Tennessee. The Joint Center convened the first China-US workshop last September in Knoxville to address environmental aspects of bioenergy production and sustainability. About 40 scientists from the partner institutions and six program officers from the U.S. National Science Foundation (NSF), along with representatives from the Ministry of Science and Technology of China, and the Bureau of Science and Technology for Resources and Environment of CAS attended the workshop. As a follow-up activity, the second China-US workshop, sponsored by the National Natural Science Foundation of China, the U.S. National Science Foundation, the Bureau of International Cooperation of CAS, and the Institute of Geographic Sciences and Natural Resources Research of CAS, will be held on October 15-18, 2008, in Beijing, China, with focus on bioenergy consequences for global environmental change.

2. BACKGROUND

The Chinese and US economies are globally dominant drivers of fossil fuel consumption and the release of greenhouse gases and are thus strategically linked to the sustainable development of alternative and renewable energy sources. This is further driven by a desire for a modicum of energy independence and less reliance on petroleum imports for transportation fuel as prices continue to escalate based on demand or speculation. In the US this has given rise to a robust new rural economy of bioethanol production, which is attempting to meet mandates by expanding and diversifying to non-food, cellulosic feedstocks to meet current and future demand. The US Department of Energy has completed the "Billion Ton Study" indicating that for cellulosic biomass from forest products and cultivated feedstock biomass, such as switchgrass, are needed in order to achieve transportation biofuel goals over the next two decades. In China, the government and the renewable energy industry are poised to capitalize on the marketing potential of biofuels. China reports that a comparable billion tons of cellulosic material may be available for biofuel production annually from agricultural wastes. China's 21st Century Agenda emphasizes renewable energy as a foundation for development and the

Medium- and Long-term Development Plan for Renewable Energy targets 30 GW of biomass power based on agricultural, forestry wastes, and energy crops by 2030. However, bioenergy creates impacts across all stocks of natural and human capital and its systems are more cross-sectional than those of other energy sources. It has been warned that the large-scale use of biomass as an energy source will have significant impacts on the sustainability of natural resources (e.g., land and water), ecosystem biodiversity, and environmental protection. It is therefore necessary to carefully assess the impacts of bioenergy production in the context of environmental sustainability and global climate change.

3. WORKSHOP GOALS AND OBJECTIVES

Through the workshop, participants will discuss the long-term impacts of bioenergy production on global environmental change in the context of socio-economic and technology processes. The workshop will seek to develop joint research/education programs between China and the U.S. in the areas of bioenergy production, feedstock management, and technology transfer. Specifically, the 2008 workshop will:

1) Evaluate the potential of carbon sequestration through bioenergy production;
2) Address the role of biomass management in protecting eco-environmental systems;
3) Explore bioenergy strategies for incorporating social and economic factors into natural resources management and restoration;
4) Develop a framework for large-scale China-U.S. joint research on the sustainability and security of bioenergy production;
5) Establish a mechanism to engage students and junior researchers in collaborative, cross-cultural research that addresses bioenergy and global environmental change.

4. WORKSHOP SPONSORS AND HOST

SPONSORS: U.S. National Science Foundation
Bureau of International Cooperation, Chinese Academy of Sciences (CAS)
National Natural Science Foundation of China
Institute of Geographic Sciences and Natural Resources Research, CAS

HOSTS: Institute of Geographic Sciences and Natural Resources Research, CAS
Research Center for Eco-Environmental Science, CAS

5. WORKSHOP PARTICIPANTS

Workshop participants (approximately 70) will include faculty, staff, and students from the four founding and two new partners of the China-US Joint Research Center. Program leaders from federal agencies—among them, the U.S. Environmental Protection Agency (USEPA), and U.S. Department of Energy (USDOE) —and from research agencies within the Chinese government—among them, Chinese Academy of Sciences (CAS), Natural Science Foundation of China (NSFC), Ministry of Science and Technology (MOST) —will advise and direct the international collaboration. Visitors will include research leaders from other U.S. and Chinese universities who are interested in developing strong international research programs via the China-U.S. Joint Research Center.

6. WORKSHOP ORGANIZERS AND COMMITTEES

This second China-US workshop, convened by the China-U.S. Joint Research Center for Ecosystem and Environmental Change, will be held in Beijing, China, October 15-18, 2008, and hosted jointly by two institutes of Chinese Academy of Sciences: the Institute of Geographic Sciences and Natural Resources Research (IGSNRR) and the Research Center for Eco-Environmental Science (RCEES). They are also partners in the China-U.S. Joint Research Center.

Scientific Committee

Chair: Wen-Hua Li (Academician of Chinese Academy of Engineering, and Professor of IGSNRR, CAS)

Vice-Chairs: Gary S. Sayler (Director, UT-ORNL Joint Institute of Biological Science)

Gui-Bin Jiang (Deputy Director, RCEES, CAS)

Members: Randy Gentry (Director, Institute for a Secure and Sustainable Environment, UT)

John Bickham (Director, Center for the Environment, PU)

Qing-Xiang Guo (Director, Anhui Key Laboratory of Biomass Clean Energy, University of Science and Technology of China)

Sheng-Gong Li (Professor, IGSNRR, CAS)

Ming Xu (Professor, IGSNRR, CAS)

Organizing Committee

Chair: Bo-Jie Fu (Director, Bureau of Environment and Resources, CAS)

Vice-Chairs: Zhi-Yun Ouyang (Deputy Director of RCEES, CAS)

Cheng-Hu Zhou (Deputy Director of IGSNRR, CAS)

Members: Jie Zhuang (Research Director, Institute for a Secure and Sustainable Environment, UT)

Guo-Qiang Zhuang (Professor, RCEES, CAS)

Yu-Guo Du (Director of the Environmental Biotechnology Lab, RCEES, CAS)

Han-Qing Yu (Professor, University of Science and Technology of China)

Xiao-Min Sun (Professor, IGSNRR, CAS)

Ying Sun (Associate Professor, IGSNRR, CAS)

Organizing Secretariat

Secretary-General: Gui-Rui Yu (Deputy Director of IGSNRR, CAS)
+86-10-64889268 (office); 135-01270996 (cell); yugr@igsnrr.ac.cn

Secretaries: Qiu-Feng Wang (IGSNRR, CAS)
+86-10-64889432 (office); 36-61363392 (cell); qfwang@igsnrr.ac.cn

Bin Wan (RCESS, CAS);
137-18179834 (cell); bwan@rcees.ac.cn

7. LANGUAGE

English will be the official language of the entire event.

8. VENUE

Meeting room 2602 at the Institute of Geographic Sciences and Natural Resources Research (IGSNRR), Chinese Academy of Sciences (CAS)

Address: 11A Datun Road, Chaoyang District, Beijing.

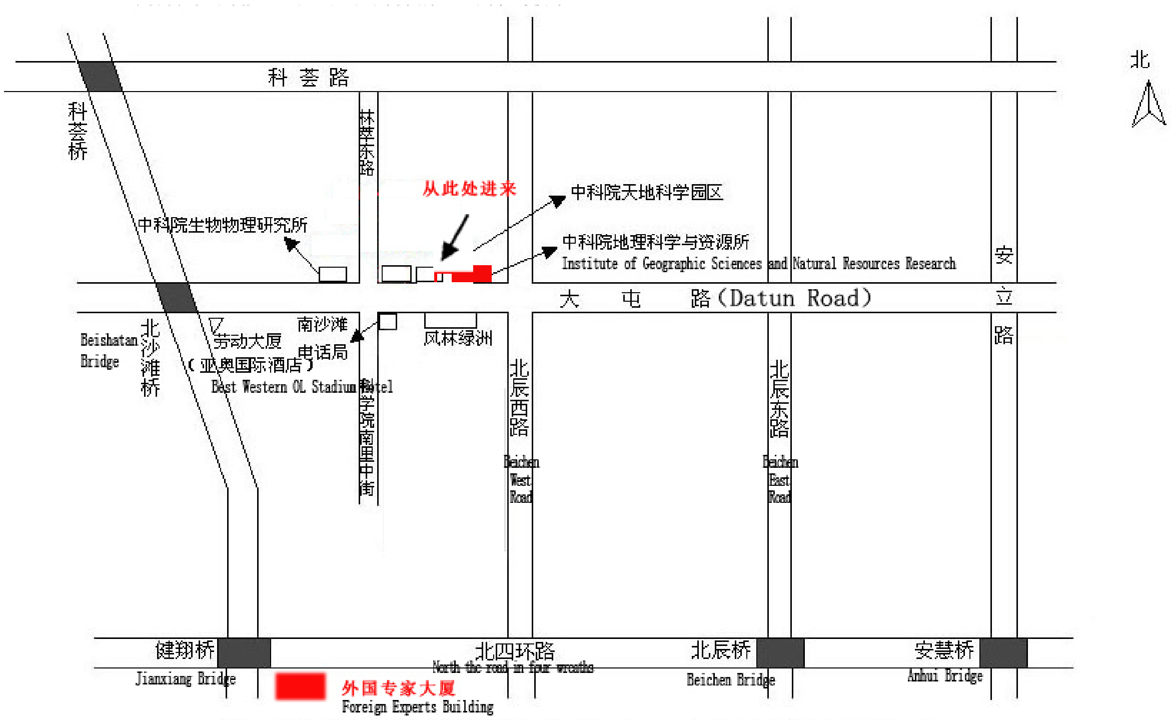
9. ACCOMMONDATION AND TRANSPORTATION

The international participants will stay at Beijing Foreign Experts Building at No. 8 Hua Yan Bei Li, Chaoyang District, Beijing, China (Tel: +86 10 8285 8888. Fax: +86 10 8284 5589). The workshop organizers will cover the hotel room charges during your attendance period as scheduled. Note that room charges include breakfast (7:00-8:00). Please also note that the participants will be responsible for any incidental expenses such as phone, fax, laundry, and any room foods (any alcoholic beverages, meals, drinks, etc.) posted on your room account. In-room internet is also available with a charge rate of approximately US$0.74 per minute and up to US$8.8 per day. For those who want to use the room internet, please contact the hotel reception-front or the workshop assistants. By the way, the workshop provides high-speed wireless Internet access at the meeting room without any charge.

The workshop will take place at the Institute of Geographic Science and Natural Resources Research, Chinese Academy of Sciences (11A Datun Road, Chaoyang District, Beijing), which will be only 10 minutes drive away from the hotel- Beijing Foreign Experts Building, and just next to the Olympics Game site. The local organizer will take the international participants from/to the hotel and the meeting place by shuttle bus. You are requested to catch the shuttle bus at 8:00, Oct 15- 17, at the lobby of the hotel.

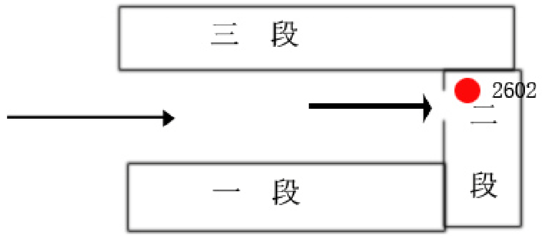
10. TIPS

It takes about 40 minutes to the Beijing Foreign Experts Building (Hotel) from the Beijing International Airport. Except as otherwise stated, the international participants, who arrive on Oct 13-14, will be picked up at the airport by students from the host institute. However, in case you come by yourself or taxi, the following map would be useful in guiding you to the venue-Institute of Geographical Science and Natural Resources Research, Chinese Academy of Sciences and the hotel, which are shown in red.



地址：北京市朝阳区大屯路甲11号 中科院地理科学与资源研究所
路线：北沙滩桥朝东第三个红绿灯走辅路（千万不要过地下通道）走到丁字校路口调头，
由中科院天地科学园区登记进地理所。

地理所方位图



会议室2602在2段6层02房间

If you need any help during the workshop, please contact:

Qiu-Feng Wang (IGSNRR, CAS):
+86-10-64889432 (office); 136-61363392 (cell);
qfwang@igsnrr.ac.cn

Jie Zhuang (University of Tennessee, USA):
134-365-965-28 (cell);
jzhuang@utk.edu

PART II：AGENDA OF THE CHINA-US WORKSHOP

Tuesday, October 13-14, 2008

Registration (the Beijing Foreign Experts Building)

Wednesday, October 15, 2008

8:30-9:50 am **Welcome and Introduction**

Chairman: Prof. Wen-Hua Li (Academician of Chinese Academy of Engineering, and Professor of IGSNRR, CAS)

8:30 Welcome and opening remarks
(Jing-Hua Cao, Deputy Director, Bureau of International Cooperation, CAS)

8:50 Opening address by leaders of the China-US Joint Research Center
(Dr. Gary Sayler, UT/ORNL)

9:20 Acceptance Ceremony of New Partners and Speeches by New Partners
(Purdue University and University of Science and Technology of China)

9:40-10:00 am **Tea/Coffee Break and Workshop Group Picture**

10:00-12:00 pm **Keynote Addresses − Overview of Bioenergy Development**

Moderators: Dr. John Bickham (Purdue University) and Dr. Xing-Guo Mo (IGSNRR)

10:00 Introduction of the workshop objectives
(Dr. Jie Zhuang, workshop coordinator)

10:10 "Sustainable Production of Biofuels" (K01)
(Dr. Alan Hecht, U.S. Environmental Protection Agency)

10:45 "The Land Resources Available for Bioenergy Development in China-from the Viewpoint of Food Security" (K02)
(Dr. Gao-Di Xie, IGSNRR, CAS)

11:20 "Recent Progress in Biomass Energy Studies at USTC" (K04)
(Dr. Qing-Xiang Guo, University of Science and Technology of China)

12:00-1:30 pm **Lunch and Poster Presentation**

1:30-4:50 pm **Plenary Addresses Bioenergy Production and Environmental Sustainability**

Moderators: Dr. Shao-Qiang Wang (IGSNRR) and Dr. Jie Zhuang (UT)

1:30 "Development Potentials and Policy Options of Biomass in China" (O01)
(Dr. Lei Shen, IGSNRR, CAS)

1:55 "Environmental Grand Challenge of Biodiversity Loss" (O02)
(Dr. John Bickham, Purdue University)

2:20 "The Woody Bio-energy Development and Its Possible Effects on Ecological Environment in Jiangxi Province" (O03)
(Dr. Shi-Huang Zhang, IGSNRR, CAS)

2:45-3:10 pm **Tea/Coffee Break**

3:10 "Using Hydrologic Tracers and Geochemistry to Assess Surface Water and Ground Water Interactions for Ecosystem Sustainability" (O04)
(Dr. Randy Gentry, the University of Tennessee)

3:30 "Crop Production Defined by Climate and Water in the North China Plain" (O05)
(Dr. Qiang Yu, IGSNRR, CAS)

