RCN Conference on Pan American Biofuels & Bioenergy Sustainability

Golden Tulip Recife Palace, Recife, Brazil
July 22-25, 2014

PAN-AMERICAN BIOFUELS & BIOENERGY SUSTAINABILITY
AN NSF RESEARCH COORDINATION NETWORK

Conference Program

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Golden Tulip Recife Palace,
Recife, Brazil July 22-25, 2014

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Conference Program Overview

Tuesday July 22	
Evening Welcome Event	**5:30 pm – 7:30 pm (Panoramic Room)**
Conference Registration	2:00 pm – 5:00 pm
Introductory Presentations and Keynote	5:30 pm – 6:30 pm
Welcome Reception (Drinks and Appetizers)	**6:30 pm – 7:30 pm**

Wednesday July 23 Day 1			
Morning theme sessions:		**8:30 am – 11:30 am**	
Conference Registration		7:30 am - 8:30 am	
Socioeconomic Issues (Boa Viagem Room)	Water-Energy Nexus (Candeias Room)	Biodiversity (Piedade Room)	Energy Policy (Imperial Room)
Lunch, at Hotel		**11:30 am – 1:00 pm**	
Afternoon cross-disciplinary sessions		**1:00 pm – 4:00 pm**	
Biogeochemical Cycles (Boa Viagem Room)	Life Cycle Assessment (Candeias Room)	Biomass Supply Chain (Piedade Room)	
Poster Session: Technical Presentations		**4:30 pm – 6:30 pm (Meeting Foyer)**	

Thursday July 24 Day 2			
Morning cross-disciplinary sessions:		**8:30 am – 11:30 am**	
Technological Innovation (Boa Viagem Room)	Ecosystem Impacts: Using Science and Indigenous Knowledge (Candeias Room)	Bioenergy and Social Justice (Piedade Room)	Sustainability Issues in Biofuel and Bioenergy Industries (Imperial Room)
Lunch, at Hotel		**11:30 am – 1:00 pm**	
Afternoon cross-sector sessions		**1:00 pm – 4:00 pm**	
NGO-Government Perspectives (Boa Viagem Room)	Brazilian Biofuel Sustainability Issues (Candeias Room)	Industry-Government Perspectives (Piedade Room)	Industry-Academic Perspectives (Imperial Room)

Friday July 25 Day 3	
Morning session:	**8:30 am – 11:30 am (Panoramic Room)**
Synthesis presentations and discussion: RCN Conference attendees will all be involved in discussions about lessons learned, and next steps in studying biofuels and bioenergy development	
Lunch, at Hotel	**11:30 am – 1:00 pm**
Afternoon RCN Steering Committee session:	**1:00 pm – 4:00 pm**

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NOTE: Presentation Abstracts available on RCN Conference Website:
www.panamrcn.org → PanAM RCN Conference Program link

Day 1

Wednesday, July 23, 2014: Policies for the Sustainable Development of Biofuels in Pan America **08:30 AM - 11:30 AM** (Imperial Room)	
Chairs:	Barry Solomon, Michigan Technological University, Michigan, USA Alberto Acevedo, National Agricultural Technology Institute (INTA), Buenos Aires Argentina
8:30 AM	Policies for the Sustainable Development of Biofuels in Pan America: A Review and Synthesis of Five Countries . **B. Solomon**, A. Banerjee, A. Acevedo, K. Halvorsen, and A. Eastmond
8:50 AM	Climate Change, Decarbonisation, and Bioenergy Production: Integrating Policy Science into a Broader Context . **K. E. Halvorsen**
9:10 AM	A Blueprint for Sustainability Certification Implementation in the U.S. and Brazil . **J. Endres** and **R. Aguiar**
9:30 AM	Indirect Effects of Bioenergy: International Standards and Science . **M. Davis**, K. Kline, F. Ghatala, and D. Goldin
9:50 AM	Biofuel Sustainability in Latin America and the Caribbean: A Review of Recent Experiences and Future Prospects . **R. Bailis**, **B. Solomon**, C. Moser, and T. Hildebrandt
10:10 AM	Trajectory of Wood Energy Policies in the United States: Sustainability and Governance in Global Markets . **D. Becker**
10:30 AM	Roundtable Discussion of Key Research Issues and Challenges

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Wednesday, July 23, 2014: Socioeconomic Sustainability Dimensions of Biofuels in the Americas 08:30 AM - 11:30 AM (Boa Viagem Room)	
Chair:	Sam Sweitz, Michigan Technological University, Michigan, USA
8:30 AM	Interrogating Social Sustainability in the Biofuels Sector in Latin America: Global Standards and Local Experiences in Mexico, Brazil and Colombia . **T. Selfa**, C. Bain, R. Moreno, A. Eastmond, S. Sweitz, C. Bailey, T. Martins, G. S. Pereira, and R. Medeiros
8:50 AM	Global and Local Perspectives on the Jatropha Plantations for Biodiesel in Sucopo, Yucatan, Mexico . **A. Eastmond** and S. Sweitz
9:10 AM	Agro-Fuels and Income of Rural Households in Yucatan, Mexico . **J. Becerril**, A. Eastmond, and S. Sweitz
9:30 AM	Bioenergy, Land Use Change and Ecosystem Services in Tabasco, Mexico . **C. J. Vazquez-Navarrete**
9:50 AM	Effects of Use of Biofuels for Increasing Production and Productivity in Rural Communities in Northeast Brazil . **J. Ferreira Irmao** and J. Ribemboim
10:10 AM	Energy Crops, Food Security, and Rural Development: The Role of Oilseed Production Around Brazil . **R. Bailis**
10:30 AM	Roundtable Discussion of Key Research Issues and Challenges

Wednesday, July 23, 2014: Bioenergy and Biodiversity: Key Lessons and Research Priorities 08:30 AM - 11:30 AM (Piedade Room)	
Chair:	Audrey Mayer, Michigan Technological University
8:30 AM	Bioenergy and Biodiversity: Key Lessons from the Pan American Region . **K. Kline**, F. Martinelli, A. L. Mayer, R. Medeiros, C. O. F. D. Oliveira, G. Sparovek, A. Walter, and L. Venier
8:55 AM	Land Sparing Versus Land Sharing: How Might Biodiversity and Bioenergy Coexist? . **A. L. Mayer**
9:20 AM	Integrating Biodiversity Metrics in Life-Cycle Analysis of Intensive Biomass Production in North American Forests: Challenges and Considerations . **J. Verschuyl**, T. B. Wigley, C. Gaudreault, M. Margni, D. Miller, S. Riffell, B. Titus, and K. Vice
9:45 AM	The Sustainability of Forest Residue for Bioenergy in Canada: What Can Biodiversity Tell Us? . **L. Venier**, I. Aubin, K. Webster, R. Fleming, P. Hazlett, B. Titus, and H. Chen
10:10 AM	Assessing the Impacts of Pan American Bioenergy Development on Birds and Insect Pollinators . **J. Knowlton**
10:35 AM	Roundtable Discussion of Key Research Issues and Challenges