3:50 "Socioeconomic Considerations with Biofuels Production: A Preliminary Analytic Framework" (O06)
(Dr. Mary English, the University of Tennessee)

4:10 "Energy Responding of the Crop System to Water Assignments in Taihang Mount Piedmont" (O07)
(Dr. Xing-Guo Mo, IGSNRR, CAS)

4:30 "Advances in Research on Germplasm Resources and Molecular Biology of Energy Plant Sweet Sorghum" (O08)
(Dr. Gong-She Liu, Institute of Botany, CAS)

4:50-6:00 pm **Group Discussions**

Moderators: Dr. Gary Sayler, (UT/ORNL) and Dr. Fu Zhao (Purdue University)

Topic 1: “Benefits of Bioenergy to Global Environmental Sustainability: Practicability and Scalability”
Topic 2: “Sustainability Criteria for Bioenergy Production”

6:00-6:30 pm — Visit Institute of Geographic Sciences and Natural Resources Research, CAS

6:30 pm — **Reception**

Thursday, October 16, 2008

8:30-8:40 am — **Summary** of Day 1 and **Objectives** for Day 2
(Dr. Randy Gentry, UT)

8:40-10:00 am — **Keynote Address − Bioenergy and Global Carbon Cycle**
Moderators: Dr. Randy Gentry (UT)
8:40 “Selecting Metrics for Sustainable Bioenergy Feedstocks” (K03)
(Dr. Virginia Dale, Oak Ridge National Laboratory)
9:15 “Quantifying Soil Carbon Cycle Mechanisms and Flux Using ^{14}C-Enriched Leaf Litter Manipulations: Implications for the Accumulation of Carbon In Soil” (K05)
(Dr. Paul Hanson, ORNL)

9:50-10:50 am — **Plenary Addresses -- Bioenergy and Global Carbon Cycle**
Moderators: Dr. Randy Gentry (UT)
9:50 “Carbon Budget Patterns of Forest Ecosystem in Poyang Lake Basin from 1901-2001” (O09)
(Dr. Shao-Qiang Wang, IGSNRR, CAS)
10:10 “Carbon Sequestration by Terrestrial Ecosystems and Its Contribution to Reduction of GHG Emissions in China” (O10)
(Dr. Sheng-Gong Li, IGSNRR, CAS)
10:30 “Ecosystem-Atmosphere Carbon and Water Exchange Derived from ChinaFlux Network Observation” (O11)
(Dr. Yu-Ling Fu, IGSNRR, CAS)

10:50-11:05 am — **Tea/Coffee Break**

11:05-12:30 pm — **Breakout Sessions**
11:05-12:05 pm — ***Session A: Bioenergy and Global Climate Change***
Moderators: Dr. Paul Hanson (ORNL) and Dr. Sheng-Gong Li (IGSNRR)
- Topic 1: “Accounting of greenhouse gas balances of bioenergy system: methodology and modeling”
- Topic 2: “Climate change policy of bioenergy: carbon taxation and subsidy”

Session B: Bioenergy and Land Use Change
Moderators: Drs. Gao-Di Xie (IGSNRR) and Mary English (UT)
- Topic 1: “Global bioenergy potential and uncertainty from degraded land”
- Topic 2: “Land use policy for bioenergy: synergy of environmental and economic benefits ”

12:05-12:20 pm — Reporting of breakout groups by the moderators
12:20-12:30 pm — Q & A and Open Discussion Session of Breakout Reports
(Moderator: Dr. Paul Hanson, ORNL).

12:30-1:30 pm — **Lunch and Poster Presentation**

1:30-3:30 pm — **Plenary Addresses -- Bioenergy Technology and Facility**
Moderators: Dr. Gary Sayler (UT/ORNL) and Dr. Jie Bao (East China University of Science and Technology)
1:30 “Biotechnology Tools for Switchgrass Improvement” (O12)
(Dr. Neal Stewart, UT)

1:50 “Life Cycle Assessment: Principles and Its Application to Biofuel Technologies” (O13)
(Dr. Fu Zhao, Purdue University)
2:10 “Research Progress on Key Process and Integrated Eco-industrial Chains of Biobased Product—Proposal of Biobased Product Process Engineering” (O14)

(Dr. Hong-Zhang Chen, Institute of Process Engineering, CAS)

2:30 "Production of Bio-Methane and Beyond" (O15)
(Dr. Jason Shih, North Carolina State University)

2:50 "Linking Biomass-based Liquid Fuel Production Capacity to Transportation Demand and Sustainability Goals" (O16)
(Dr. Loring Nies, Purdue University)

3:10 "An Industrial Demonstration of Corn Stover Based Ethanol Processing in China " (O17)
(Dr. Jie Bao, East China University of Science and Technology)

3:30 "Anaerobic Granule-based Reactors: Biohydrogen Production from Organic Wastes" (O18)
(Dr. Han-Qing Yu, University of Science and Technology of China)

3:50 "A modified MEC-MFC coupled biocatalyzed system for hydrogen production" (O19)
(Dr. Guo-Ping Sheng, University of Science and Technology of China)

4:10-4:30 pm **Tea/Coffee Break**

4:30-5:30 pm **Group Discussions**
Moderators: Dr. Qing-Xiang Guo (USTC) and Dr. Loring Nies (Purdue)
Topic 1: "Barriers, Potentials, and Diversity of Bioenergy Technology"
Topic 2: "International Transfer of Bioenergy Technology"

6:00 pm **Dinner**

Friday, October 17, 2008

8:30-8:40 am **Summary** of Day 2 and **Objectives** for Day 3
(Dr. Jie Bao, East China University of Science and Technology)

8:40-9:00 am **International Cooperation − Policy and Opportunity**
(Moderators: Dr. Alan Hecht, U.S. Environmental Protection Agency)
8:40 "China-US Cooperation in Bioenergy Development" (O20)
(Keith Kline, Oak Ridge National Laboratory)

9:15-10:50 am **Group Discussions − Recommendations for China-US Joint Projects**
Moderators: Dr. Gary Sayler (UT/ORNL) and Dr. Sheng-Gong Li (IGSNRR)
Topic 1: Possible joint projects in the areas of bioenergy and global environmental change
Topic 2: Rapid and effective methods for mutually benefited collaboration

10:50- 11:20 am **Concluding Remarks:** Dr. Gui-Rui Yu (IGSNRR, CAS)

11:20 am **Workshop Ends**

11:20-12:30 pm **Lunch**

1:00-5:00 pm **Tour to Research Center for Eco-Environmental Sciences and the sites of Beijing 2008 Olympic Games**

5:30 pm **Dinner**

Saturday, October 18, 2008

Tour in Beijing (to the Great Wall) and site visit.

PART III: ABSTRACT OF THE WORKSHOP

1. CONTENT

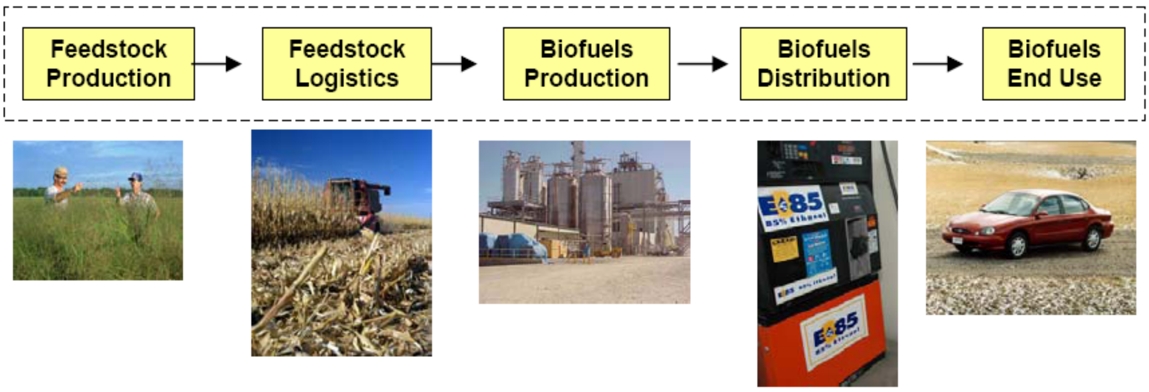
2. ABSTRACT

(K01) Sustainable Production of Biofuels

Dr. Alan D Hecht
US Environmental Protection Agency

Expanded use of biofuels, along with other renewable energy sources and increased energy conservation, has great potential to enhance energy security while protecting the environment and enhancing economic growth. Creating a sustainable production system for all feedstocks and achieving significant reductions in greenhouse gas emissions requires that the biofuel system be designed and operated in a highly efficient manner with clear sustainability goals and metrics. Toward this objective EPA research is focusing on measuring energy balance and assessing environmental and health impacts at each stage of the supply chain (figure 1) and using life cycle assessments for measuring overall greenhouse gas reductions for different feedstock.

Critical to achieving sustainable biofuel production is the development of *criteria* (such as greenhouse gas reduction, protecting air quality, maintaining soil productivity) and *indicators* (such as emissions of criteria air pollutants, soil carbon loss, pesticide and nitrogen runoff) that can identify long-term environment and health trends. U.S. legislation promotes sustainable biofuel production by requiring life cycle assessments of greenhouse gas emissions and environmental assessments of the impacts of biofuel production. By identifying and efficiently tracking appropriate economic, social, and environmental indicators for the growing biofuel system, unsustainable trends can be identified and addressed though changes in agricultural and land use practices. Cooperative US-China research aimed at identifying environmental and agricultural policies and strategies that concurrently promote clean and affordable energy, and safe and abundant food, while avoiding unintended environmental and human health consequences would greatly enhance world wide sustainable biofuel. USA EPA is specifically required to report to Congress every three years on the environmental and land use impacts on current and future biofuel production levels.



Assessing Environmental Impacts Across the Biofuel Supply Chain

(K02) The Land Resources Available for Bioenergy Development in China-from the Viewpoint of Food Security

Gao-Di Xie, Zeng-Rang Xu

Institute of Geographic Sciences and Natural Resources Research, CAS

For 95% grain self-supply, grain price rise in China gradually, other than the soaring food price in world in 2007. For the huge population and booming economy, limited land and grain production, food security in China is fragility, especially in southeastern China, however. Concerned about biofuel production impair food security, China has canceled the grain-based bioenergy program by the end of 2006. Since then, although bioenergy hasn't competed for grain with human in somewhat, it has competed arable land with grain planting still! It's urgent to identify land resource potential from the standpoint of food security. To harmonize bioenergy development and food security, land available for planting feedstock of bioenergy in China include degraded agriculture land, timberless forest land, part of unused land and land from planting system adjustment. China can make 15.65 million hectare land for bioenergy by degraded agriculture and forest land reuse, unused land developing and planting system adjustment. These lands only account for 1.6% in total terrestrial area of China, and they hardly can be used by agriculture and forest. The bioenergy development and food security are harmonized if these lands are used to plant feedstock of biofuel in future.

(K03) Selecting Metrics for Sustainable Bioenergy Feedstocks

Virginia Dale

Environmental Sciences Division, Oak Ridge National Laboratory

Key decisions about land-use practices and dynamics in biofuel systems affect the long-term sustainability of biofuels. Choices about what crops are grown and how are they planted, fertilized, and harvested determine the effects of biofuels on native plant diversity, competition with food crops, and water and air quality. Those decisions also affect economic viability since the distance that biofuels must be transported has a large effect on the market cost of biofuels. The components of a landscape approach include environmental and socioeconomic conditions and the bioenergy features [type of fuel, plants species, management practices (e.g., fertilizer and pesticide applications), type and location of production facilities] and ecological and biogeochemical feedbacks. Significantly, while water (availability and quality) emerges as one of the most limiting factors to sustainability of bioenergy feedstocks, the linkage between water and bioenergy choices for land use and management on medium and large scales is poorly quantified.

Metrics that quantify environmental and socioeconomic changes in land use and landscape dynamics provide a way to measure and communicate the influence of alternative bioenergy choices on water quality and other components of the environment.

Cultivation of switchgrass could have both positive and negative environmental effects, depending on where it is planted and what vegetation it replaces. Among the most important environmental effects are changes in the flow regimes of streams (peak storm flows, base flows during the growing season) and changes in stream water quality (sediment, nutrients, and pesticides). Unfortunately, there have been few controlled studies that provide sufficient data to evaluate the hydrological and water quality impacts of conversion to switchgrass.

In particular, there is a need for experimental studies that use the small watershed approach to evaluate the effects of growing a perennial plant as a biomass crop. Small watershed studies have been used for several decades to identify effects of vegetation type, disturbance, and land use and agriculture practices on hydrology and water quality. An ideal experimental design to determine the effects of conversion to switchgrass on surface water hydrology and quality would involve (1) small catchment (5-20 ha) drained by a perennial or ephemeral stream, (2) crop treatments including conversion from row crops to switchgrass; pasture to switchgrass (other likely scenarios); controls (no change in vegetation), (3) treatments to compare different levels of fertilization and pesticide application, (4) riparian treatments to compare riparian buffers with alternative cover types) and a treatment with no buffer, and (5) 3-4 replicates of each treatment or BACI (before-after, control-intervention) design for unreplicated treatments (ideally with several years of measurements prior to the imposition of treatments for BACI design). Hydrologic measurements would include soil moisture patterns with depth and over time; nitrogen and phosphorus chemistry; soil solution chemistry - major anions and cations, inorganic and organic forms of carbon, nitrogen and phosphorus; precipitation amount and chemical deposition; stream discharge; and streamwater chemistry.

These water quality metrics would need to be put into context of the other environmental and social conditions that are altered by growth of bioenergy feedstocks. These conditions include farm profits and yield of food and fuel, carbon storage and release, and a variety of ecosystem services such as enhanced biodiversity and pollinator services.

Innovations in landscape design for bioenergy feedstocks take into account environmental and socioeconomic dynamics and consequences with consideration of alternative bioenergy regimes and policies. The ideal design would be scale-sensitive so that economic, social, and environmental constraints can be measured via metrics applicable at relevant scales. To develop a landscape design, land managers must consider (1) what are the environmental impacts on water and air quality, carbon sequestration, and native plants and animals and their habitats; (2) what is the appropriate spatial and temporal scales at which to examine environmental effects, and (3) how can potential tradeoffs in environmental costs and benefits be considered.

Tradeoffs exist across space and time among the economic, ecological, and social consequences of alternative choices. For example, the implications of increased biofuel production from corn at a local scale may be to increase pesticide use, which could negatively affect human health. At a regional scale, nutrient flux may increase and thus degrade water quality. At the scale of the Mississippi River watershed (48% of the U.S.), production may increase the hypoxia zone in the Gulf of Mexico and cause decline of shrimp harvest in the region.

Environmental implications of biofuel choices are significant. They range from effects at the level of individual fields to hydrological response units, small watersheds, large watersheds, and, potentially, the entire world. The complexity of these issues calls for a systematical approach to understand the interactions between different implications and other forces affecting bioenergy production and land-use changes. The many implications of biofuel and cropping system choices also require multiple indicators at the different relevant spatial and temporal scales. The opportunity to design bioenergy feedstock systems to optimize socioeconomic and ecologic benefits must build from the growing scientific understanding of effects of bioenergy choices at different scales, quantitative metrics, and ways to deal with environmental tradeoffs.

(K04) Recent Progress in Biomass Energy Studies at USTC

Xi-Feng Zhu, Quan-Xin Li, Qing-Xiang Guo*

Anhui Key Laboratory for Biomass Clean Energy,

University of Science and Technology of China

As one of the renewable resources, biomass can be converted into clean energy through thermochemical method. Fast pyrolysis of biomass is a liquefaction process which directed to the production of liquid fuels.

A pyrolytic equipment was designed and set up in our laboratory, which has been used to convert biomass, for example, forest products, agricultural wastes and residues into bio-oil, a crude liquid fuel.

Experimental results indicated that the pyrolysis temperature at 420°C~540°C was suitable. Below 420℃, more charcoal formed, however, when the temperature over 540℃, the yield of liquid products decreased. The relationship between the liquid product yields and pyrolytic temperature showed that the liquid fuel yields for all kinds of feedstock increase firstly and then decrease varying with temperature. The maximum liquid yields for rice husk, sawdust and their mixture are 56%, 61% and 60% at 465℃, 490℃ and 475℃,respectively. The gas products yield for all kinds of starting biomass always increase with temperature, and charcoal decreases at higher temperature.

The energy density of the bio-oil is much higher than that of rice husk or sawdust so that it is convenient for transportation and utilization. In addition, it is worthy to note that the liquid fuel contains little S, N elements and other pollutants. The bio-oil produced from biomass can be directly used as a fuel for combustion in boiler and furnace without any up-grading. Alternatively, it can be refined to vehicle fuels.

Un-condensable products formed in the pyrolysis are gaseous mixture with low caloric value mainly due to the dilution of carrier gas nitrogen. The carrier gas nitrogen was replaced by the un-condensable gas in this work, resulting gas products with higher quality.

Energetic performance of the conversion process has been analyzed. The thermal energy contained in charcoal is more than the energy consumed by electric heating. Electricity is one of the most expensive energy. The cost of the conversion was greatly reduced when the electric heating and the carrier gas nitrogen were replaced by charcoal combustion and its hot gas, respectively.

The crude bio-oil was further converted to hydrogen or syngas through stream reforming process. A novel approach to produce hydrogen from bio-oil was obtained with high carbon conversion (>90%) and hydrogen yield (>90%) at T< 500℃by using the electrochemical catalytic reforming of oxygenated-organic compounds over the usual 18%NiO/Al_2O_3 reforming catalyst. Moreover, liquid fuels, e.g., gasoline, diesel and alcohols, have been synthesized via the biomass-based syngas in our laboratory.

Acknowledgement: This research was supported by the MOST “973” Project, Ministry of Education “211” Project, CAS, NSFC and Anhui Provence.

***Corresponding Author. E-mail: qxguo@ustc.edu.cn**

(K05) Quantifying Soil Carbon Cycle Mechanisms and Flux Using ^{14}C-Enriched Leaf Litter Manipulations: Implications for the Accumulation of Carbon In Soil

Paul J. Hanson[1], Mats Fröberg[2], Chris Swanston[3], Susan Trumbore[4], Margaret Torn[5], and Julie Jastrow[6], Tom Guilderson[7], and William J. Parton[8]

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Localized near-background releases of $^{14}CO_2$ from waste incinerators on or near the Oak Ridge Reservation (N 35° 58'; W 84°16') provided the opportunity for unique observations of the soil carbon (C) cycle at ecosystem-relevant scales. Multi-year manipulations of enriched litter additions harvested from enriched forest stands were developed as a part of the Enriched Background Isotope Study (EBIS). That study was designed to resolve key soil C cycling processes using the unique isotopic tracers for quantitative estimates of key C pools and fluxes.

The EBIS experiments included two experimental efforts: (1) a multi-year, enriched-leaf-litter addition study for tracking annual movement of labeled C for a full range of soil depths and chemical forms, and (2) a mesocosm-based study with intra-annual resolution to follow the fate of leaf-litter-derived ^{14}C-enriched material to dissolved organic C, organic and soil C pools, and CO_2 release. The leaf litter manipulation study included 3 sequential years of enriched leaf litter additions followed by two years of observations, and the mesocosm study lasted nearly two years covering two summer periods.

After one year of enriched (1005‰) or background (221‰) litter additions (2002 data points), recognizable litter greater than 1-year of age (Oi>1Y) showed the expected patterns of enrichment or dilution. There was little evidence of new C movement below the Oi horizon after one year. Surprisingly, after the second and third year of enriched litter additions (910‰ and 993 ‰, respectively) the Oi ^{14}C-signatures did not continue to increase for the 'enriched' treatment plots. ^{14}C-signatures with enrichment or dilution patterns developed within the Oe/Oa horizon after three years of treatments, and continued to develop as the enriched cohorts migrated downwards. Five years after the initial leaf-litter cohort additions, there was little evidence for a net change in the ^{14}C-enrichment of bulk mineral soils. Large C stocks may, however, mask small changes and unenriched root turnover may be masking some increases expected from enriched litter additions. These conclusions demand the addition of new structural and functional details to common biogeochemical cycling models (e.g., DayCent), and such changes are in progress.

At the annual time step resolution of the EBIS litter-manipulation studies, ^{14}C-enrich litter additions did reveal dissolved organic carbon (DOC) as a rapid mechanism for transferring surface C deep into the mineral soils. However, the annual net amount of DOC retained between 15 and 70 cm was quite small (1.5-6 g m^{-2} y^{-1}). The mesocosm observations revealed that DOC released from enriched Oi horizon material was not retained within the subtending humus. Extensive short-term retention of DOC does, however, occur in the A horizon but most is respired back to the atmosphere within an annual cycle. DOC leaching from the A horizon consisted of a mix of DOC from different sources, with the main fraction originating in the A horizon and a smaller fraction leached from the overlaying horizons (i.e., only a limited amount was derived from surface enriched litter).

Combined EBIS results suggest that in the absence of significant macrobiotic bioturbation (worms, tillage practices) incorporation of surface litter C into the minerals soils is a very slow process. Root turnover should therefore be viewed as the primary source of near-term soil C accumulation. Active management strategies to enhance soil C accumulation might look to highly productive genotypes having enhanced belowground allocation of recalcitrant C forms. Data generated from the tracking of isotopic labels over a limited number of annual cycles confirm the net effect of long-term litter addition and removal studies, but also allowed us to isolate and propose the underlying mechanisms necessary to capture critical soil C cycling processes.

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(O01) Development Potentials and Policy Options of Biomass in China

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Biomass, one of important renewable energy, is playing and will continue to play an important role in future energy structure all over the world. China government has consistently promoted the development of biomass since 1980s. For renewable energy in general, it has developed rapidly in the past ten years in China. In 2005, China's renewable energy provided 8% of total energy consumption, excluding the traditional use of biomass energy, and renewable power provided near 16% of China's total electricity output. Since the enforcement and effectiveness of Renewable Energy Law in 1st of January 2006, renewable energy industries have been become one of the hot points, and the development of renewable energy in China will also make a great contribution to global climate change alleviation.

Biomass is at a rapid development stage in China, and some technologies are commercialized or near commercialized and have large development potential from resource, technology and industry points. Biomass has begun to play a role in the energy structure, and has the potential for large scale development and occupies a certain position. It is expected that the biomass will be important substitute energy especially at the remote rural areas in China. Meanwhile, biomass will make more and more contributions for global climate change.

This paper mainly analyzes the position and role, resources availability and spatial distribution of biomass in China. It then reviews three common policy options, including feed-in law, renewable portfolio standards (RPS) and tendering, which are the three most prominent policies in the US and Europe to stimulate the commercialization of renewable energy projects, and points out their conditions for application in China's biomass development. It also analyzes some current policy choices in China, focusing on the approaches of legislation, strategic planning and economic incentives.

Key words: Biomass; Resources Availability; Policy Option; China

(O02) Environmental Grand Challenge of Biodiversity Loss

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The planet's biological diversity is rapidly being lost due to multiple pressures of anthropogenic origin. Over-fishing, poaching, deforestation, climate change and other factors have resulted in an increased extinction rate the like of which has not been seen since the end of the Mesozoic. This, combined with the fact that perhaps as little as only one species in six has been described by science means that most of the species of organisms on the planet might go extinct before they are even discovered. This presentation focuses on the relationship between the biodiversity crisis and biofuels. Since the biofuels economy will likely be based upon a new agricultural paradigm, it will have far reaching ecological impacts that will include exacerbating the extinction crisis. In order to prepare for this eventuality, systematic studies are needed for a wide range of organisms, including studies of taxonomy, biogeography and genetics.

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(O03) The Woody Bio-energy Development and Its Possible Effects on Ecological Environment in Jiangxi Province

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With the gradual exhaustion of fossil fuel on the earth, the energy price is increasing year by year. As a result, the development and utilization of bio-energy is achieving more and more attention in the world, and some bio-energy related projects have even been drawn up.

China is a nation with large area of highland and upland, the mountainous or hilly area takes 43% of the national territory total. So, it is very important to fully use these hilly areas in bio-energy development in China and woody species will take the most important role.

There are many woody species are suitable for bio-energy purpose in China, and 5 species, including *Jatropha curcas L*, *Pistacia chinensis*, *Xanthoceras sorbifolia*, *Cornus wilsoniana* and *Camellia oleifera*, are considered to be the most important and valuable species. *Camellia oleifera* oil, named as "oriental olive oil", is a high-class and healthful edible oil, which is highly approved by huge consumers domestic and abroad.

Jiangxi province, locating in the southern China, is very suitable for the development of wooded bio-energy, because the highland and upland take as much as 78% of the provincial territory. The total area of barren hill and slope is about 200,000 hectares in Jiangxi,and the area of *Cornus wilsoniana* plantation will exceed 66700 hectares by 2010.

This report elaborated the characteristics, the planting extensions, the situations of development and management on the bio-energy trees of *Cornus wilsoniana* and *Camellia oleifera*. A comparison was made on the optimum reaction conditions, the physical and chemical properties in extracting bio-diesel from four oils of *Jatropha curcas L*, *Cornus wilsoniana*, *Camellia oleifera*, *Vernicia fordi*,and *Rape Oil*. The importance of tree species selection and optimization was addressed. The feasibility that linking the forest stand improvement and woody bio-energy development was discussed. We also exhibited the blueprint on the bio-energy study of our group.

(O04) Using Hydrologic Tracers and Geochemistry to Assess Surface Water and Ground Water Interactions for Ecosystem Sustainability

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In many cases the ability to determine and quantify groundwater and surface water interaction can be difficult, depending on the scale of the interaction and problem posed by the research. The task is further complicated by possible transient interactions that can obscure geochemical signals observed in the groundwater, or surface water system. As climate change drives the hydrologic variability in natural systems, the question of the net impacts to ecosystems, including agricultural systems will be a primary concern for the sustainability of these systems. The impetus of this work is to provide case studies where hydrologic conceptual models were tested along with geochemical and isotopic evidence. The tracer techniques used in the research include geochemical, stable isotopes, and the radioisotope beryllium-7 which provide a robust dataset for evaluation of the groundwater – surface water interactions.

Hydrologic conceptual models can be best evaluated given a range of geochemical and isotopic synoptic data. As shown below, **Figure 1**, identifies a conceptual model for the Ramsey Prong Basin in the Great Smoky Mountain National Park in eastern Tennessee, where aquatic habitat sustainability has been a primary concern. Synoptic geochemical and isotopic data were collected from several locations along the main channel of the Ramsey Prong to begin to develop and understanding of the hydrologic interfaces within the stream and groundwater reservoir.

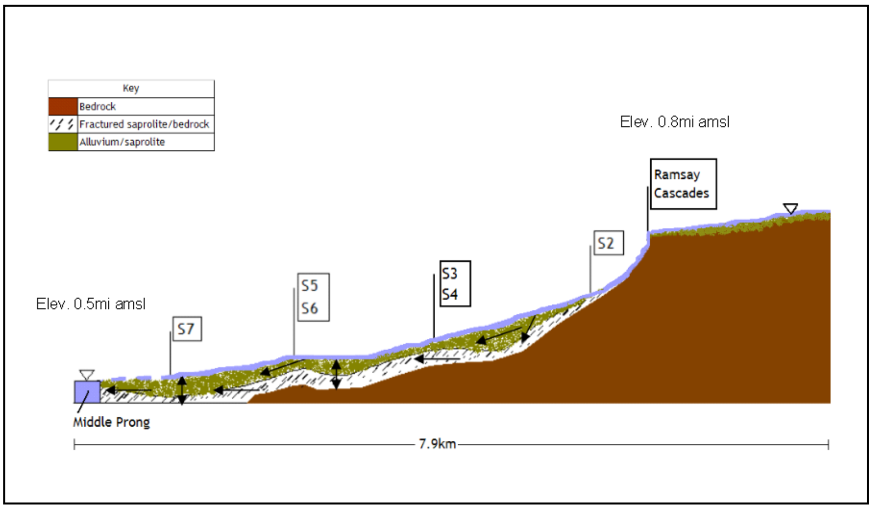

Figure 1. Conceptual model for the Ramsey Prong Basin in GSMNP.

(O05) Crop Production Defined by Climate and Water in the North China Plain

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The North China Plain (NCP) is one of the major winter wheat (Triticum aestivum L.) producing areas in China. Excessive pumping of groundwater for irrigation has significantly lowered the water table, which leads to the imbalance between use and replenishment of groundwater resources. Sustainable agricultural water management requires to better understand how crop yield, water productivity (WP) and water balance components, are affected by climate variability and management practices.

Agricultural systems modeling is a useful means to analyze the performance of farming systems under long term historical climate variations. Crop models were calibrated and validated, against three years (1998-2001) of experimental data of wheat-maize rotations at Luancheng in the NCP. They were used to simulate crop production and water balance components as affected by climate variations and water management strategies.