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Wednesday, July 23, 2014: Bioenergy Development and Integrated Water Resources Management 08:30 AM - 11:30 AM (Candeias Room)	
Chairs:	David Watkins, Michigan Technological University, Michigan, USA Márcia M.G.A. Moraes, UFPE – Pernambuco, Brazil
8:30 AM	Bioenergy Development and Integrated Water-Energy Management in Pan America . **D. Watkins**, M. M. G. A. Moraes, H. Asbjornsen, A. Mayer, J. Licata, J. Gutierrez Lopez, T. Pypker, V. Gamez Molina, G. F. Marques, A. C. G. Carneiro, H. M. Nuñez, H. Önal, and B. D. N. Germano
8:50 AM	Implications of Woody Bioenergy Feedstock Production for Water Supply and Hydrologic Regulation Services . **J. Gutierrez-Lopez**, J. Licata, T. Pypker, and H. Asbjornsen
9:10 AM	Impacts of Sugarcane Expansion on Water Resources in Areas of São Paulo State . **M. M. Guarenghi** and A. Walter
9:30 AM	Energy-Water Nexus: An Input-Output Dynamical MODEL . **G. A. D. Oliveira** and **F. M. C. D. Souza**
9:50 AM	Hydro Economic Modeling and Water Scarcity Cost in a Watershed with Irrigated Bio Fuel Crops Production . **G. Fernandes Marques**
10:10 AM	An Economic Analysis of Land Use Changes and Sugarcane Production in Brazil: The Role of Irrigation Water . **A. C. G. Carneiro**, H. M. Nuñez, **H. Önal**, and M. M. G. A. Moraes
10:30 AM	Roundtable Discussion of Key Research Issues and Challenges

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Wednesday, July 23, 2014: Biogeochemical Research Priorities for Sustainable Biofuels and Bioenergy Feedstock Development in the Pan America Region **01:00 PM - 04:00 PM (Boa Viagem Room)**	
Chairs:	Brian Titus, Pacific Forestry Centre, Natural Resources Canada, Victoria, BC, Canada Hero Gollany, US Dept of Agriculture, Oregon, USA
1:00 PM	Biogeochemical Research Priorities for Sustainable Biofuel and Bioenergy Feedstock Production in Pan-America . **H. Gollany**, **B. Titus**, A. Scott, H. Asbjornsen, S. Resh, R. Chimner, D. Kaczmarek, L. Leite, A. Ferreira, K. Rod, J. Hilbert, M. V. Galdos, and M. Cisz
1:25 PM	Soil Organic Carbon Measurement Protocols: A USA and Brazilian Comparison and Recommendation . **M. Davis**, D. Abulebdeh, B. J. R. Alves, M. V. Galdos, D. L. Karlen, and K. Kline
1:50 PM	Advances in the Knowledge on the Impacts of Waste Management Forest Harvesting on Soil Quality of the NE in Argentina . **A. M. Lupi**, R. Fernández, R. Martiarena, N. Pahr, A. Von Wallis, M. D. L. A. Garcia, and J. Aparicio
2:15 PM	Lipid Accumulation and Nitrogen Removal for Chlorella vulgaris and Scenedesmus Obliquus Using Wastewater . **A. Ruiz Marin Sr.** and Y. Canedo Lopez Sr.
2:40 PM	Forest Biomass Harvesting and Site Productivity: Is Policy Ahead of Biogeochemical Science? . **E. D. Vance**, W. M. Aust, B. D. Strahm, R. E. Froese, R. B. Harrison, and L. A. Morris
3:05 PM	Roundtable Discussion of Key Research Issues and Challenges

Wednesday, July 23, 2014: Opportunities and Challenges for Biomass Supply Chains **01:00 PM - 04:00 PM (Piedade Room)**	
Chairs:	J. Richard Hess, Idaho National Laboratory, , Idaho Falls, ID, USA Pasi Lautala, Michigan Technological University, MI USA
1:00 PM	Opportunities and Challenges in the Design and Analysis of Biomass Supply Chains . **P. Lautala**, T. Laitinen, R. Bittencourt, A. M. Valente, M. R. Hilliard, E. Webb, I. Busch, R. Handler, J. R. Hess, M. Roni, and J. A. Hilbert Sr.
1:25 PM	Biomass Transportation Systems in Brazil: The Cases of the Ethanol Industry and the Constrains for Exporting Pellets . **A. Walter**
1:50 PM	Tropical Maize and Lipid Cane As Sustainable New Bioenergy Crops . **V. Singh**
2:15 PM	Lignocellulosic Biomass Residues Identification and Selection in Five Countries of Latin America, As a Feedstock for Second Generation Ethanol Production . **E. Ruz**
2:40 PM	Uncovering System Behaviors in Biofuels Supply Chain Network Using an Agent-Based Simulation Approach . **D. B. Agusdinata**
3:05 PM	Roundtable Discussion of Key Research Issues and Challenges

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Wednesday, July 23, 2014: Standardization of Environmental Life Cycle Assessments of Biofuels 01:00 PM - 04:00 PM (Candeias Room)	
Chairs:	David R. Shonnard, Michigan Technological University, Houghton, MI USA Julio Sacramento, Univ Autônoma de Yucatan, Merida Mexico
1:00 PM	Standardization of Environmental Life Cycle Assessments of Biofuels in the Pan America Region . **D. R. Shonnard**, J. A. Hilbert Sr., B. Klemetsrud, J. Sacramento, F. Navarro, R. Handler, N. Suppen, and R. Donovan
1:20 PM	Biofuel Life-Cycle Analysis: Possible for Standardization? . M. Q. Wang, J. B. Dunn, and **H. Cai**
1:40 PM	Nest Experience in Life Cycle Assessment (LCA) Research and Development Projects Related with Biofuels and Residues Energy Conversion . **M. H. Rocha**, E. E. Silva Lora, and M. M. Vicente Leme
2:00 PM	Environmental Implications of Jatropha Biofuel from a Silvi-Pastoral Production System in Central-West Brazil . **R. Bailis** and G. Kavlak
2:20 PM	Life Cycle Assessment Study on a Soybean Complex Transformation Chain over Three Years of Production of Biodiesel As a Coproduct . **J. A. Hilbert Sr.** and S. Galbusera
2:40 PM	Incorporating Bioenergy into Sustainable Landscape Designs . **V. H. Dale**, K. Kline, J. K. Costanza, C. T. Smith, I. Stupak, A. Walter, and C. O. F. D. Oliveira
3:05 PM	Roundtable Discussion of Key Research Issues and Challenges

Wednesday, July 23, 2014: Poster Session: Pan American Biofuel and Bioenergy Sustainability 04:30 PM - 06:30 PM (Meeting Foyer)	
1	Effects of Maize Weevil Infestation on Corn and Utilization of Infested Corn for Ethanol Production . **G. A. Corrêa**
2	Assessment of an Power Generation Industrial Unit from Vinasse Treatment in Uasb Reactor . **A. F. D. M. S. Santos**, M. A. D. M. Sobrinho, and A. C. V. Handel
3	Energy-Water Nexus: An Optimal Control Model . **G. A. D. Oliveira** and **F. M. C. D. Souza**
4	Comparison of Anaerobic Reactors for Electricity Production in PILOT Scale from Vinasse . **A. F. D. M. S. Santos**, **M. A. D. Motta Sobrinho Sr.**, and A. C. van Handel
5	Switchgrass Genotype Study As a Bioenergy Crop in Kansas, USA . **D. Min** and V. Prasad
	(Continued on next page)

Wednesday, July 23, 2014: Poster Session: Pan American Biofuel and Bioenergy Sustainability
04:30 PM - 06:30 PM (Meeting Foyer) (continued)