Without irrigation, the simulated GY of wheat ranged from 0 to 4,500 kg ha^{-1}, and of maize from 0 to 5,000 kg ha^{-1}. Applying one-, two-, three- or four irrigations based on soil water status could increase the mean wheat yield to 2,900, 4,000, 4,800 or 5,200 kg ha^{-1}, respectively. The mean maize yield was 2,600, 4,600, 5,800 kg ha^{-1} by no-irrigation, one- and two irrigations applied, respectively. Crop yield increased disproportionately with irrigation water supply. WP increased from no-irrigation to two-irrigation, but there is little difference or decrease from two- to four-irrigation for wheat, and it is almost same for one- and two-irrigation for maize. The irrigation water requirement varied greatly with climatic conditions, ranging from 140 to 270 mm under different irrigation schedules for wheat, and 130 to 170 mm for maize. ET increased with the irrigation amount. Under the double cropping system, there is little deep drainage (DD) to recharge the groundwater except during the maize season in extremely wet years when precipitation is high. In NCP irrigation water use determines the groundwater table change, heavy irrigations in this paper led to 1.5 m year^{-1} decline in groundwater table in area under study. One-, two-, and three irrigations (i.e., 65, 150 and 200 mm season^{-1}) are recommended for wheat to achieve the maximum WP in wet, medium and dry season types, respectively. For maize, no irrigation needs to be applied in wet years, while one- or two irrigations (i.e., 40 and 90 mm season^{-1}) in medium and dry seasons. With such irrigation scheduling, 2800 m^3 ha^{-1} of water could be saved for a crop rotation year with crop yield only 7.8 % lower than that with full irrigation.

Current wheat yields in the NCP stabilize around 5,000 kg ha^{-1} while the demand for wheat in China is growing due to the increase in population and the change in diet. Since options for area expansion of winter wheat are limited, the production per unit of area needs to be increased. We use a calibrated crop growth simulation model to quantify wheat yields for potential and water-limited production situations using 40 years of weather data from 32 meteorological stations in the NCP. Simulation results are linked to a Geographic Information System (GIS) facilitating their presentation and contributing to the identification of hotspots for interventions aimed at yield improvements. In the northern part of the NCP, average simulated potential yields of winter wheat go up to 9,700 kg ha^{-1}, while average water-limited yields only reach 3,000 kg ha^{-1}. In the southern part of the NCP, both average potential and water-limited yields are about 7,500 kg ha^{-1}. Rainfall is the limiting factor to winter wheat yields in the northern part of the NCP, while in the southern part, the joint effect of low radiation and high temperature are major limiting factors. Temporal variation in potential yields throughout the NCP is low in contrast with the temporal variation in water-limited yields, which is especially great in the northern part. The study calls for the collection of location-specific and disaggregated irrigated and rainfed wheat yield statistics in the NCP facilitating the identification of hotspots for improvement of current wheat yields.

Key words: Irrigation Scheduling; Temporal Variability; Spatial Variability; Potential Yield; Water-limited Yield; Crop Models.

(O06) Socioeconomic Considerations with Biofuels Production: A Preliminary Analytic Framework

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For biofuels production on a commercial scale, science and technology are essential. They are not sufficient, however. To optimally undertake biofuels production – in particular, growing and processing feedstock -- socioeconomic factors should be considered as well. This presentation lays out a preliminary framework for analyzing socioeconomic factors relevant to biofuels production. The framework is intended as a starting point for integrating these factors with environmental and technological factors, in order to systematically analyze conditions under which biofuels production can be undertaken effectively and sustainably.

Standard demographic information (e.g., population size and density; age, gender, education, and income composition) is an important basic platform. In addition, however, other socioeconomic factors need to be considered – for example: (1) economic opportunities and their commensurate requirements for capital, knowledge, and skills; (2) individual values, including values regarding change; (3) individual beliefs, together with typical information sources and typical methods for processing information and reaching decisions; (4) social structures and social norms; and (5) relationships between the public and private sectors. These factors must be considered within the context of scientific and technological innovation, various types and scales of biofuels production, and government policies and programs that directly address or indirectly affect biofuels production.

(O07) Energy Responding of the Crop System to Water Assignments in Taihang Mount Piedmont

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An ecosystem model (VIP model) is used to simulate the production of winter wheat and summer maize under different irrigation assignments in the Taihang Mount piedmont. Then energy flow of these planting systems (wheat and maize) is quantitative analyzed through serial energy indexes. The results showed that the yield of crops and the output of organic energy accrued as the input of water increased, leading to higher ratios of both energy investment and environment load. The energy conversion efficiency, environment load ratio and environment sustainability index were different in diverse planting system. It was also illustrated that the maximum environment sustainability index (total energy production/environment load ratio) could only been reached when moderate water was given. To keep the agriculture sustainable in this area, an optimum structure of planting system adapted to the water management should be developed.

(O08) Advances in Research on Germplasm Resources and Molecular Biology of Energy Plant Sweet Sorghum

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Facing the world's energy crisis and the increasing deterioration of the global environment, people urgently need to develop renewable energy sources. The importance of biomass energy as a clean, renewable energy source has been recognized. The shortage of biomass is one of the bottlenecks that should be overcome in developing bioenergy. Sweet sorghum is high in biomass production and sugar content, tolerates drought, water logging, low fertility and high salinity and alkalinity of the soil, and is regarded as one of the energy crops with greater potential for improvement. This paper reviews the recent advances and problems to be solved in research on the taxonomy, biological characteristics, germplasm evaluation and genome information of sweet sorghum, and discusses the prospects of the research and development of sweet sorghum as an energy crop.

Key words: Sweet Sorghum; Bioenergy; Advances in Research

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(O09) Carbon Budget Patterns of Forest Ecosystem in Poyang Lake Basin from 1901 to 2001

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Poyang Lake receives water from 5 major rivers (Gan, Fu, Xin, Rao, Xiu) and exports water into Yangzi River, which becomes an independent water system . The catchments of the whole Poyang Lake Basin has an area with 16.22 $\times 10^4 km^2$, which occupies about 97.2% of Jiangxi province. Since 1980s, the Integrated Management of Poyang Lake Watershed caused great changes in landscape and ecosystem. These ecological restoration projects have large effect on C cycle and C transport in Poyang Lake Basin. Research objectives of this study are as follow.

(1) To understand the spatial pattern of terrestrial C storage in Poyang Lake Basin through comprehensive inventory research of typical forest ecosystems;

(2) To simulate the spatio-temporal pattern changes of C balance in Poyang Lake Basin based on terrestrial C cycle model, which particular emphasis is placed on forest ecosystem；

(3) To assess the effect of ecological restoration project on C sources/sinks function in Poyang Lake Basin and present ecosystem C management measure.

Key words: Carbon budget; Forest ecosystem; Poyang Lake

(O10) Carbon Sequestration by Terrestrial Ecosystems and Its Contribution to Reduction of GHG Emissions in China

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Over past several decades, the interest in carbon sequestration by terrestrial ecosystems and its balancing the global carbon budget has been increasing since the terrestrial ecosystems can account for over 40% of the emissions of carbon from fossil fuels and are one of most important players in reducing greenhouse effect. As the third largest country (9.6 million squares kilometers) by the total land coverage, China occupies approximately 6.5% of the world land area and boasts diverse climates and biomes with latitudinal longitudinal, and altitudinal gradients or belts. The Chinese territory stretches about 5,500 km north to south and around 5,000 km east to west. There are tropical, subtropical, temperate, medium temperate and frigid temperate climate zones from the south of China to the north, and humid, semi-humid, semiarid to arid areas from the southeast to the northwest. The Tibetan Plateau, also known as the Qinghai-Tibetan (Qingzang) Plateau, is the highest and biggest plateau is covered by a high-altitude arid steppe interspersed with mountain ranges and large brackish lakes.

Carbon sequestration by terrestrial ecosystems in China plays an important role in balancing and reducing national greenhouse gas emissions. Over past two decade, based on the inventory data, ecological models and land-surface flux measurements, many studies have been conducted to quantify carbon sequestration potential of China's terrestrial ecosystems in terms of gross primary productivity (GPP) net primary productivity (NPP), net ecosystem productivity (NEP) and carbon stock in vegetation and soils. This presentation gives a brief introduction of present progresses of studies on carbon sequestration of China's terrestrial ecosystems and its contribution to reduction in GHG emissions. Many studies have shown that forests in China is a carbon (C) sink on average for atmospheric carbon dioxide, sink strength have a strong spato-temporal variability, and afforestation and reforestation play a critical role in this aspect. Grassland and agricultural ecosystems act either as a C sink or as a C source highly dependent upon locations and anthropogenic influences such as grazing, irrigation and fertilization. Wetlands in China posses a big capacity for carbon sequestration and its functioning as a carbon sink has become weak as a consequence of over-exploitation and biodiversity loss. Land use change over the last two decades due to rapid economic growth, especially industrialization and urbanization, may create a large impact to functioning and services of China's terrestrial ecosystems. It is still a big challenge to restore disturbed and depredated ecosystems (including grasslands, forests, crop fields, wetlands, etc.) in China to render them sequestrate atmospheric carbon in long-term. Meanwhile, a critical issue is to discern direct human effects and the impact of climate change on carbon sequestration. Besides, future study focuses for carbon cycling are put on how carbon sequestration potential of China' terrestrial ecosystems will vary in response to climate change and human disturbances and what are efficient ways to optimize this potential in the upcoming two or three decades.

(O11) Ecosystem–Atmosphere Carbon and Water Exchange Derived from ChinaFLUX Network Observations

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The eddy covariance flux measurements can provide plenty of information for studying the characteristics of carbon and water exchange over specific ecosystem and their responses and adaptations to climate change. And groups of flux towers spread across a landscape or biomes have evaluated the effects of disturbance, complex terrain, biodiversity, stand age, land use, land management (e.g. irrigation, fertilization, thinning, grazing, cultivation, prescribed burning) and low-probability events (e.g. summer droughts/heat spells, wind-throw, freeze damage) on carbon and water fluxes.

ChinaFLUX has carried out continuous measurements of carbon, water vapor and energy fluxes over typical forest, grassland and cropland ecosystems since 2003. The seasonal and interannual variation and annual budgets of carbon and water fluxes of typical terrestrial ecosystems in China were revealed and their response to environmental (radiation, temperature, water and soil nutrient) and biotic (photosynthesis, canopy structure, ecosystem function type and growing season) factors were investigated. Both the temperate forest and the subtropical evergreen forest in Eastern China are carbon sinks over the observation years, even there were considerable variability in their annual NEE due to climate fluctuations. There is large spatial and temporal variation in the carbon budget over different grassland ecosystems in China. Results showed that temperature and precipitation are the two key factors controlling the spatial pattern of ecosystem carbon budget in China.

Water-use efficiency (WUE) at stand level of different forest and grassland ecosystems was also estimated from flux observations. Average annual WUE was high at old temperate mixed forest and young subtropical plantation, and low at old subtropical evergreen forest. It was also found that temperate and subtropical forest ecosystems had different relationships between gross primary productivity (GPP) and evapotranspiration (ET). The asynchronous response of GPP and ET to climatic variables determined the coupling and decoupling between carbon and water cycles for the two forest types. Mean annual temperature and annual precipitation were also the main factors controlling the spatial pattern of WUE for the forest ecosystems in eastern China, especially in vegetative season. At grassland ecosystems, WUE racked closely with GPP in seasonality, suggesting that photosynthetic processes were the dominant regulator of the seasonal variations in WUE. Analysis indicated that leaf area index (LAI) is responsible for the seasonal and interannual variations, as well as the inter-site difference, in WUE of grasslands.

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(O12) Biotechnology Tools for Switchgrass Improvement

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Switchgrass (*Panicum virgatum* L.) has been identified as a bioenergy crop because of its high productivity, low inputs, and wide adaptability. Switchgrass can possibly be an effective alternative energy source and an environmental friendly bioenergy crop plant. Switchgrass is native to most of the US and known as an obligate outcrosser, and the germplasm for cropping is still quite 'wild' in its morphology. Furthermore, like other plants, its cell walls are recalcitrant to digestion for cellulosic applications. Data in Tennessee and elsewhere indicate that the variety 'Alamo' is the highest yielding type in most field trials conducted to date. Therefore Alamo is a relevant starting germplasm for genetic manipulation.

It is widely considered that biotechnology will be useful both to rapidly improve bioenergy crops as well as providing tools to genetically manipulate them for scientific evaluation. While there exist tissue culture and genetic transformation procedures, these are largely inefficient and in need of improvement if switchgrass is to fulfill its potential for increased biomass and lower recalcitrance. Basal tools such as transient expression and appropriate vectors can accelerate improvements of stable transformation systems.

Our research group is interested in engineering switchgrass for 4 suites of traits: 1. Altered plant architecture for shorter internodes, delayed flowering and altered shoot:root growth allocation; 2. Decreased recalcitrance by altered expression of cell wall biosynthesis genes, including those for lignin biosynthesis; 3. Decreased recalcitrance by the expression of cell wall degrading enzymes, especially cellulosomes; and 4. Biocontainment to eliminate gene flow through pollen.

During the early stages of our switchgrass biotechnology research program we have developed enabling technologies and tools. The first of these is a protoplast system for transient evaluation of transgenes. We developed a protocol to isolate large numbers of viable protoplasts from both leaves and roots of two switchgrass genotypes. Furthermore, we demonstrate transient expression of polyethylene glycol (PEG)-mediated DNA uptake in the isolated protoplasts by measuring the activity of β-glucuronidase (GUS) reporter gene driven by either the C*auliflower mosaic virus* (CaMV) 35S promoter or the maize ubiquitin 1 promoter. Protoplast transformation with either the 35S or the ubiquitin promoter resulted in an increase in GUS activity compared to the untransformed controls; however, the extent of GUS activity was considerably higher for the ubiquitin promoter than for the 35S promoter.

Second, we have designed and constructed a versatile set of 24 Gateway-compatible destination vectors (pANIC) to be used in grasses. Gateway compatibility allows for convenient insertion of any open reading frame (ORF) or other target sequence of interest. These vectors can be used for 1) transgene overexpression or 2) targeted gene silencing using double stranded RNA interference. Two main transformation methods exist for monocotyledonous plants: biolistic bombardment and *Agrobacterium*-mediated transformation. The pANIC set includes vectors which can be utilized for both applications, with all vectors containing three basic elements: 1) a Gateway cassette for overexpression or silencing of the target sequence, 2) a plant selection cassette and 3) a visual reporter cassette.

Third, we are improving tissue culture and transformation methods for switchgrass to enable high throughput transformation. It is important for these tools to be further developed to realize the full potential of biotechnology to modify switchgrass for improved bioenergy applications.

(O13) Life Cycle Assessment: Principles and Its Application to Biofuel Technologies

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Similar to living organisms, engineered products and systems have their life cycle as well i.e. from raw materials extraction and acquisition, manufacturing, transportation and distribution, use and maintenance, reuse and recycle, and all the way to disposal and waste management. A product or system interacts with the environment directly or indirectly through energy and material flows at every stage of its life cycle. This complicates the development of "greener" products or systems since traditional analyses focus only on one certain life cycle stage and may lead to shifting of environmental consequences from one life cycle stage to another, from one geographic area to another, and from one environmental medium to another. By taking a cradle to grave approach, Life Cycle Assessment (LCA) evaluates all the interdependent stages of a product's life cycle as well as the accompanying material and energy exchanges with surrounding industrial infrastructures and ecological systems holistically. LCA enables the estimation of the cumulative environmental impacts, and provides a comprehensive view of the environmental aspects of the product or process and a more accurate picture of the true environmental trade-offs. As defined by US EPA, LCA is a technique to assess the environmental aspects and potential impacts associated with a product, system, or service, by 1) compiling an inventory of relevant energy and material inputs and environmental releases; 2) evaluating the potential environmental impacts associated with identified inputs and releases; 3) interpreting the results to help you make a more informed decision. Performing LCA can help engineers and decision makers fully characterize the environmental trade-offs associated with product or process alternatives. So far LCA is arguably the most powerful tool available for the development of product, system, and technology that enhance environmental sustainability.

One area within which LCA methodology has been finding increasing application is biofuel technology development. Although being critical to provide energy and mobility essential to our society and economy, current practices in transportation fuel production are far from sustainable. Until now the U.S. transportation sector relies almost exclusively on gasoline and diesel derived from petroleum oil as the energy source, which leads to mounting environmental concerns including climate change and resource depletion. Biofuels, as the main alternatives to petroleum based fuels, have been receiving increasing attention. However, expanding biofuel (e.g. corn or cellulosic ethanol and biodiesel) production may lead to serious environmental consequences including biodiversity loss, landscape change, soil erosion, and water resource degradation and depletion. Transportation fuels, either petroleum based, or alternatives such as biofuels, impacts the environment through material and energy flows over entire life cycles. Consequently the environmental sustainability of biofuel technologies can only be evaluated holistically using tools such as LCA. In this presentation, applying of LCA methodology to a variety of biofuel technologies in production or under commercialization is reviewed, and challenges facing the development of LCA models for evaluating the environmental sustainability of biofuels are discussed.

The most widely used LCA tool to evaluate the environmental impacts of alternative transportation fuel technologies is the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model developed by Argonne National Laboratory. The GREET model takes into account the consumption of total energy, petroleum, coal and natural gas, greenhouse gas, and regulated air emissions (i.e. volatile organic compounds, carbon monoxide, nitrogen oxide, particulate matter with size smaller than 10 micron, particulate matter with size smaller than 2.5 micron, and sulfur oxides) over the entire life cycle. Besides energy consumption and GHG emission, there are other environmental impacts that need to be considered in the development of sustainable transportation fuel technology. These include water resource depletion and degradation, land use, soil erosion, food supply, biodiversity, to name a few. Numerous research is ongoing to expand GREET model to include these impacts, with initial efforts on land use and water resource. A preliminary analysis on life cycle energy consumption, GHG emission, fresh water withdrawal, and land use of representative biofuels (both biochemically and thermochemically derived) is presented here. It is argued that the major challenges associated with conducting a more complete, predicative LCA include data availability, model and data uncertainty, co-product credit/burden allocation, and controversies on weighing different environmental impacts.

The current efforts in developing LCA model could eventually lead to tools that quantify the potential of biofuel technologies for improved energy security and reduced environmental degradation, which have been the two major concerns associated with the current transportation fuel system. However, these efforts may not be sufficient to address the issue of resilience, an important perspective of sustainability. Since global environmental degradation is a result of the complicated dynamic interaction of socio-economic, institutional, and technological activities, it is not realistic to view environmental sustainability as steady state equilibrium. Therefore, a sustainable engineering solution itself should also be “sustainable” or resilient. That is, it should be able to survive external disturbances even they are large or unforeseen. Unfortunately, traditional engineered systems are usually designed to operate within a narrow range of states close to the optimum, and they tend to resist perturbations from the optimum. These systems can recover rapidly from small and anticipated disturbances but may fail catastrophically under large or unforeseen perturbations. In contrast with engineering systems, an ecological system usually can survive large unforeseen perturbations and either maintains its function and structure or under certain conditions shifts to a different equilibrium state with different function and structure. Although biofuels reduce the dependence on foreign oils thus bring resilience against supply shock of crude oil to transportation fuel production while improving energy security, challenge of resilience remains since production of biofuels could be vulnerable to many hazards that can damage crops, ranging from drought to plagues to storms (e.g. the recent Midwest flooding). This is especially true if the technology depends heavily on a single feedstock as the energy source. Therefore, a sustainable biofuel technology should maintain some key characteristics of an ecological system, i.e., diversity, efficiency, adaptability, and cohesion in order to be resilient. These characteristics again can only be evaluated holistically. Toward this end, integrating resilience evaluation into LCA methodology is discussed to conclude this presentation.

(O14) Research Progress on Key Process and Intergrated Eco-industrial Chains of Biobased Product-Proposal of Biobased Product Process Engineering

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Bioprocessing of biomass to bioenergy, biomaterials and biochemicals has been becoming a hot topic internationally. Presently, the main problem for bio-products preparation is lack of effective components fractionation technology and integrated conversion process. Based on cellulosic feedstock characteristic and key issues related to conversion process and product engineering, the concept of biobased product process engineering is proposed. In addition to giving a novel fractionation–conversion system of biomass, this paper also introduces four key technical platforms, namely unpolluted steam explosion and components fractionation, purified microbial solid-state fermentation, solid-phase hydrolysis coupled with liquid-phase ethanol fermentation, and recycling membrane hydrolysis-fermentation. The fractionation–conversion system will provide R&D approach and technical support for the whole biomass utilization and bio-products eco-industrialization.

Key words: Biobased Product; Fractionation–conversion; Steam Explosion; Enzymatic Hydrolysis; Fermentation.

(O15) Production of Bio-Methane and Beyond

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Anaerobic digestion is a microbial process that breaks down and converts organic waste into biogas that contains methane at 60-70%. Distinguished from the methane in natural gas, it is also called bio-methane because this methane is generated from a biological process. In modern animal agriculture, animal waste is generated daily in large amounts on large animal farms. Theoretically, it is possible to select and adapt a thermophilic (high temperature) bacterial culture to a higher growth rate and to convert the waste into biogas at a higher rate. A thermophilic anaerobic digestion (TAnD) system for poultry manure was developed first in the laboratory. TAnD at 50-60 ^{o}C produced biogas at 4x higher rate than that at mesophilic temperatures (30-40 ^{o}C) and 10x higher than that at ambient temperature (15-20 ^{o}C). As a result, the TAnD volume can be more compact.

To prove the concept, a prototype TAnD was constructed and operated on the North Carolina State University research farm for a 4,000-hen house that generated approximately 400 kg manure each day. The digester was of a simple plug-flow design with a flexible plastic bag, equipped with an insulation system and a hot-water heater fueled by the biogas produced by the system. Hot water was added to the manure into the digester to give the desirable concentration and temperature of the digestion mixture. Daily biogas production was monitored by a gas meter and analyzed by a gas chromatograph. In three years of operation, the pilot digester produced biogas at high rate, 80% of the potential obtained in the tightly controlled laboratory digester. Many other ecological benefits were demonstrated with the system on farm. Nutrients in the effluent were recycled for feed supplement and aquaculture. The pathogens associated with fecal materials were completely destroyed by TAnD. Supported by UNDP, a TAnD for 50,000 laying hens with 5 tons of manure per day were constructed in Beijing in 1992. Made of concrete, the TAnD in Beijing is still in operation, but close to its retirement. The simple yet efficient TAnD design was awarded with a US patent in 1996. In recent years, large scale digesters, thermophilic or mesophilic, for daily treatment of hundreds tons of animal waste are increasingly popular in Europe and emerging in China. Biogas produced by large digesters can be converted into electricity and heat for neighboring townships and villages. It can be a significant source of bio-energy in rural areas. Utilization of methane can earn carbon credits and reduce GHG. Overall, it can be developed into an integrated system called Holistic Farming.

TAnD has multiple benefits in pollution abatement, nutrients recovery, odor reduction, pathogen and disease control (TAnD, in particular), energy production, and emission control of methane and ammonia. For many years, digester construction and operation, or the “hardware”, has been studied extensively by engineers. Unfortunately, the biological system, or the “software” is still a black box. An operating digester can be wealthy resources of anaerobic, facultative, and un-culturable microorganisms. It contains many novel enzymes and genes, yet to be identified and discovered.

A feather-degrading bacterium was discovered and isolated from the TAnD. Its keratinase and the gene encoding this enzyme were subsequently isolated and sequenced. Genetic manipulation for over-expression and up-scale fermentation made the mass production of the enzyme possible. This keratinase, capable of degrading all kinds of plant and animal proteins, is heat-stable and suitable for the use as a feed additive. Many research and commercial tests demonstrated that dietary supplement of the keratinase enhanced feed digestibility and improved poultry growth. A biotechnology company, namely, BioResource International, was founded for technology transfer and commercial development. Keratinase-based feed additive is now produced in industrial scale and marketed globally.

Key words: Thermophilic Anaerobic Digestion; Bio-methane Production; Feather Degradation; Keratinase; Feed Enzyme.

Acknowledgement: The author wishes to thank many former collaborators and students whose efforts have made the work possible. Research grants from USDOE, USDA, USFDA, US Poultry & Egg Association and NC Biotechnology Center throughout the years are greatly appreciated.

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(O16) Linking Biomass-based Liquid Fuel Production Capacity to Transportation Demand and Sustainability Goals

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Developing a sustainable biofuel production system requires the integration of a number of interdependent systems. Agricultural systems include biomass production, harvesting and transportation of biomass to processing facilities. Additional systems encompass the biorefining process, fuel distribution system and consumption of the fuel by end-users. At a conceptual level the overall objective is to optimize the efficiency with which we collect energy derived from land and transfer that energy to the wheels of a vehicle. In addition to considering the environmental impacts and sustainability of the technology for collecting energy from land (e.g. biomass, wind, solar) we must also consider the effects of the end-use vehicle technology on the total system. For example, burning ethanol in an internal combustion powered vehicle at less than 30% efficiency results in dramatically lower land-use efficiency than a system utilizing future fuel-cell electric powered vehicles. Farm based wind turbines that charge conventional battery powered electric vehicles approach 90% efficiency in transferring energy to wheels. Both enzymatic and thermal biomass processing technologies are under development that will produce a diverse array of biofuels. Evaluation of the processing efficiency, yields, impacts and the fuel performance and characteristics will be a necessary component of the transformation to sustainable renewable energy systems. Thus, visionary optimization of modern renewable energy systems requires consideration of new energy sources and new vehicle technology. For example, it is possible to combine biomass cropping systems with wind farms to achieve even greater land-use effectiveness for producing energy. Linking production capacity with liquid fuel demand and needs must also be included in the system analysis. Determining the most critical needs for liquid fuel is necessary for ensuring that biofuel supply capacity meets the transportation demand side. Because there are no commercially feasible alternatives to liquid fuel for aircraft, supplying biofuels to this transportation sector could be a critical need. In contrast there are numerous alternative technologies available for personal vehicles, such as electric cars. Furthermore, inclusion of electric personal vehicles in transportation system planning would alleviate demand side pressure on biofuels and improve urban air quality as well. The evaluation of future transportation technology and fuel demand for heavy trucks, rail and marine shipping is also necessary to complete reasonable forecasts of the sufficiency of future liquid fuel production capacity and subsequent integration into the overall transportation infrastructure.

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(O17) An Industrial Demonstration of Corn Stover Based Ethanol Processing in China

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The production of fuel ethanol from lignocellulosic material such as corn stover is one of the major alternatives to supply renewable transportation fuel in the future. Industrial demonstration of fuel ethanol production from lignocellulosic feedstocks such as corm stover is a key step towards the commercialization of the processing technology. Currently in China there are at least five demonstration plants scaled from 3,000 t/a to 15,000 t/a fuel ethanol using corn stover or wheat straw for production of fuel ethanol is under the construction and operation test for the purpose of technical and economic feasibility assessment of the commercial production of lignocellulosic feedstocks. Most of the demonstration plants were supported either by the government grant or by the giant energy corporations such as PetrolChina or Sinopec. This presentation briefly introduces one of the major demonstration plant in the aspect of technical choices and flowsheet simulation.

In the industrial demonstration plant, corn stover was pretreated using steam explosion method in a continuous processing equipment of SunOpta Inc. (Toronto, Canada); the pretreated corn stover was hydrolyzed using the cellulase enzyme Accelerase 1000 from Genencor International (Rochester, NY, USA) under the very high solid loading up to 30% of water insoluble solid (WIS); the hydrolysate was fermented simultaneously with the saccharification (hydrolysis) into ethanol using a *Saccharamyces cerevisiae* mutant strain developed by our lab; the very high viscous ferment broth contains 7-8% (v/v) ethanol; finally the high viscous ferment broth was distillated in a two step process, first to a direct distillation without steam stripping to recover 90% of ethanol and then the 99.5% in the molecular sieve adsorption unit. The complete flowsheet of the industrial demonstration plant with the scale of 3000 tons ethanol annually was simulated Aspen plus software. The Aspen plus flowsheet was composed 26 compounds, 75 streams, and 34 blocks. The physical properties of the biomass compounds referred to several sources such as Aspen built-in database, the database by NREL, and other published sources. The practical process was mixed of the batch (Saccharification and fermentation) and continuous ones (pretreatment and distillation), an equivalent flowsheet was established to fit the steady simulation model on Aspen plus platform. The flowsheet simulation model was used to calculate the mass and heat balance for the design basis of the industrial demonstration plant. The flowsheet simulation model is used as the tool for the technical and economic assessment of the whole process technology.

Keywords: Industrial demonstration; Process technology; Fuel ethanol; Corn stover; Flowsheet simulation.

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(O18) Anaerobic-granule-based Reactors: Biohydrogen Production From Organic Wastes

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Hydrogen is an efficient energy carrier with high energy content per unit mass. Anaerobic fermentative production of H_2 decomposes organic substrates, and thus has an additional merit of converting organic wastes into more valuable energy sources. In this work, the experiment was conducted to evaluate the performance of an upflow anaerobic sludge blanket (UASB) with granules for H_2 production from a sucrose-rich wastewater at various, pH, substrate concentrations and hydraulic retention times (HRTs). Based on free energy calculations, the formation thermodynamics of caproate, an important aqueous product, were analyzed. The H_2 partial pressure, H_2 production rate and H_2 yield were pH-dependent, in the range of 0.28 to 0.52 atm, 61 to 145 ml-H_2/L/h and 0.68 to 1.61 mol-H_2/mol-glucose, respectively. The maximum H_2 partial pressure was observed at pH 3.4, while both maximum H_2 production rate and H_2 yield were found at pH 4.2. The H_2 partial pressure in biogas decreased with increasing substrate concentration, but was not sensitive to the variation of HRT in a range of 6-22 h. The H_2 production rate increased with increasing substrate concentration, but decreased with increasing HRT. The thermodynamic analysis on caproate formation suggests that the production of caproate was dependent on H_2 partial pressure and H_2, as an electron donor, would be consumed in the formation of caproate. The experimental results demonstrate that H_2 could be produced continuously and stably from the acidogenic-granule-based UASB reactor.