6	Utilization of Crab Shells As Heterogeneous Catalyst in the Synthesis of Methyl and Ethyl Biodiesel . **G. Reis**, F. D. S. Medeiros, J. B. S. Costa, A. S.Moura, R. Oliveira DA Silva, V. M.D. Pasa, and C. C. C. Bejan
7	Poverty in the Pirapama Basin: The Role of Management of Hydrological Resources . **J. H. N. Viana** and M. M. G. A. Moraes
8	Maximizing Ethanol Production from Genetically Modified Cyanobacteria Grown Autotrophically . C. Delpino, V. Estrada, and **M. S. Diaz**
9	Water Allocation and Resources Management Using a Hydro-Economic Optimization Model: The Case Study of the Sub-Middle São Francisco Watershed . **G. Souza da Silva** and M. M. G. A. Moraes
10	Considering Water Quality and Energy Efficiency to Define Optimum Operation of Integrated Systems of Water Supply and Value of Use of Water Quality . **L. Rodella**, C. A. G. de Amorim Filho, and M. M. G. A. Moraes
11	Enhanced Pyrolysis Oil Properties through Pretreatment of Aspen with Controlled Torrefaction . **B. Klemetsrud**, J. Klinger, D. R. Shonnard, and E. Bar Ziv
12	Sorghum As an Advanced Biofuel: Price Effect on Wheat, Corn and Soybean Markets . **K. Pokharel**, R. P. Wibowo, and F. Nti
13	A Prototype Methodology for Incorporating Sustainability Indicators in Biorefinery Process Design . **J. C. Sacramento Rivero** and L. E. Vilchiz Bravo
14	Optimal Control Strategies for Different Stabilization Pond Systems . **M. P. Ochoa**, V. Estrada, and P. M. Hoch
15	Analysis of the Solid Waste Management of the Sugarcane Industry in Pernambuco . M. G. Souza Melo, **M. D. C. M. Sobral**, and A. L. N. Ferreira
16	Polymeric Membranes and Gas Separation: Homogenous Blends of Matrimid®5218 and P84 . **J. Carson**
17	Incorporation of Sweet Sorghum Juice into Current Dry-Grind Ethanol Process . **K. Saul**
18	Biogas in the Brewery: An Exploration of Practice and Sustainability . **J. Jurado**

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Day 2

Thursday, July 24, 2014: Technological Innovation in Biofuel and Bioenergy Sustainability **08:30 AM - 11:30 AM (Boa Viagem Room)**	
Chairs:	Mark Mba Wright, Iowa State University, Ames, IA, USA Michael T. Timko, Worcester Polytechnic Institute, Worcester, MA, USA
8:30 AM	Small Is Better: Fostering Growth in the Biofuels Industry with Energy Manufacturing . **M. Mba Wright**, R. C. Brown, and P. Componation
8:50 AM	Small-Scale Biorefineries: Towards the Biofuel and Bioenergy Sustainability at Local Basis . R. Souza Aguiar, P. H. Sousa Baudel, R. A. Jose, C. A. M. de Abreu, and **H. M. Baudel**
9:10 AM	Alcoholic Fermentation Using Immobilized Cells in Calcium Alginate . J. C. Duarte, **J. R. Nunhez**, J. A. R. Rodrigues, P. J. S. Moran, and G. P. Valença
9:30 AM	Incorporation of Sweet Sorghum Juice into Current Dry-Grind Ethanol Process for Improved Ethanol Yields, Energy Saving, and Water Efficiency . **N. B. Appiah-Nkansah**, K. Saul, W. Rooney, and D. Wang
9:50 AM	The Continuous-Flow Solid Acid Catalyst Hydrothermal Biorefinery . **M. T. Timko** and G. Tompsett
10:10 AM	Biodiesel Production from Used Cooking Oil Using Calcined Sodium Silicate Catalyst . M. O. Daramola, **D. Nkazi**, and K. Mtshali
10:30 AM	Roundtable Discussion of Key Research Issues and Challenges

Thursday, July 24, 2014: Bioenergy and Social Justice **08:30 AM - 11:30 AM (Piedade Room)**	
Chair:	Theresa Selfa, SUNY – ESF, Syracuse, NY, USA
8:30 AM	Food Security and Biofuels: Can Policy Flexibility Reduce Food Price Crises for the Poor? Part One: Global Markets and Brazil Sugar Cane Production Case . **M. R. L. V. Leal** and K. Kline
8:55 AM	Food Security and Biofuels: Can Policy Flexibility Reduce Food Price Crises for the Poor? Part Two: US Maize Production System Case . **K. Kline** and M. R. L. V. Leal
9:20 AM	Questioning the Social Dimensions of Sustainability: The Biofuel Industry and the Weakening of Traditional Communities in Brazil . **A. L. de Campos Paula** and V. Zuchetto
9:45 AM	The Sugarcane Industry and the Global Economic Crisis . **M. L. Mendonça**
10:10 AM	Roundtable Discussion of Key Research Issues and Challenges

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Thursday, July 24, 2014: Sustainability Issues in Biofuel and Bioenergy Industries 08:30 AM - 11:30 AM (Imperial Room)	
Chair:	Marcelo Cunha, State University of Campinas
8:30 AM	Looking for Sustainability in Biofuel and Bioenergy Industries: Some Challenges and Opportunities . **M. Cunha, State University of Campinas**
8:48 am	Achieving Sustainable Biodiesel Production in Brazil: Challenges and Opportunities . **J. Minelli**
9:06 AM	Green House Gas Savings Produced By Argentine Biodiesel Use . **J. A. Hilbert Sr.** and S. Galbusera
9:24 AM	Bioethanol Dehydration Assessment with Environmental Issues . **M. Colombo**, F. D. Mele, M. R. Hernández, M. Kahwaji Janho, and J. E. Gatica
9:42 AM	Opportunities and Challenges Considering the Socioeconomic Dimension for Brazilian Ethanol Industries in the Recent Past . **A. Marques**
10:00 AM	Diesel Displacement in the Sugarcane Ethanol Life-Cycle: A Comparative Analysis of Different Integrated Systems . **S. P. Souza** and J. E. A. Seabra
10:18 AM	Direct and Indirect Impacts of Agricultural Land-Use Due to Increased Production of Grain-Based Ethanol in Kansas, USA: A County-Level Analysis . **J. Bergtold** and B. Lauer
10:36 AM	Roundtable Discussion of Key Research Issues and Challenges

Thursday, July 24, 2014: NGO-Government Perspectives on Biofuel and Bioenergy Sustainability 01:00 PM - 04:00 PM (Boa Viagem Room)	
Chair:	André Guimarães, Conservation International, Americas Dulce Benke, Conservation International, Brazil
1:00 PM	Activists Follow As Markets and States Transnationalize Northeast Brazilian Sugarcane, 1954-1989 . **R. Pinto**
1:25 PM	Assessing the Sustainability of Ethanol Production in Mexico from Three Crops . **C. García**
1:50 PM	Sustentability: socioeconomic and environmental considerations . **R. Frazao**
2:15 PM	Market mechanisms for sustainable production . **G. Nardelli**
2:40 PM	Future scenarios for the expansion of bioenergy and its potential impacts . **M. Moreira**
3:05 PM	Roundtable Discussion of Key Research Issues and Challenges

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Thursday, July 24, 2014: Brazilian Biofuel and Bioenergy Sustainability Issues and Case Studies 01:00 PM - 04:00 PM (Candeias Room)	
Chair:	Arnaldo Walter, University of Campinas-Unicamp, Campinas, SP, Brazil
1:00 PM	Biofuel in Brazil: Soybean and Palm Oil Impacts on Socioecological Systems . **F. Martinelli**, **T. Martins**, and R. Medeiros
1:20 PM	Process Integration Case Study for the Second Generation Ethanol Production . S. Rouzinou, **P. Brito**, and V. Pylkkanen
1:40 PM	Bioenergy Production through Microalgae in Brazil: An Activity Joint with Ethanol Plants of the Country . **L. R. Holanda** and F. S. Ramos
2:00 PM	Socioeconomic Aspects of Sugarcane Producing Municipalities in Brazil . **P. Gerber Machado Sr.**
2:20 PM	Analysis of the Viability of Ethanol Production in Brazil: Economical, Social & Environmental Implications . **I. Alvarez Murillo**
2:40 PM	Socioenvironmental Aspects of the Palm Oil for Biodiesel Production in the Center of Endemism Belém - Brazil . **G. S. Pereira**, **R. Medeiros**, **B. H. Coutinho**, and **T. Martins**
3:00 PM	Roundtable Discussion of Key Research Issues and Challenges