The characteristics of the H_2-producing granules were evaluated. The mature granules had a diameter ranging from 0.10 to 0.35 cm and an average density of 1.036 g/mL, whereas they had a high settling velocity of 32-75 m/h. The granules had fractal nature with a fractal dimension of 1.78. The ratios between the observed and predicted settling velocities by Stokes' law were in a range of 1.00 to 1.50, and their fluid collection efficiency ranged from 0 to 0.19, indicating that their permeabilities were lower and that there was little advective flow through their interior. Molecular diffusion appeared to play an important role in the mass transfer through the granules.

The hydraulic characteristics of the granule-based reactor were investigated using tracer studies and hydraulic models were developed to describe the sludge bed and liquid zones of reactor. Experimental results indicated a downward trend in the degree of mixing with increased both gas flow and liquid flow. The dead zone of the reactor was in a range of 0-0.19%, suggesting the poor hydraulic mixing of reactor could be neglected. A two-compartment axial dispersion model was more suitable to describe the hydraulic characteristics of H_2-producing UASB reactor than an *N*-compartment CSTR model. In addition, a linear dependence of the dispersion coefficient in the first zone on the liquid and gas upflow velocity was found.

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(O19) A Modified MEC-MFC Coupled Biocatalyzed System for Hydrogen Production

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Microbial fuel cells (MFCs) are devices that use bacteria as the catalysts to oxidize organic and inorganic matter and generate current, whereas microbial electrolysis cells (MECs) are a reactor for biohydrogen production using an extra power (above 0.6 V). The MEC-MFC-coupled biocatalyzed system was configured by combining the MEC and MFC, in which hydrogen was produced in a hydrogen-producing MEC and the extra power was supplied by an electricity-assisting MFC. The advantage of this system is the *in-situ* utilization of the electric energy of the related MEC/MFC as well as the hydrogen production without external power supply. The hydrogen production was elevated by increasing the phosphate buffer concentration. At 10 mM of phosphate buffer, the hydrogen production rate reached 2.2 ml l^{-1} d^{-1}, the cathodic hydrogen recovery (R_{H2}) and systemic coulombic efficiency (CE) were 88-96% and 28-33%, respectively, and the overall systemic hydrogen yield (Y_{H2}) peaked at 1.21 mol-H_2 mol-acetate^{-1}. The hydrogen production in the MEC-MFC-coupled system was manipulated by the power input on the MEC. R_{H2}, CE, and Y_{H2} decreased with the increasing in the loading resistance, and increased with the increasing in the MFC output voltage. To improve the power supply for hydrogen production, other MFCs were introduced into the coupled system in series or in parallel connections. When the MFCs were connected in series, the hydrogen production was significantly enhanced. In comparison, the parallel connection slightly decreased the hydrogen production. The MEC-MFC-coupled system has a potential for biohydrogen production from wastes, and provides an effective way for *in situ* utilization of the power generated from MFCs. Connecting several MFCs in series can effectively increase power supply for hydrogen production, and has potential to be used as an enhanced hydrogen production strategy in the MEC-MFC-coupled system.

(O20) China-US Cooperation in Bioenergy Research and Development

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The U.S. Department of Agriculture (USDA) and Department of Energy (DOE) have many ongoing projects and activities to foster cooperation among researchers in China and the US. This presentation provides a brief overview of several of these activities, focusing on plans for future research related to biomass resource assessment. Among the recent collaborations in bioenergy research and development are those related to:

1.The agriculture research collaboration protocol signed in 2002 and renewed in 2007 among MOST and USDA (Salazar)

2.The Biofuels R&D collaboration MOU signed December 2007 among NDRC and USDA- DOE (Kline, Wallace)

3.Other China – US collaborations:

1. U.S.-China Agriculture Science and Technology Protocol: USDA-Ministry of Science and Technology (MOST) Cooperation in Agriculture Science and Technology - Joint Working Group (Jorge Salazar)

In December 2007, the U.S. Department of Agriculture (USDA) and China's Ministry of Science and Technology (MOST) renewed a Protocol that supports expanded science and technology exchanges with China related to agricultural products. Specific areas of cooperation include agricultural biotechnology, natural resource management, dairy production and processing, food safety, agricultural product processing, biofuels research and development, and water-saving agricultural technology. Collaborative research takes place at virtual laboratories (U.S. and Chinese laboratories performing complementary work on topics of mutual interest) and covers issues related to grazing land ecosystems management, soil and water conservation, wheat quality and pathology, plant genetic resources exchanges, agricultural product processing, and bioenergy. Ongoing activities include:

National Resource Management: Collaborating on the Soil and Water Assessment Tool (SWAT) and considering a new cooperative research program on assessing soil degradation and erosion in the Northeast Black Soil Region, a major food production area of China.

Water Saving Technology: Collaborating on the proposed development of a Joint Center for Efficient Irrigation with the Ministry of Water Resources' Institute for Water and Hydropower Research (IWHR) in China. Research includes a proposal for an Economic-Hydrologic Decision Support Tool.

Agricultural Products Processing: Collaborating with the Chinese Academy of Agricultural Mechanization Sciences, on the proposed establishment of a USDA-MOST website. The website would be a place to release news on all MOST-USDA collaborative projects.

Agricultural Biotechnology: Collaborating with the Crops Research Institute in CAAS on a joint center for Wheat Quality and Pathology.

Bioenergy: Collaborating with Tsinghua University Institute of New Energy Technology; research proposals include a project to develop sorganol (production of ethanol from sweet sorghum stalks).

2. U.S. –China Biofuels Cooperation Memorandum of Understanding

The U.S. Department of Agriculture (USDA), the U.S. Department of Energy (DOE), and China's National Development and Reform Commission (NDRC) signed a Memorandum of Understanding (MOU) on biofuels cooperation. The two countries agreed to work together on the scientific, technical, and policy aspects of biofuels development, production, and use. These areas include biomass production and sustainability, conversion technologies, bio-based products, and rural development strategies. Activities are just getting underway. Two priority areas are associated with a biomass resource assessment and feedstock -conversion research associated with sweet sorghum and cellulosic ethanol production.

Integrated Biomass Resource Assessment Methodology – applied tools, software, and sustainability (Keith Kline, ORNL): The purpose of this task is to support development of a biomass resource assessment methodology that meets local planning and rural development requirements for China. This will be achieved through the exchange experiences, knowledge and tools that support crop resource assessments and analytical projections of future supplies (including examples of remote sensing and economic modeling). Sustainability criteria will be integrated as appropriate throughout the process, identifying key issues and decision points associated with the analysis of environmental, social and economic impacts. This set of activities will support collaborations to apply training and exchange experiences under related collaborations on Life-Cycle Assessment methodologies. Technical exchanges, seminars and applied training activities will be integrated with the three component areas identified in the MOU – (a) biomass resource potential assessment, (b) analytical tools, GIS and methods, and (c) sustainability – as the assessment methodology is developed and tested in a pilot activity. Training will be structured to promote bilingual participation and materials in both languages will be shared via an activity-tracking web page.

Feedstock-conversion research (William Wallace, NREL): Activities here are proposed to include: (a) evaluate the performance of specific fermentation organisms, including ones provided by both the Chinese and US partners, in processing environments that replicate Chinese conditions; (b) develop information on the performance of both the organisms and the ethanol and/or butanol production processes; and (c) characterize desirable changes to the organisms to improve performance in real-world industrial conditions. A joint US-China team will design a series of parametric bench-scale experiments, measurement protocols, and evaluation metrics to be used in evaluating ethanol and/or butanol fermentation organisms. One set of experiments will occur in U.S. laboratories and one set in Chinese processing facilities. The experiments will look at key issues such as (a) ethanol and/or butanol yields and titers for three different feedstocks, (b) organism ability to utilize various C5 and C6 sugars for each feedstock, and (c) the impacts of pretreatment conditions and the presence of inhibitors in hydrolysates on organism growth and performance. The US-China team will evaluate the data and develop a report.

3. Other China – US collaborations:

There are many other areas of China-US collaboration that are relevant to bioenergy research and development. These include additional formal agreements for collaboration on issues and topics that may overlap with bioenergy. Among the formal agreements that could be relevant are: (1) U.S.-China Environmental Industries Forum Memorandum of Cooperation; (2) Memorandum of Agreement on the Safety of Food and Feed; and (3) Guidelines for U.S.-China High-Technology and Strategic Trade Development. Climate change, modeling and monitoring represent another important area of interaction. Energy security, water, and global climate change are all linked.

(P01) Accelerated Domestication for Maximizing the Biomass Production and Characterization of Cell-wall Genes in Poplar for Bioenergy

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The genus *Populus* (poplar), including aspens, cottonwoods, and their many hybrids, has been recognized as a leading candidate for dedicated woody biomass crop by the Department of Energy of the United States. The genus *Populus* has also been adopted as a model for forest tree genetics and genomics (Bradshaw *et al*. 2000). The reasons are that *Populus* has:1) a small genome size --the haploid genome size is only ca. 520 Mbp, similar to rice, only 4x larger than *Arabidopsis* and 40x smaller than pine, 2) rapid juvenile growth -- allowing meaningful measures of important traits to be taken within a few years after establishment of genetic trials, 3) heterosis (*i.e.*, hybrid vigor) commonly occurring among interspecific hybrids – allowing best genetic combination being captured and maintained, and exploited for establishing extensive industrial poplar plantations for forest products and bioenergy, 4) ease of clonal propagation -- allowing manipulations to be evaluated across common genetic backgrounds, destructive sampling (*e.g.*, wood quality assessment) without loss of the genotype, replication of experiments across time and space, and genetic stocks to be archived in clonal nurseries to be shared with researchers worldwide, and 5) high-throughput transformation and in vitro propagation -- transgenic trees can be produced, thus allowing detection and characterization of gene function. Since the latest whole genome duplication is relatively recent, *Populus* is also unique for studying genome evolution and functional divergence of duplicated genes. Our *Populus* programs focus on accelerated domestication for maximizing the biomass production through biotechnology and characterization of cell-wall genes in poplar for bioenergy.

To be used economically for bioenergy production, poplar must be produced in high yield, low cost with “designed” cell wall properties for successive characterization and conversion. Any strategies for improving traits related to the biomass production and reducing the production costs will greatly reduce the overall biomass feedstock cost, therefore, making bioethanol more economically competitive. The target traits which have been investigated include: 1) enhancement of rooting from hardwood cuttings, 2) enhanced biomass productivity through accelerated growth rate, unit land productivity, and extended growth period, and 3) enhanced production efficiency in marginal land through improving stress tolerance and fertilizer use efficiency. Through deployment of such high-yielding, highly water- and land-use efficient poplar for plantation, it will make bioenergy crop production more effective and cost of feedstock materials less expensive and environmentally more sustainable.

The second major focus area is to understand cell wall biosynthesis and regulation. Processing cellulosic biomass for bioethanol will be more efficient if the cell walls are “designed” for more efficient chemical or enzymatic treatment. Such design for cell wall properties requires better understanding of cell wall formation and degradation which are controlled by many large families of genes. We are currently characterizing several cell-wall-formation related gene families: 1) the xyloglucan endotransglucosylase/hydrolases (XTHs), which cut and paste the cross-linking xyloglucan polymer linking to cellulose microfibrils, 2) endo-β-mannanase gene family which is involved in cell wall assembly, 3) the

Cobra gene family, which is involved in cell wall expansion and lignin/cellulose deposition and balance, and stem strength, 4) the caffeoyl-CoA O-methyltransfrase (CCOMT) family which is involved in lignin biosynthesis, 5) the core lignin biosynthetic genes in poplar, and 6) the carboxyl methyltransferase genes involved pectin biosynthesis. More details will be described in the poster.

Another focus area is to study the *Populus* genome evolution and duplicated gene divergence. We have studied Dof gene family, XTH and methyl salicylate esterases.

Selected Publications:

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7 Zhao, N., J. Guan, F. Forouhar, T. J. Tschaplinski, Z.-M. Cheng, and F. Chen. Two poplar methyl salicylate esterases display comparable biochemical properties but divergent expression patterns. Submitted.

8 Ye, X. and (Max) Zong-Ming Cheng The COBRA Gene Family in *Populus* and Gene Expression in Vegetative Tissues and in Response to Hormones and Environmental Stresses. Submitted.

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(P02) A Model for Investigating the Impact of Nanoparticles Potentially used in Agricultural Production of Biofuels and Present in Surface Runoff in Aquatic Systems

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Grain-based ethanol production has increased dramatically with rising oil costs. Government policy requires major increases in production of corn-based ethanol as a viable alternative energy choice. Biofuel production is dependent on application of fertilizers and pesticides to increase large-scale crop production levels to supply increasing demand. Application of nanoparticles (NPs) in agriculture is being widely developed in gene therapy, modified seeds and most abundantly in microemulsion/encapsulation of pesticides. NPs appear to be more toxic due to their size and could move into the biological organisms easily if present in surface runoff. Information is needed on the toxic effect of using NPs in widespread crop production on biological organisms, air, water or soil and accumulation in food chains. Toxicity and uptake of silver (Ag) NPs in developing fathead minnow (*Pimephales promelas*) embryos provides a model for study of microparticles potentially present in agricultural runoff and groundwater. We describe toxicity of small (30-50nm) and larger (41-100nm) nanoparticles in embryos exposed to varying concentrations of either sonicated or stirred AgNPs. Size, distribution and concentration of NPs were characterized during 96 hr exposure using Transmission Electron Microscopy (TEM) and Dynamic Light Scattering (DLS). LC_{50} of larger Ag NPs was 10.6 mg/L stirred and 1.36 mg/L sonicated; and for smaller Ag NPs was 9.4 mg/L stirred and 1.25 mg/L sonicated causing a dose-response increase in the prevalence of larval deformities. Uptake of nanosilver into embryos was observed by TEM within a 24hr period. This high-throughput toxicity test can perform future risk assessment and dose response relationships of any NPs used in biofuel crop production in fathead minnows. Surface runoff and groundwater contamination from NPs used in corn-based biofuel production could have significant impacts on water quality and biological ecosystems and can be investigated using this model.

(P03) Bioenergy Production Drives Carbon Storage and Protection in Degraded Soils

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Bioenergy production from perennial energy plants, such as switchgrass, provides a sustainable ecological engineering approach to increasing storage of atmospheric CO_2 in the belowground environment. The storage and protection mechanisms include root biomass accumulation, soil erosion control, physical protection of organic carbon in aggregated soil structure, water-carbon interactions, and transport of dissolved organic carbon to deep soil horizons.

Existing studies have shown that root biomass of most perennial grasses accounts for approximately two-thirds of the total biomass of plants and plants are rooted as deep as three meters in soil profile (Ma et al., 2000). Deep-rooting not only enhances organic carbon content of deeper soil horizons where it is not easily mineralized and decomposed but also creates root channels through which surface organic matter moves to deep horizons. For example, tall fescue and smooth bromegrass increased the soil carbon pool by 17.2% compared with a corn-soybean rotation (Lal et al., 1998). Mark Liebig (2006, USDA News) found that switchgrass fields had an average of about seven tons more soil carbon per acre than nearby corn and wheat fields.

Perennial energy grasses can also reduce soil erosion by more than 90% by increasing soil water conservation and the proportion of stable soil aggregates. This suggests biomass production could be an important strategy for controlling watershed erosions of degraded ecosystems.

Our recent study indicates that restoration to perennial grass increased physical protection of organic carbon in soil microaggregates (McCarthy et al., 2008). By using ultra-small angle x-ray scattering (USAXS) before and after combustion of microaggregates (53-250 μm) at 350°C, we took advantage of differences in x-ray scattering contrast between soil minerals, organic matter (OM), and air to evaluate the distribution of the total- and OM-filled porosity within microaggregates. Results show that the OM preservation arose from the evolution of the architectural system of microaggregates during their formation and stabilization. Land-use options (conversion of soils from long-term cultivation to perennial vegetation through restoration of native tallgrass prairie) and agricultural treatments (conventional tillage versus no-till at two levels of N inputs) with increasing OM in microaggregates were associated with encapsulation of colloidal OM by minerals, that creating protected OM-filled pores at the submicron scale within the microaggregate structure. For example, in the tallgrass chronosequence, microaggregates from the continuously cultivated soil had the lowest level of organic carbon, but 80% of the OM that did survive cultivation was in OM-filled pores; OM levels in the microaggregates increased slowly over time since following the restoration, as did the fraction of that OM in OM-filled pores until in the oldest (24-year) restoration, 90% of the OM was in OM-filled pores. OM totally encapsulated within the pore structure can create spatial and kinetic constraints on microbial access to and degradation of OM. Encapsulation of OM increases the capacity for its protection relative to sorption on mineral surfaces, and comparison of its extent among treatments suggests important feedback loops.

Hydrological effects may also be a mechanism that promotes long-term preservation of organic carbon in soil structures (Zhuang et al., 2008). We investigated the hysteretic water retention characteristics (i.e., difference between the main drying and wetting curves) of water-stable microaggregates (53-250 μm) isolated from soils subject to different management practices: tallgrass prairie restoration on a Mollisol and tillage with and without nitrogen fertilization on an Alfisol. The results show that the presence of OM in <5 μm diameter pores increases water retention in microaggregates. Comparison of the drying and wetting curves between intact and combusted (OM removed) microaggregates indicated a strong retention of water by pore-filling (encapsulated) OM. This retention suggests that the high water saturation in microaggregates from soils under management practices that increased OM-filled porosity, which also offered physical protection of the OM, may be a positive feedback mechanism that retards OM decomposition in micropores. The water retention data measured on intact and combusted microaggregates were consistent with the results of USAXS measurements.

Another mechanism that controls carbon storage in no-tilled, biomass-producing soils is the vertical transport of dissolved organic carbon (DOC) from shallow to deep soil horizons, where soil biological activity is low. Brye et al. (2002) reported that DOC fluxes ranging from ~2- to 4 g-C m^{-2} $year^{-1}$ for Wisconsin cropland and prairie. Mostly, DOC transport is assumed to be responsible for the fact that more than 70% of the world soil organic carbon inventory is in deeper soil horizons (below 30 cm) (Hammer et al., 1995). The movement of organic carbon to deeper soil horizons involves several key processes. They include (1) preferential sorption and competitive Exchange (e.g., low molecular weight, hydrophilic DOC will be preferentially mobilized, while larger, more hydrophobic and aromatic-rich moieties will be preferentially retained in shallow soil horizons); (2) heterogeneous saturation of sorption sites for organic carbon (depending on mineral properties and discrete heterogeneous DOC moieties); and (3) preferential flow processes (macropore flow is widespread in no-tilled soils). DOC represents the most dynamic part of organic carbon in soils, long-term trends in soil carbon storage should be first revealed by changes in the production, fate, and transport of DOC. Shift in the DOC composition in deeper soils could be used as a timely indicator for optimizing carbon sequestration strategies.

In summary, cellulosic bioenergy production from perennial energy plants offers an environmentally and economically sustainable approach to restoring degraded ecosystems while turning them into large carbon pools.

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(P04) ChinaFLUX Data Management System

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In ChinaFLUX, there are 8 sites applying micrometeorological method to acquire the carbon flux data. Every year, large volume of data including 10Hz raw data, averaged data and some ancillary data are produced. An Internet-based data manage system called ChinaFLUX Data Information System (ChinaFLUX DIS) has been developed to archive, store, process and publish the data.

ChinaFLUX DIS is based on Client/Server and Browser/Server model, and composed of six subsystems: 1) real-time data monitoring subsystem, 2) 10Hz Raw data process subsystem, 3) averaged data (include ancillary data) management subsystem, 4) WEBGIS subsystem, 5) carbon flux data process subsystem, and 6) data sharing subsystem. Real-time data monitoring subsystem is established to monitor the status of sensors and transmit the data from site to ChinaFLUX center. 10Hz Raw data process subsystem is designed to process the raw data to standard files. Averaged data management subsystem is based on Excel Server, a kind of commercial software, and helps data managers to input the data into a database easily. WEBGIS subsystem helps the users query some mps as a part of background information of the site via Internet. Carbon flux data process subsystem is used for data quality control and gap-filling. Data sharing subsystem makes all the ChinaFLUX data available to ChinaFLUX members and the public. Through this subsystem, users may browses metadata by category, query the data and download the result data, browses the general information of each site, and make a graph containing the data stored in the database.

(P05) County Scale Straw-source Energy of Huanghuaihai Plain in China

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Bio-energy has attracted more attention for offering one way to reduce greenhouse gas emissions by using bio-fuels, coming from vegetation, replace fossil-fuel as the price of crude oil surging up. But it would threat food production in China, if don't think twice. Because some crop land would probably change into biomass production land. Then, there would be chances in using waste biomass and biomass from degraded and abandoned land. It has over-exploited agricultural resources and is difficult to develop degraded and abandoned land but don't increase CO_2 emission with current technology. So, the best way is to make full use of waste biomass.

Huanghuaihai Plain, China, is one of the most important regions for providing abundant food. Its population density is high not only in China, but also in the world. The waste biomass is, in the main, straw of wheat and corn for the area. The amount and distribution of straw is, therefore, a primary work for large scale bio-energy development. In this study, we calculated the straw-source energy per unit area for Province of China and counties of Huanghuaihai Plain. The result lists as follow:

- Straw-source energy main located in eastern China. It is convenient to produce electricity and near main energy consumer region. Eastern China also has put impressive press on environment protection. Jilin, Shandong, Henan, Jiangsu, Hunan and Jiangxi maybe the better place to build straw-source power plant.
- Straw-source energy per unit area are distinct for counties. The highest was 23.044 (MJ $\cdot m^{-2}$), and the lowest was only 6.662 (MJ $\cdot m^{-2}$).
- In county scale, the county that near large mountain or called piedmont plain has abundant straw. These regions are potential exist to produce bio-energy In Huanghuaihai Plain, the counties located along Taihang Mountain and around Shandong Central Hills and Mountains.

There are many factors involved when dispose and reuse the straw. This work is just as a primary study for application, and should design experiment about (1) the environment influence after most straw was removed from crop land; (2) developing vegetation power but don't disturb the stability of feedstock provision.

(P06) Estimation and Uncertainty Analysis of Terrestrial Carbon Fluxes in China Based on Eddy Covariance Flux Measurements and Model Data Fusion Techniques

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Accurate prediction of terrestrial carbon cycle dynamics is crucial for forecasting climate change, managing natural resources and controlling increasing green house effect. Eddy covariance techniques, remote sensing data and terrestrial ecosystem models improved our capability of quantifying terrestrial carbon fluxes and variations in space and time. However, due to incomplete data, imperfect models, and lack of understanding of ecosystem processes and mechanisms, there are still great uncertainties in forecasting ecosystem carbon budget and its pattern. In this study, we analyzed the random error of CO_2 flux measured by eddy covariance systems in eight terrestrial ecosystems in China using the daily-differencing approach. The results showed that random measurement error of NEE more closely followed a double-exponential, rather than a normal distribution. The relationships between NEE random error and environment variables (i.e., PPFD, temperature, and wind speed) were further studied to provide the uncertainty evaluation for observed flux data at ChinaFLUX sites. Among the eight sites, variation in the random error followed consistent and robust patterns in relation to environment variables. We also compared and analyzed the effects of different types of error distributions of NEE measurement and corresponding cost functions on estimation of parameter and carbon fluxes at the Changbaishan and Qianyanzhou sites. Modeled annual total NEE using the normal error distribution was lower than that using the double exponential error distribution. On the regional scale, remotely-sensed vegetation index and eddy covariance flux data were used to estimate the gross primary production (GPP) and its uncertainties in grassland transect in Tibetan plateau by a vegetation photosynthesis model (VPM).The total of GPP in the grassland transect reached to 52.38 Tg C(1Tg=1012g) in 2004 and the uncertainty of estimated GPP in most pixels were 25%~35%.

(P07) Expression Profiling for the Detection and Monitoring of Environmental Contaminants within Aquatic Systems

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Microarray expression profiling is becoming a common tool in the field of ecotoxicogenomics to determine the mechanism of action of specific toxicants and to establish “genetic signatures” for identification of the toxicant. Ecotoxicological risk assessment has typically been based on the effective concentration (EC_{50}) and/or lethal concentration (LC_{50}) endpoint in organisms from different trophic levels. However, the gains made in molecular techniques such as transcriptional profiling and DNA chips, which allow for the identification of biomarker genes, provide an alternative to animal testing. Aquatic systems throughout the world have been increasingly plagued in recent years by harmful algal blooms (HABs). These HAB species produce toxins that pose threats to multiple trophic levels within the ecosystem, and also to human health. Saxitoxin is a potent neurotoxin produced by several species of dinoflagellates and cyanobacteria found in both marine and freshwater systems. It binds with high affinity to the sodium channel of nerve and muscle cells, and can ultimately lead to death in mammals via respiratory paralysis. Humans are typically exposed to the toxin through the consumption of shellfish that have bioaccumlated the toxin. Currently, the mouse bioassay is accepted by the AOAC as the current standard for detecting and measuring saxitoxin, and is the only method approved by the United States Food and Drug Administration for the detection and quantitation of the toxin in shellfish extracts. However, this method has come under criticism in recent years by animal rights and ethical groups, as this assay measures the time to death of live mice after intraperitoneal injection of the suspected toxic sample. Using expression profiling to measure environmental contaminants such as toxins provides an alternative to the live/dead endpoint assays. Information derived from the profiling data includes the mode of action of the contaminant and the genetic signature of the organism being profiled; these types of information are used in the development of biomarkers of effect and biomarkers of exposure, respectively. Understanding how toxins influence biological systems is essential to developing better predictive capabilities of water quality, allowing for the intelligent development of water quality indicators such as biomarkers or reporter gene assays.

The genetic fingerprint obtained with recent microarray analyses with the yeast *Saccharomyces cerevisiae* identified a set of copper and iron homeostasis genes as being significantly differentially expressed upon exposure to saxitoxin. From the array data, a subset of genes was chosen for further analyses, which included measuring the response of these genes at various time points and saxitoxin concentrations. The aim of this recent work was to compare the transcriptional regulation of these genes upon exposure of *S. cerevisiae* to saxitoxin and other environmental contaminants. As the genetic fingerprint most closely resembled that of excess copper, a comparison of gene regulation after exposure to saxitoxin and excess copper was of particular interest. *S. cerevisiae* S288C was grown in minimal media and exposed to 16uM saxitoxin or various compounds of environmental concern. Gene expression was examined with quantitative reverse-transcriptase PCR using gene-specific primers and Taqman™ probes. Expression levels were measured using absolute quantification. In addition to multiple functional genes, expression levels of the housekeeping gene β-actin (ACT1) were also measured. Data for each functional gene were initially measured as transcript copies ng^{-1}; these values were normalized by dividing the transcript copies ng^{-1} of each sample to its corresponding *ACT1* copies ng^{-1} value. Both copper and saxitoxin induced the expression of the metallothioneins *CUP1* and *CRS5*, with greater induction upon exposure to copper, and repressed expression of the copper transporter *CTR1* and cupric/ferric reductase *FRE1* at similar levels. Expression of the iron-transporter *ENB1* and *SLF1*, a gene involved in a secondary copper detoxification system, remained relatively unchanged in both treatments. Expression of the multicopper oxidase *FET3*, required for high-affinity iron transport, remained unchanged in copper treatments, but was down-regulated 3.5-fold in saxitoxin treatments.

Comparing the transcriptional response of metal-associated genes in *S. cerevisiae* upon exposure to saxitoxin and copper resulted in similar yet distinct profiles upon exposure to copper and saxitoxin, indicating that the genetic signature of *S. cerevisiae* is unique to saxitoxin. In light of these findings, the expression profile of these select genes to other environmental contaminants is currently under investigation. If the expression pattern to saxitoxin is found to be distinct from other contaminants, a combination of these genes can then be used in the development of a biomarker for saxitoxin.

In summary, we have obtained the genetic signature of *S. cerevisiae* to saxitoxin, and from this data selected a subset of genes which we believe showed potential for biomarker development. These genes were further investigated for consistency, reliability, and specificity of response. This study provides a working-model approach of using expression profiling to monitor environmental contaminants in an effort to move away from the traditional methods of live/dead assays.

(P08) Genetic Ecotoxicology: Past, Present, Future

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Genetic Ecotoxicology is defined as the study of the effects of toxicants and radiation on the genetic material of aquatic and terrestrial organisms, and related population and community level responses. It is a complex discipline that integrates biochemistry, molecular biology, genetic toxicology, ecology and population genetics.

The basic principles of Genetic Ecotoxicology emerged from early studies in radiobiology. In the 1950's, radiation exposure was shown to alter the development, growth and reproduction of mammals, fishes and invertebrates. Growth retardation, suppression of cell division and modified cell differentiation were detected in radiation-exposed organisms. With an increasing awareness of environmental pollution as a contributing factor to the health of all organisms, current research has centered on the effects of chemical toxicants, in addition to radiation, on the genetic material of organisms.