Thursday, July 24, 2014: Industry-Government Perspectives on Biofuel and Bioenergy Sustainability 01:00 PM - 04:00 PM (Piedade Room)	
Chair:	Abraham Sicsu, General Office of Science and Technology, Recife Brazil
1:00 PM	Bioenergy and Biofuels: Presentation . **A. Sicsú**
1:20 PM	Commercial Experience of Rapid Thermal Processing (RTP) of Sustainable Biofuels . **M. J. Cleveland** and D. Szeezil
1:40 PM	The Sustainability of Biofuels in Brazil . **S. T. Coelho** and J. Goldemberg
2:00 PM	Bioethanol Industry Perspectives in Brazil . **J. G. Eugenio de França**
2:20 PM	Bioenergy in Northeastern Brazil: Opportunities and Challenges . **R. S. Cezar Menezes** and C. de Lima Júnior
2:40 PM	Forest Biomass Harvesting and Site Productivity: Is Policy Ahead of Science? . **E. D. Vance**, W. M. Aust, B. D. Strahm, R. E. Froese, R. B. Harrison, and L. A. Morris
3:00 PM	Roundtable Discussion of Key Research Issues and Challenges

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Thursday, July 24, 2014: Industry-Academic Perspectives on Biofuel and Bioenergy Sustainability 01:00 PM - 04:00 PM (Imperial Room)	
Chairs:	M. Regis L.V. Leal, Brazil Bioethanol Science and Technology Lab, Campinas, Brazil Hayri Önal, University of Illinois, Urbana-Champaign, IL, USA
1:00 PM	Sustainability in Biofuel and Bioenergy Sectors: The Role of Public Policy . **H. Önal**
1:18 PM	Biofuels and Bioenergy Sustainability Assessment Methods . **D. Schuster** and L. Alexander
1:36 PM	Biogas Generation from Sanitary Landfill Leachate . **V. Mello**, V. Lima, S. Holanda, J. Ferreira, J. F. Jucá, and M. Motta Sobrinho Sr.
1:54 PM	The Potential Use of Waste Stabilization Ponds for Biofuel Production By the Microalgae Biomass . **M. Paiva**
2:12 PM	The Sustainability of Brazilian Sugarcane Ethanol: The Contribution of the Brazilian Bioethanol Science and Technology Laboratory (CTBE) . **M. R. L. V. Leal**
2:30 PM	Comparison of Acid and Enzymatic Hydrolysis of Jerusalem Artichoke Tubers for Fermentative Butanol Production . **T. Sarchami**
2:48 PM	Understanding Concentration and Pressure Changes during Ultrasonication-Enhanced Blending of Petrol-Ethanol Blended Fuel . **D. Nkazi**, M. O. Daramola, and S. E. Iyuke
3:06 PM	Roundtable Discussion of Key Research Issues and Challenges

Day 3

Friday, July 25, 2014: Synthesis Presentations and Discussion 08:30 AM – 11:30 AM (Panoramic Room)	
8:30 AM	Summary and Reflections on RCN Conference
8:45 AM	Reporting of Session Chairs on Key Discussion Points Raised during Day 1, Day 2 sessions
10:00 AM	Small Group Discussions and Reflections
10:30 AM	Reporting to Large Group
11:00 AM	Assessment

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Technical Program
Wednesday, July 23, 2014: 8:30 AM-11:30 AM

Wednesday, July 23, 2014: 08:30 AM - 11:30 AM, Boa Viagem Room
Socioeconomic Sustainability Dimensions of Biofuels in the Americas
Chair: Samuel Sweitz, Michigan Technological University

Session Overview
Although many Pan American governments continue to incentivize the growth of the biofuels industry, one of the key challenges for biofuels sustainability has been concern about its social impacts and implications. This session focuses on the Pan American region and invites research abstracts on the social implications of future biofuel and bioenergy expansion. Examples of relevant topics include food security, land and resources rights, and related topics. Case study presentations are also welcomed

Wednesday, July 23, 2014: Socioeconomic Sustainability Dimensions of Biofuels in the Americas 08:30 AM - 11:30 AM (Boa Viagem Room)	
Chair:	Sam Sweitz, Michigan Technological University, Michigan, USA
8:30 AM	Interrogating Social Sustainability in the Biofuels Sector in Latin America: Global Standards and Local Experiences in Mexico, Brazil and Colombia . **T. Selfa**, C. Bain, R. Moreno, A. Eastmond, S. Sweitz, C. Bailey, T. Martins, G. S. Pereira, and R. Medeiros
8:50 AM	Global and Local Perspectives on the Jatropha Plantations for Biodiesel in Sucopo, Yucatan, Mexico . **A. Eastmond** and S. Sweitz
9:10 AM	Agro-Fuels and Income of Rural Households in Yucatan, Mexico . **J. Becerril**, A. Eastmond, and S. Sweitz
9:30 AM	Bioenergy, Land Use Change and Ecosystem Services in Tabasco, Mexico . **C. J. Vazquez-Navarrete**
9:50 AM	Effects of Use of Biofuels for Increasing Production and Productivity in Rural Communities in Northeast Brazil . **J. Ferreira Irmao** and J. Ribemboim
10:10 AM	Energy Crops, Food Security, and Rural Development: The Role of Oilseed Production Around Brazil . **R. Bailis**
10:30 AM	Roundtable Discussion of Key Research Issues and Challenges

8:30 AM Interrogating Social Sustainability in the Biofuels Sector in Latin America: Global Standards and Local Experiences in Mexico, Brazil and Colombia

Theresa Selfa, SUNY – ESF, Syracuse, NY, Carmen Bain, Department of Sociology, Iowa State University, Renata Moreno, Syracuse University, Amarella Eastmond, CIR, UADY, Merida, Mexico, Sam Sweitz, Social Sciences, Michigan Technological University, Houghton, MI, Conner Bailey, College of Agriculture, Auburn University, Tatiana Martins, Sustainable Development Practices Graduate Program, UFRRJ/ International Center of Studies in Sustainable Development, CIEDES, Rio de Janeiro, Brazil, Gustavo Simas Pereira, IFRJ/RJ and UFRRJ/IF/DCA, IFRJ and UFRRJ, Rio de Janeiro, Brazil and Rodrigo Medeiros, Department of Environmental Sciences, Federal Rural University of Rio de Janeiro / Conservation International, Americas Center for Sustainability

Abstract:
Across the Americas, biofuels production systems are diverse due to geographic conditions, historical patterns of land tenure, different land use patterns, government policy frameworks, and relations between the national state and civil society, all of which shape the role that biofuels plays in individual nations. Although many national governments throughout the Americas continue to incentivize the growth of the biofuels industry, one of the key challenges for biofuels sustainability has been concern about its social impacts and implications. In this article, we discuss some of the key social tensions, issues and implications of the recent expansion of biofuels production in Mexico, Colombia, and Brazil. We consider the ability of governments and non-state actors in multi-stakeholder initiatives (MSI) to address social and environmental concerns that affect rural livelihoods. We find that each of our cases suggests that both government and MSIs are falling short in their efforts to integrate and address a broader range of livelihood impacts.

8:50 AM Global and Local Perspectives on the Jatropha Plantations for Biodiesel in Sucopo, Yucatan, Mexico

Amarella Eastmond, Unidad de Ciencias Sociales, Universidad Autonoma de Yucatan, Merida Yucatan, Mexico and Samuel Sweitz, Michigan Technological University

Abstract:
Based on preliminary fieldwork data from Sucopo (municipality of Tizimin, Yucatan, Mexico), we analyze the local socioeconomic impacts from the establishment -and later abandonment - of 3,000 ha of jatropha plantations by Global Clean Energy Holdings. The information was obtained from interviews with Sucopo inhabitants and secondary sources. It is argued that the current global demand for "sustainable biofuels" has built on historical systems of resource extraction in the region (such as the henequen industry) which linked consumer demand in the global north to land, labor and natural resources in the global south. These linkages have fostered a growing dependence between local households, on the one hand, and global market forces, on the other, putting long-term food security and social and cultural capital at risk. By examining the jatropha plantations in the context of biofuel policies, operational practices on the ground and local socioeconomic impacts on the land and labor markets, wages, food security, and traditional village life, we describe and analyze distinct visions of sustainability held by the different stakeholders. We conclude that as long as global notions of sustainable biofuels fail to consider local ones, future biofuel projects in the area are likely to be short lived.

9:10 AM Agro-Fuels and Income of Rural Households in Yucatan, Mexico
Javier Becerril, Facultad de Economia, UADY, Merida, Mexico, Amarella Eastmond, CIR, UADY, Merida, Mexico and Sam Sweitz, Social Sciences, Michigan Technological University, Houghton, MI

Abstract:
This study examines the effects of Agro-Fuels Industry (AFI) on wide annual income of rural households in Yucatan, Mexico. This uses the "Propensity Score Matching" approach and cross-sectional data of 907 inhabitants from 192 households in three municipalities: Santa Elena, Muna and Tizimín. The findings reveal a robust positive and significant impact on the total annual income of the people who work for the AFI established in the eastern region of Yucatán. Specifically there is a positive difference of $ 14,123.0 pesos (US$1,100) annually among people who work as employees for the AFI and working in any other gainful employment within or outside the study area.

9:30 AM Bioenergy, Land Use Change and Ecosystem Services in Tabasco, Mexico
Cesar J. Vazquez-Navarrete, Ciencia de los alimentos e ingeniería, Colegio de Postgraduados, Tabasco, Mexico

Abstract:
Tabasco was an extended, rich, flooded lowland. The expansion of agriculture and oil industry and the growth of human population have transformed it to a highly fragmented, drained and complex flat surface in the last 75 years. All these changes influence over wealth and prosperity of tabasquean people. However, the knowledge of the impact in the ecosystems and their services is incipient yet. Recent studies explore economic approaches to evaluate ecosystem services. These approaches have twofold goals; first, it examines the link between human wealth and ecosystem health and second, it permits researchers and decision makers to develop compatible solutions with ecosystem functions; specially, when government introduces and fosters new economic activities. For instance, palm oil is cultivated to food purposes in Mexico, however, this crop has a potential to become one of the main biofuel in tropical regions. This study employed the ecosystem approach to examine the development of bioenergy industry in the form of oil palm. One of the main objectives of this study is to explore implications of the conversion of ecosystems and agroecosystems to oil palm. Methodology consisted on the construction of different scenarios by considering two factors: (i) the agronomical potential growth of oil palm in Tabasco at different levels of expansion and (ii) the land use change regarding to some levels of expansion. The study area was the Chontalpa Region in Tabasco, Mexico. Results show the changes in land use mainly in ecosystems, the gain or losses of economic values owing to the conversion of ecosystems and agroecosystems to oil palm, and the new economic balance for farming economy. In brief, oil palm would play a new incentive of agricultural and economic growth. This study recommends further research to develop a better understanding of social and ecological implications of future biofuel and bioenergy expansion.

9:50 AM Effects of Use of Biofuels for Increasing Production and Productivity in Rural Communities in Northeast Brazil
Jose Ferreira Irmao, Economics, UFRPE, Recife, Brazil and Jacques Ribemboim, Economics, UFRPE

Abstract:
The paper contains results of a research undertaken for the ANEEL (National Agency for Electric Energy) on the sources of sustainable energy for production in small agriculture in Northeast Brazil. The aim was to identify forms of uses of electric energy in family farming agriculture for stimulating local development in rural communities. Methods of research included field work and application of questionnaires in rural communities and settlements of landless workers. Research covered seven of the nine Northeastern states in a sample of small landholdings. Results shown a very good potential for increasing production and productivity through the use of electric energy, in special, by means of irrigated agriculture when communities dispose of biofuel energy. Attention was also posed in the use of alternative sources of energy, those made available by sun and wind energy. Additional results also indicated that the use of energy in agro-industrial activities such as fruit processing and livestock production increase productivity, income and employment in rural communities mainly those outside main roads and means of transportation. But one further and less effective result was that the successful means for increasing production, productivity and income of small landholdings depend strongly on programs of education, promotion of rural non-agricultural activities and policies aiming reduction of urban-rural inbalances.

10:10 AM Energy Crops, Food Security, and Rural Development: The Role of Oilseed Production Around Brazil

Robert Bailis, School of Forestry and Environmental Studies, Yale University, New Haven, CT

Abstract:
Biodiesel in Brazil is relatively new in comparison to ethanol and is currently used in a five percent blend (B5) nationwide. The biodiesel program is based on three “fundamental pillars”: social inclusion, environmental sustainability, and economic viability. The majority of the nation’s biodiesel is derived from soy, which raises problems for both social inclusion and environmental sustainability. Soy has been implicated in destruction of Amazon and Cerrado biomes. However, as the world’s second largest soybean producer, Brazil’s soy complex serves multiple domestic and international markets. The tremendous expansion of soy largely predated the introduction of biodiesel. The cultivated area grew much more rapidly in the five years prior to the policy than in the five years after its implementation, possibly driven more by demand for soymeal than for oil used to make biodiesel. Thus, attribution of environmental impacts is unclear. Further, while the policy of social inclusion requires that a portion of feedstock be sourced from small farmers, the industry’s dependence on soy makes this questionable. Soy tends to be planted in large, heavily mechanized, monoculture plantations, not amenable to smallholder inclusion. Efforts to introduce alternative crops deemed more environmentally or socially sustainable like Jatropha curcas, castor, oil palm and some native palms have not gained much momentum and they have seen little utilization as biodiesel feedstocks. This paper and the associated presentation examine the implications of dependence on soy for the sustainability of Brazil’s biodiesel industry and discuss the prospects for larger volumes of alternative feedstocks to be introduced.

Wednesday, July 23, 2014: 08:30 AM - 11:30 AM, Candeias Room
Pan American Bioenergy Development and Integrated Water Resources Management
Chair: David Watkins, Civil and Environmental Engineering, Michigan Technological University
Co-Chair: Márcia M.G.A. Moraes, UFPE – Pernambuco, Brazil

Session Overview
Large-scale bioenergy production will affect the hydrologic cycle in multiple ways, including changes in canopy interception, evapotranspiration, infiltration, and the quantity and quality of surface runoff and ground recharge. This session focuses Pan American biofuel and bioenergy development and invites research abstracts on water footprint analyses, water quality, integrated water-energy analyses, watershed scale studies linked to biofuel and bioenergy development, and other related topics, including case studies.