Genetic Ecotoxicology, as a subfield of Ecotoxicology, can trace its origin to the application of the Biomarker Approach in the assessment of environmental health that began in the 1980's. Biomarkers are currently used as clinical-type ecotoxicological tests because they can be considered 'toxic endpoints' of exposure to chemicals, class of chemicals or even a mixture of chemicals. The capability of Biomarkers to predict genetic effects at higher levels of biological organization is limited. To address these limitations, new approaches are being developed that not only help validate Biomarker data, especially data obtained under field conditions, but also extend our quantitative understanding of chemical toxicity. As a result, the field of Genetic Ecotoxicology is expanded significantly to include investigations that extend toxic exposure to subsequent population-level effects with evolutionary implications.

(P09) Greenhouse Gas Inventory in the Agriculture, Forestry and Other Land Use Sector of Beijing

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Greenhouse gas (GHG) inventory in the Agriculture, Forestry and other Land Use (AFOLU) Sector, following the methodology presented by IPCC, could reveal anthropogenic greenhouse gas emissions and sinks of terrestrial ecosystems at the regional and national scale. Using IPCC's Tier 1 or Tier 2 method, this paper presents Beijing's AFOLU GHG inventory for the years 2001 through 2006 with the data from land use change surveys, agricultural statistics and special emission factors of Beijing. The inventory includes source categories as follows: net CO_2 flux from carbon stock changes in Land Use, Land-Use Change, and Forestry, net CO_2 flux from carbon stock changes in urban trees, CH_4 emission from rice cultivation, and CH_4 emission from livestock enteric fermentation and manure management. It shows that annual GHG emission from AFOLU sector is about 840 Gg CO_2 equivalents from 2001 to 2006 in average, accounting for 4% of annual CO_2 emission from energy sector in Beijing at the same time. To prepare China's AFOLU inventory by province, it faces the challenge from the acquirement of activity level data and emission factors and the application of models.

(P10) Impacts of Biofuel Productions on Hydrology and Water Quality in the Midwest USA

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The overall goal of this project was to quantify the long-term water quality impacts of land management changes associated with increased demands for corn and energy crops to meet ethanol production demands in the United States. The broader question in US ethanol production is to address suitable feedstocks that would be economically and environmentally sustainable. A modeling approach utilizing two nonpoint source hydrologic/water quality models, namely, GLEAMS-NAPRA, and SWAT were used in this study. GLEAMS-NAPRA is a field scale model and is used to simulate regional annual losses in nitrate-nitrogen, total phosphorus, atrazine (1-chloro-3-ethylamino-5-isopropylamino-2,4,6-triazine), pyraclostrobin (Methyl {2-[1-(4-chlorophenyl)-1H-pyrazol-3-yloxymethyl]phenyl}methoxycarbamate), erosion, runoff and percolation to the edge-of-field and bottom-of-root-zone associated with multiple cropping scenarios. The GLEAMS-NAPRA model was also used to quantify long-term effects of varying corn stover removal rates on nutrient availability and erosion losses as well as the potential effects of alternative crop management systems to meet bioenergy demands. SWAT, a river basin-scale model, was utilized to assess impacts of agricultural land management changes within complex regional watersheds, with consideration to upland and in-stream processes controlling sediment and nutrient losses. Model results showed that agricultural management decisions would greatly impact nutrients, runoff and pesticides losses from agricultural fields and could potentially have greater impacts on runoff losses of those pollutants compared with the projected changes in crop rotations alone. Simulation results revealed that soil loss was an important component in understanding biofuel production impacts on the environment because persistent agrochemicals often attach to soil particles and, over-time, biomagnify and bioaccummulate up the food-chain posing risks to higher species. The push to increase US ethanol production with corn-grain could create a land management practice that focuses on yield increases to meet required feedstock volume while showing little or no regards for environmental consequences. The use of cellulosic materials could mitigate the potentially negative water quality impacts associated with corn-grain feedstock.

(P11) Introduction to Chinese Terrestrial Ecosystem Flux Research Network (ChinaFLUX)

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The Chinese Terrestrial Ecosystem Flux Research Network (ChinaFLUX) is a long-term national network of micrometeorological flux measurement sites that measure the net exchange of carbon dioxide, water vapour, and energy between the biosphere and atmosphere. The ChinaFLUX network includes eight observation sites (ten ecosystem types) and encompasses a large range of latitudes (21º 57' N to 44º 30' N), altitudes, climates and species. It relies on the existing Chinese Ecosystem Research Network (CERN), fills an important regional gap and increases the number of ecosystem types in FLUXNET.

The three grassland sites (HB, NMG and DX), located in the northwestern part of China along the Temperate-Alpine Rangeland Transect (China Grassland Transect , CGT), which spans from the Daxinganling Mountain Range in the northeast to the Qinghai-Tibet Plateau in the southwest, cover an altitudinal range from 1200 m to 4300 m. The CGT transect is a part of the Euro-Asian Continenta Grassland Transect (EACGT). The HB site includes three ecosystem types that represent the typical grassland vegetation on the Tibet Plateau in China, where the influence of the monsoon climate is small.

The four forest sites (CBS, QYZ, DHS, and XSBN) are influenced by monsoon climate to varying degrees. The DHS, QYZ, and CBS forest sites are distributed along the North-South Transect of Eastern China (NSTEC, the Fifteen Transect of Global Change and Terrestrial Ecosystems, GCTE). The NSTEC transect is part of the Euro-Asian Continental Eastern Transect (EACET), while the NMG and CBS sites are along the North East Chinese Transect (NECT, the Fifth Transect of GCTE). Along the NECT transect, the landscape changes from forest to grassland, and the NECT transect becomes a bridge between the forest transect of NSTEC and the grassland transect of CGT.

A crop site (YC) in the Northern China Plains, where annual rotation of wheat and maize is the dominant farming practice, was also equipped with the eddy covariance instrumentation. Although the net, long-term carbon flux in croplands, particularly heavily tilled ones as YC, is negligibly small, the eddy covariance and ecophysiological measurements provide us useful data for SVAC model development and validation. Additionally, the data will be used to investigate crop water use which is an important water conservation issue.

Data and site information are available online at the ChinaFLUX web sites (http://www.chinaflux.org/). Expanding the scope of the FLUXNET database, ChinaFLUX offers new opportunities to quantify and compare the magnitudes and dynamics of annual ecosystem carbon and water balance and to explore the biotic and abiotic effects on ecosystem processes of carbon dioxide and water vapour exchange that are unique to ecosystems in China, such as the vegetation communities on the Qinghai-Tibet plateau. Besides, ChinaFLUX also provides more insights to help define the current status and enable future prediction of the global biogeochemical cycles of carbon, water and trace gases.

Keywords: Eddy covariance; Complex terrain; Qinghai-Tibet plateau; Carbon and water cycle; Asian monsoon climate

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(P12) Patterns and Environmental Control Factors of Vegetation and Soil Carbon in China，Based on Literature Survey

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Because of the large area, particular monsoon climate, diverse ecosystems, and fast growing economy, China is playing an important role in global carbon cycle and climate change. In this study, we have surveyed most published literature to synthetically investigate the spatial patterns of vegetation and soil carbon pools for better understanding the terrestrial carbon cycles in China.

Most researches have confirmed the total soil carbon pool in China is about 127~168 Pg C with 80~90 Pg soil organic carbon (SOC); and the overall mean density of SOC is about 9.2~12.4 kg m^{-2} and 4.29 kg m^{-2} for soil inorganic carbon (SIC). The high densities of SOC (>40 kg m^{-2}) are mostly distributed in the northeast China, Qinghai-Tibet Plateau, and Yunnan-Kweichow Plateau; while the low values(<5 kg m^{-2}) are mainly appeared in northwest China. However, the high densities of SIC (~36.48 kg m^{-2}) are found in northwest China. South and east China has the lowest density of SIC (<2 kg m^{-2}). The distribution of soil carbon is mostly controlled by climatic factors, especially temperature and precipitation. Density of SOC is significantly negatively correlated to temperature but positively to precipitation, which is just opposite for SIC.

The total vegetation carbon pool in China varies from 6 to 30 Pg C depending on the method adopted. Accordingly, the densities of vegetation carbon based on different vegetation types are among 0.34 and 5.7 kg m^{-2}. Forest has the highest densities and pools; followed by grassland and shrub land. The areas with high vegetation densities are mostly located in northeast, southeast and southwest forests in China. And the low ones are distributed in west regions where great amount of areas are dominated by grasses or bare lands or desert. Besides, the distribution of vegetation carbon densities is nearly converse to that of population, which partly indicating human activities significantly affect the vegetation variations. The same as soil carbon, vegetation carbon is mostly controlled by temperature and precipitation. Based on inventory data, researchers have verified that temperature has the most important contribution to forest carbon storage. However, model scientists declaim that in high latitude regions of China, the vegetation carbon is mainly limited by water, especially for grassland ecosystems.

Basically, the whole carbon pools of China's terrestrial ecosystems are about 133~198PgC, about 6.8%~8.8% to global terrestrial ecosystem carbon pools. Accurate estimation of carbon pools and enhancement of carbon sequestration in China's terrestrial ecosystems would be critical for carbon cycle research and global warming mitigation.

(P13) Study of operation patterns, household income and will of planting energy crops

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The theme of this paper is to figure out the household's income and will of planting *Jatropha* and its operation patterns. Based on the data acquired from the questionnaires in three typical village in Shuangjiang county, Yunnan province, this paper sums up three different planting operation patterns, which are defined as CNPC (China National Petroleum Corporation)-SFA (State Forestry Administration), Shenyu-Household and Independent Household. The characteristics of each pattern are described and the comparison between them is performed.

Then, the cost and benefit of these three different patterns are analyzed. Moreover, the net present value (NPV) of income in the next 20 years since planting is calculated to find that the Independent Household pattern obtains the highest value both in the practical *Jatropha* price level (3 RMB/kg) and theoretic one (1.5 RMB/kg), which are 183630 RMB/ha and 84840 RMB/ha. The CNPC-SFA pattern gains 54015 RMB/ha and 34260 RMB/ha in practical and theoretic price level, while Shenyu-Household gained 36195 RMB/ha in both price levels. However, household in the Shenyu-Household pattern shares lest risk and receives more stable income.

In order to judge the possibility that major crops are replaced by *Jatropha*, tea, bamboo, sugarcane, corn and tomato are selected as major crops according to three core principals, which are concluded as similar planting circumstance, suitable planting scale and not belonging to grain crops. The NPVs of them are calculated, which are 395430 RMB/ha, 292395 RMB/ha, 199110 RMB/ha, 52080 RMB/ha, 187965 RMB/ha. It is proved that planting *Jatropha* in the most profitable pattern, known as Independent Household pattern, is not as competitive as tea, bamboo and sugarcane. By contrast, planting *Jatropha* is more competitive than corn both in two different price levels. In addition, it is not quite certain that whether planting *Jatropha* is more advantageous than tomato, especially at the practical price.

The will of household planting *Jatropha* is learned to discover tree major features. First, there is an obvious gap between planting will and actual activities. Second, the influence factors playing an impact on planting will are different according to specific regions. Third, planting will vary from different planting phases, such as initial-planting and second-planting. Based on the attributes of these influence factors, the paper divides and contributes them to basic influence factor cluster, governmental influence factor cluster and substitutable influence factor cluster, so as to take a deeper discussion of them. After that, the paper distinguishes the initial-planting will and second-planting will to learn that the structure and content of influence factors are changed. In the second-planting phase, the drivers in the whole chain of *Jatropha* industry, including planting, breeding, collecting, transporting and marketing, begin to affect household planting will. Besides, household not only takes planting *Jatropha* as an approach to get more income, but also combines and incorporates it with other crops, for the sake of optimizing planting structure and attaining most income. Moreover, government plays a more important role in the second-planting.

Key words: *Jatropha*; Operation Patterns; Cost-benefit Analysis; Income; NPV; Planting Will

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(P14) Study on Atmospheric Deposition and Key Processes of Belowground Carbon Cycling along North-south Transect of Eastern China

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Terrestrial transect approach is thought as a powerful method to study the responses of ecosystem functioning to environment change. North-south transect of eastern China (NSTEC) has a temperature-driven gradient and was set up in 2000 by IGBP as the fifteenth standard transect. Based on the data collected from CERN database and published sources, a pattern of N deposition along NSTEC was interpolated using inverse distance weight method. In order to understand the regional scale patterns of leaf N and P stoichiometry. A total of 513 samples taken from 41 dominant species at 57 sites were taken throughout northeastern China. Besides, soil-atmospheric CO_2 and CH_4 fluxes had been measured for over three years using the static chamber technique in six forests to actually estimate carbon budget between atmosphere and forest soils. The results showed that:

(1) Nitrogen deposition declined from south to north ranged from 5 to 70 kg ha^{-1} yr^{-1} along NSTEC, and was significantly correlated with mean annual precipitation. The deposited N in agricultural ecosystem was mainly composed of ammonium N (NH_4^+-N) accounting for 58.9% of total N, and that of nitrate (NO_3^--N) was only 6.9%. In addition, three deposited centers of N deposition such as South China, Sichuan Basin, Yangtze River Delta were formed through spatial analysis.

(2) Leaf P (2.64 mg/g) was significantly higher, leaf N (17.59 mg/g) and N/P (6.59) were lower than those of Chinese and global flora, respectively, which suggested that temperate forest ecosystems are N limited in northeastern China. Net primary productivity in the region would increase in a short-term by exogenous N importation under an increase in N deposition in the future. Species and climatic factors were the two primary variables that affected leaf N and P in the region, answering for approximately 54%, 61%, and 60% of the total variation of leaf N, P and N/P, respectively.

(3) From tropical zone, subtropical zone to temperate zone, litter decomposition rate of forest ecosystems declined. For the factor of interregional climate, mean annual temperature was dominant and mean annual precipitation was subordinate. Excepting testing the importance of initial C%, N% and C/N ratio on the contribution of decomposition rate, we supposed that initial concentrations of other elements, such as K, might also play an important role in controlling the decomposition rate of prophase.

(4) Natural forest soils were usually the source for atmospheric CO_2 (221.6 to 528.6 mg CO_2 m^{-2} h^{-1}) and the sink of atmospheric CH_4 (-10 to -60 μg CH_4 m^{-2} h^{-1}). Soil CO_2 efflux in the tropical and subtropical forests were higher than that of the temperate forests, and it was lower in coniferous forests than that of broadleaved forests under the same climate zone. Soil CH_4 uptake in the climax forest ecosystems was much more than that of the artificial conifer plantation.

Keywords: Containing C emission; Nitrogen Deposition; Litter Decomposition; Biological Stoichiometry; North-south Transect of Eastern China (NSTEC)

PART IV: CONTACT INFORMATION

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