Wednesday, July 23, 2014: Bioenergy Development and Integrated Water Resources Management 08:30 AM - 11:30 AM (Candeias Room)	
Chairs:	David Watkins, Michigan Technological University, Michigan, USA Márcia M.G.A. Moraes, UFPE – Pernambuco, Brazil
8:30 AM	Bioenergy Development and Integrated Water-Energy Management in Pan America . **D. Watkins**, M. M. G. A. Moraes, H. Asbjornsen, A. Mayer, J. Licata, J. Gutierrez Lopez, T. Pypker, V. Gamez Molina, G. F. Marques, A. C. G. Carneiro, H. M. Nuñez, H. Önal, and B. D. N. Germano
8:50 AM	Implications of Woody Bioenergy Feedstock Production for Water Supply and Hydrologic Regulation Services . **J. Gutierrez-Lopez**, J. Licata, T. Pypker, and H. Asbjornsen
9:10 AM	Impacts of Sugarcane Expansion on Water Resources in Areas of São Paulo State . **M. M. Guarenghi** and A. Walter
9:30 AM	Energy-Water Nexus: An Input-Output Dynamical MODEL . **G. A. D. Oliveira** and **F. M. C. D. Souza**
9:50 AM	Hydro Economic Modeling and Water Scarcity Cost in a Watershed with Irrigated Bio Fuel Crops Production . **G. Fernandes Marques**
10:10 AM	An Economic Analysis of Land Use Changes and Sugarcane Production in Brazil: The Role of Irrigation Water . **A. C. G. Carneiro**, H. M. Nuñez, **H. Önal**, and M. M. G. A. Moraes
10:30 AM	Roundtable Discussion of Key Research Issues and Challenges

8:30 AM Bioenergy Development and Integrated Water-Energy Management in Pan America
David Watkins[1], Márcia M.G.A. Moraes[2], Heidi Asbjornsen[3], Alex Mayer[4], Julian Licata[5], Jose Gutierrez Lopez[6], Tom Pypker[7], Vivianna Gamez Molina[8], Guilherme Fernandes Marques[9], Ana Cristina G Carneiro[2], Hector M. Nuñez[10], Hayri Önal[11] and Bruna da Nobrega Germano[2], (1)Civil and Environmental Engineering, Michigan Technological University, Houghton, MI, (2)Department of Economics, Universidade Federal de Pernambuco, Recife, Brazil, (3)Department of Natural Resources and Environment, University of New Hampshire, (4)Civil and Environmental Engineering, Michigan Tech Univ., Houghton, MI, (5)National Institute of Agricultural Technology, Concordia, Argentina, (6)Department of Natural Resources and Environment, University of New Hampshire, Durham, NH, (7)Department of Natural Resources, Thompson Rivers University, Kamloops, BC, Canada, (8)Civil and Environmental Engineering, Northern Arizona University, Flagstaff, AZ, (9)Civil Engineering, Centro Federal de Educação Tecnológica de Minas Gerais, Belo Horizonte, Brazil, (10)Department of Economics, Centro de Investigación y Docencia Económicas, Aguascalientes, Mexico, (11)Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, IL

Abstract:
Large-scale bioenergy production will affect the hydrologic cycle in multiple ways, including changes in canopy interception, evapotranspiration, infiltration, and the quantity and quality of surface runoff and groundwater recharge. As such, the water footprints of bioenergy sources vary significantly by type of feedstock, soil characteristics, cultivation practices, and hydro-climatic regime. Furthermore, water management implications of bioenergy production depend on existing land use, relative water availability, and competing water uses at a watershed scale. This paper reviews previous research on the water resource impacts of bioenergy production--from plot scale hydrologic and nutrient cycling impacts to watershed and regional scale hydro-economic systems relationships. Primary gaps in knowledge that hinder policy development for integrated management of water-bioenergy systems are highlighted. A number of case studies in Pan America are analyzed to illustrate relevant spatial and temporal scales for impact assessment, along with unique aspects of biofuel production compared to other agroforestry systems, such as energy-related conflicts and tradeoffs. Based on the case studies, the potential benefits of integrated resource management are assessed, as is the need for further case-specific research.

8:50 AM Implications of Woody Bioenergy Feedstock Production for Water Supply and Hydrologic Regulation Services
Jose Gutierrez-Lopez, Department of Natural Resources and the Environment, University of New Hampshire, Durham, NH, Julian Licata, National Institute of Agricultural Technology, Concordia, Argentina, Tom Pypker, Department of Natural Resources, Thompson Rivers University, Kamloops, BC, Canada and Heidi Asbjornsen, Department of Natural Resources and Environment, University of New Hampshire

Abstract:
Woody bioenergy plantations are generally managed to maximize biomass production. This can be accomplished through various management approaches, such as species selection, short rotation lengths, genetic breeding programs, planting density, species combinations, and chemical and fertilizer application. One of the consequences of maximizing productivity in bioenergy plantations is a trade-off between increased carbon uptake by rapidly growing trees (positive for carbon sequestration and climate change amelioration) and increased water use by plantations relative to the original native

vegetation or pre-existing vegetation the original vegetation (negative for downstream water supply). Moreover, the particular management regime employed for bioenergy production can also affect soil hydraulic properties that determine partitioning of throughfall between soil and groundwater recharge versus runoff, thereby influencing peak and dry season flows. However, few studies have examined the impacts of establishing bioenergy plantations on these hydrologic services, and the trade-offs compared to alternative management practices. In this presentation, we show initial results from research in Wisconsin, USA that quantifies water use in two aspen plantations (ages 10 and 24) and a mature aspen-dominated forest stand (age 33) to understand potential consequences of increased bioenergy production in the region on water supply. Findings indicated that average stand transpiration in the 10 and 24 year old stands was 25K L d^{-1} and 16K L d^{-1} ha^{-1}, respectively, compared to 62K L d^{-1} ha^{-1} for the mature stand. These differences in stand water use reflect both the higher estimated sapwood area for the 10 year old stand (25.7 m^2 ha^{-1}) compared to the 24 year old and mature forest stand (12.0 and 10.2 m^2 ha^{-1}, respectively), combined with the much higher mean sap velocity for the mature forest stand (44.1 cm h^{-1}) compared to the 10 and 24 year old stands (9.0 and 15.0 cm h^{-1}, respectively). These results highlight the importance of considering potential carbon-water tradeoffs when designing and managing tree plantations for bioenergy production, and underscore the need to balance both biomass accumulation and water use. We discuss our findings within the larger context of understanding the potential implications of stand water use in bioenergy plantations across different stand ages, species, and management regimes for downstream water supply and hydrologic regulation services.

9:10 AM Impacts of Sugarcane Expansion on Water Resources in Areas of São Paulo State

Marjorie M. Guarenghi[1,2] and Arnaldo Walter[1], (1)University of Campinas-Unicamp, Campinas, Brazil, (2)Laboratório Nacional de Ciência e Tecnologia do Bioetanol – CTBE/CNPEM, Campinas, Brazil

Abstract:
The expansion of sugarcane cropping for bioethanol production can impact both the quantity and the quality of water resources in the region where it occurs. Land use changes and different management practices can modify the runoff processes in the watersheds and the river flows (TUCCI and CLARKE, 1997). The consumption of water resources associated to sugarcane and ethanol production has decreased during the last years. This has been possible due to the use of fertirrigation and due to the reduction of water withdraws for the industrial phase through the optimization of some processes and water reuse (ELIA NETO et al., 2010). However, the vinasse and the use of agrochemicals can contribute to the pollution of water bodies (GOLDEMBERG et al., 2008).
This abstract is based on the master's thesis of the first author which evaluated whether it is possible to observe impacts of sugarcane expansion both on the quantity and the quality of water bodies. For this research, data of water monitoring in the state of São Paulo were used; these database is publically available and this was a premise for defining the research: what can be understood from the data publically available?
Data used were those from the monitoring stations regarding precipitation, discharge and quality parameters; they are provided by the Brazilian Water Agency (ANA), Department of Water and Energy (DAEE) and Brazilian Commission for the Environment (CONAMA).
The selection of studied areas was made considering the monitoring stations with the longest historical series (above 15 years), with less than 10% of failures, and located in areas with significant expansion of sugarcane over the years. Stations located near hydroelectric plants were avoided and small scale rivers

basins were prioritized. To evaluate the water quality impacts, an additional criterion used was the availability of parameters related to agrochemical inputs and vinasse.
The selection of studying sites was limited by the unavailability of long time series of discharge and variables of water quality in areas with growing sugarcane cultivation. Besides the unavailability of long time series, many data of gauging stations have several failures, mainly in small scale catchments.
In Brazil, the implementation of a water monitoring network was motivated by the importance of hydroelectric plants. This explains the shortage of gauging stations in basins with less than 500 km2 (PAIVA and PAIVA, 2003). The methodology for evaluating the effects of land use change in river flow is more conclusive in small-scale basins (COSTA, 2003). However, the hydrological monitoring network in small-scale basins has constrains, and data is available for just few years or the series have several failures.
The selection of areas to assess the potential impacts on water quality was also constrained by the shortage of time series during long periods for many parameters related to agrochemical inputs and stillage, as potassium and nitrogen series. Among the 80 water quality monitoring stations preselected, approximately 25 stations have data for nitrogen concentration along six years, and less than 10 have registered parameters for potassium. The stations with registers of potassium correspond to information for three large rivers, and the monitoring of this parameter started only in 2001.
Based on the procedure described above, three studying sites in São Paulo State were chosen: the regions of Jaú, Pontal and Ribeirão Preto.
The Jaú River basin, located at the central part of São Paulo State, has an area of 417 km2. In this area, it was only possible to evaluate the discharge between 1982 and 1999. During these eighteen years, the area planted with sugarcane increased 20% (regarding the total area) followed by a reduction of pasture area. In the 1990s, sugarcane cropping area represented more than 50% of the total area of the region. The ethanol and sugarcane production is very important to the economy of the cities in the region of Jaú. Three mills of sugar/ethanol are placed close to the Jaú River.
In the regions of Pontal e Ribeirão Preto, with drainage watershed of 12.445 km2 and 10.679 km2, respectively, both the river discharge and the water quality parameters of the Pardo River were analyzed. In those areas, the area planted with sugarcane grew 40% during the period of evaluation of the streamflow (between 1974 and 2011). In 2010, more than 60% of the total area of the Pontal region and around 50% of Ribeirão Preto region were occupied by sugarcane cropping. Seven sugar/ethanol mills are located near the discharge and water quality stations analyzed.
The historical time series provided by the monitoring stations were analyzed using nonparametric procedures. The Mann-Kendall's test was applied to detect trends, as well as Pettitt's test to determine abrupt changes. Discharge data were correlated with the sugarcane planted area in each studied region over the years. The main water quality variables analyzed were potassium, total phosphorus, nitrate, nitrite, and ammonium. The concentrations of these parameters were correlated to sugarcane planted area and to the population growth.
According to the test, no trend and no changing point were detected in total annual discharge of the rivers analyzed. In fact, all these time series present better correlation to precipitation series. No significant correlation was observed between sugarcane growth and the river flows.
The quality parameters series in Pardo River showed significant increasing trends, except the potassium concentration for which no trend was observed. However, the parameters evaluated are not only influenced by the agrochemical inputs and vinasse containing nitrogen, as well as phosphorus and potassium due to sugarcane production. The increase on concentrations can be associated to the fertilizers leaching, as well as to the discharge of sewage and industrial effluents without appropriated treatment from urban areas.

Despite the use of appropriate procedures for the analysis of hydrological data, the research results are inconclusive. Among the biggest sugarcane producers, São Paulo State is supposed to be the one with the largest water monitoring network. But even in this case, time series are poor for analyzing the relationship between land use changes and its effects on water resources.
The stations with the largest time series correspond to meso- or large-scale basins. In these areas, several anthropogenic, climatic and geographical factors impact on water resources. So, it is difficult – and in some cases impossible – to isolate the effects of sugarcane expansion on catchment hydrology. Impact assessments on water quality were also constrained by the shortage of important monitoring parameters related to agriculture practices and to residues from urban areas and from industrial activities. The bulk of quality monitoring stations are in large rivers, and several time series have failures that constrain the assessment along the time. Therefore, based on the database available to São Paulo State it was not possible to determine the impacts of sugarcane expansion on the water resources.
For the proper evaluation of impacts on water resources caused by the expansion of sugarcane activity, using statistical procedures, it would be necessary to monitor specific areas in small-scale watersheds. This would allow proper data gathering in regions where the influence of other factors could be reduced. To make this possible, investments are required for the installation of new gauging stations to expand the network of water controlling stations.

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9:30 AM Energy-Water Nexus: An Input-Output Dynamical Model
Geraldo A. de Oliveira, DASE, IFPE - INSTITUTO DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE PERNAMBUCO, RECIFE, Brazil and **Fernando M. Campello de Souza**, PPGEE, UFPE - UNIVERSIDADE FEDERAL DE PERNAMBUCO, RECIFE, Brazil

Abstract:
Energy and water are of utmost importance for any country's economy and way of life. Understanding the intricate relationship between energy and water and developing technologies to keep that relationship appropriate is an important key to a sustainable and secure future for any country.

There are trade-offs between energy and water. Large scale power plants — nuclear, coal, biomass and of course, hydroelectric — use lots of water. Conversely, making drinkable, potable water, and piping it into big cities, involving typically large distances, certainly requires plenty of energy.

Water and energy are strongly tied and certainly dependent on each other, with each affecting the other's availability. Water is necessary for energy development and generation, and energy is needed to supply, use, and treat drinking water and waste water. Both, energy and water, are essential to our health, quality of life, and economic growth, and demand for both these resources continues to rise.

Water and energy are the two most fundamental resources of modern civilization. People die, and one cannot grow food, if water is not available. Without energy, one cannot run computers, or power homes, schools, offices, farms, and industrial plants. As the world's population grows in number and affluence, the demands for both resources are increasing faster than ever.

The earth holds about eight million cubic miles of freshwater — tens of thousands of times more than humans' annual consumption. Only about 2.5% of the world's water is freshwater. Unfortunately, less than 1% is accessible via surface sources and aquifers, and the rest is imprisoned in underground reservoirs and in permanent ice and snow cover. Also, the available water is often not clean or not located close to population centers.

The reality that each of these precious resources, energy and water, might soon cripple the use of the other has been under-appreciated. To generate energy, massive quantities of water are consumed, and to deliver clean water, massive quantities of energy are consumed. Desalination, a process that removes salt from water, is the most energy-intensive and expensive option for treating water and is used where alternatives are very limited. Other energy needs associated with water occur at the point of end-use, often in households, primarily for water heating, water cooling, clothes washing, and pumping water. Many people are concerned about the perils of peak oil — running out of cheap oil. A few are voicing concerns about peak water. But almost no one is addressing the conflict between the two: water restrictions are hampering solutions for generating more energy, and energy problems, particularly rising prices, are curtailing efforts to supply more clean water.

Physical constraints on the availability of water for energy sector use encompasses both quantity and quality issues: there may not be enough of it or that which is available may be of insufficient quality. These restrictions may be natural or may arise from regulation of water use. One cannot build more power plants without taking into account that they impinge on the freshwater supplies. And one cannot build more water delivery and cleaning facilities without increasing energy demand. Solving the dilemma requires new global policies that integrate energy and water solutions and innovative technologies that help to boost one resource without draining the other. One need an analytical tool, a mathematical tool, to treat this problem. One mathematical dynamical model is proposed here.

Water and energy are fundamentally linked. Policy reforms in both industries, however, do not appear to acknowledge the links nor consider their wider implications. This is clearly unhelpful, particularly as policy makers attempt to develop effective responses to water and energy issues, underpinned by prevailing drought conditions and impending climate change, and an ever increasing demand for both resources.

Energy production requires a reliable, abundant, and predictable source of water, a resource that is already in short supply throughout much of the world.

The time has come to consider both issues as one. Instead of water planners assuming they will have all the energy they need and energy planners assuming they will have all the water they need, one must get them in the same room to make decisions. A restructuring of the institutional arrangements is in order. And one will need an analytical tool. This is the underlying idea of this proposed analytical model.

One analyzes here the links between water and electricity — termed water-energy nexus, or energy-water nexus — in the general context. For that matter a dynamic input-output Leontief model is proposed.

The Supply Chain Model

The supply chain management is a central tool in business administration.

The input-output matrix summarizes the matching of supply and demand amongst the various sectors of the economy; the gross purchase or sales of physical products among the various sectors of economy. It also describes the technology of production.

Two important economic variables are supply, ***s***, and demand, ***d***. It is assumed that if demand grows, then supply will grow, or should grow, to match it. And vice-versa. In other words, supply keeps tracking demand. There exists thus a feedback phenomenon.

Since demand is always varying, there will be always a dynamic equilibrium. The system is, in general, always moving. It is the dynamics of this movement that one wants to study and control. It is the essence of a supply chain management. In the case of the energy-water interplay this is crucial, since these two variables are closely intertwined.

The variable which provokes the increasing or decreasing of production is the difference between demand and supply. As the population grows, the demand for water (which has no substitute) and energy will grow, and not always in a balanced fashion. There will be a “demand surplus” or a “supply surplus”.

Earth and the communities that live upon it are part of a system. By approaching these massive problems from an integrated standpoint, one begins to solve problems in a more systematic way.

The energy-water nexus is attracting the attention of diverse stakeholders around the world and it is becoming more and more clear that one cannot plan for the planet’s future if one does not consider energy and water as a whole.

Water and energy policy, planning and management must be integrated to encourage conservation, motivate innovation and ensure sustainable use of water and energy. It takes a significant amount of water to create energy, and a significant amount of energy to move and treat water.

One may not realize it, but when one uses energy, one is also using water indirectly — lots of it!

The model proposed here includes the dynamical aspects of the interplay between water and energy, due to the necessity of having stocks, and allows a thoroughly comprehension and control of this interaction. It was implemented in a spread sheet. Several possibilities concerning the links between these two resources, as well as the control of the system (policies) are analyzed.

9:50 AM Hydro Economic Modeling and Water Scarcity Cost in a Watershed with Irrigated Bio Fuel Crops Production

Guilherme Fernandes Marques, Instituto de Pesquisas Hidráulicas, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

Abstract:
Bio fuels production, such as ethanol, fills an important role in meeting a common objective to increase renewable energy use in several countries. Recently, irrigation has demonstrated potential to significantly improve sugar cane productivity in Brazil, contributing to further increase production without expanding the crop area. Water resources are a critical element in planning biofuel production in this context; given potential demands for irrigation, waste assimilation and use of shared infrastructure, like multipurpose reservoirs also used for hydropower generation and urban water supply. To avoid transferring impacts to the producer watersheds (water conflicts, waste production and other externalities) biofuels should planned considering the regional hydrology and water availability, existing infrastructure and competing water demands, including economic ones. Such integrated approach should allow investigation of infrastructure expansion, water transfers and conjunctive use opportunities with groundwater management, for example. This research involves a framework to investigate water management, policy and operational decisions, based on the economic value of the water in the watershed. The framework uses a network based, hydro economic optimization model, with an objective function that minimizes the water's scarcity cost to users, subject to physical and legal constraints in the system. The information produced should be useful to (a) support the water allocation among economic demands, especially the ones related to bio fuel crops production, (b) support the development and adaptation of water planning and management in watersheds where the production of bio fuels is expected to increase, (c) understand the impact of bio fuel production in the water's availability and economic value and (d) evaluate economic costs of meeting environmental demands in a scenario with high water consumption for bio fuel production.

10:10 AM An Economic Analysis of Land Use Changes and Sugarcane Production in Brazil: The Role of Irrigation Water

Ana Cristina G Carneiro[1], Hector M. Nuñez[2], **Hayri Önal**[3] and Márcia M.G.A. Moraes[1], (1)Department of Economics, Universidade Federal de Pernambuco, Recife, Brazil, (2)Department of Economics, Centro de Investigación y Docencia Económicas, Aguascalientes, Mexico, (3)Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, IL

Abstract:
Brazil is the second largest producer and consumer of ethanol in the world. Nearly half of the liquid fuels consumed by light duty vehicles in the country is comprised by ethanol derived from sugarcane. Being the largest exporter, Brazil also plays an important role in the growing global biofuel markets. It is often argued that with a more efficient utilization of the pastures and by converting a small fraction of the vast amount of pasture lands to cropland, Brazil could increase its sugarcane and ethanol production

further to meet the domestic and global ethanol demand. Sugarcane is a water intensive crop; therefore, significant amounts of irrigation water would be needed if sugarcane acreage expands beyond the traditional production areas. While the potential for expanding sugarcane area through livestock intensification and pasture land conversion has been investigated in a few previous studies, less attention has been given to the availability of water resources needed for such expansion. This paper presents a comprehensive approach and investigates the prospects for increasing sugarcane production in Brazil considering the competition between sugarcane and other crops for available land and water resources. A spatially explicit price endogenous mathematical programming model is developed for this purpose where the agricultural and transportation fuel sectors are simulated and equilibrium in commodity and fuel markets is determined in a simultaneous framework. The productivity in agriculture, the demands for major food/feed crops, domestic and export demands for ethanol, and irrigation water availability are projected for 2030 to carry out a prospective economic analysis. The model results show that without the consideration of irrigation water, livestock intensification can allow expanding the sugarcane production by nearly 150 percent compared to the base case (2007). However, when the water resources availability is incorporated along with the cropland limitation the potential for sugarcane expansion is reduced to merely 5 percent. These results demonstrate the important role of water resources and irrigation infrastructure development if Brazil targets a serious expansion in its ethanol industry.

Wednesday, July 23, 2014: 08:30 AM - 11:30 AM, Piedade Room
Bioenergy and Biodiversity: Key Lessons and Research Priorities in the Pan America
Chair: Audrey Mayer, Michigan Technological University

Session Overview:
Understanding how large-scale bioenergy production can affect biodiversity is important if society is to meet current and future sustainable development goals. This session invites abstracts of research on biodiversity and ecosystem impacts of biofuel and bioenergy production systems in the Pan America region.

Wednesday, July 23, 2014: Bioenergy and Biodiversity: Key Lessons and Research Priorities 08:30 AM - 11:30 AM (Piedade Room)	
Chair:	Audrey Mayer, Michigan Technological University
8:30 AM	Bioenergy and Biodiversity: Key Lessons from the Pan American Region . **K. Kline**, F. Martinelli, A. L. Mayer, R. Medeiros, C. O. F. D. Oliveira, G. Sparovek, A. Walter, and L. Venier
8:55 AM	Land Sparing Versus Land Sharing: How Might Biodiversity and Bioenergy Coexist? . **A. L. Mayer**
9:20 AM	Integrating Biodiversity Metrics in Life-Cycle Analysis of Intensive Biomass Production in North American Forests: Challenges and Considerations . **J. Verschuyl**, T. B. Wigley, C. Gaudreault, M. Margni, D. Miller, S. Riffell, B. Titus, and K. Vice
9:45 AM	The Sustainability of Forest Residue for Bioenergy in Canada: What Can Biodiversity Tell Us? . **L. Venier**, I. Aubin, K. Webster, R. Fleming, P. Hazlett, B. Titus, and H. Chen
10:10 AM	Assessing the Impacts of Pan American Bioenergy Development on Birds and Insect Pollinators . **J. Knowlton**
10:35 AM	Roundtable Discussion of Key Research Issues and Challenges

8:30 AM Bioenergy and Biodiversity: Key Lessons from the Pan American Region
Keith Kline, Environmental Science Division, Climate Change Science Institute and Center for Bioenergy Sustainability, Oak Ridge National Laboratory, Oak Ridge, TN, Fernanda Martinelli, Sustainable Development Practices Graduate Program, UFRRJ/ Conservation International Brasil, Rio de Janeiro, Brazil, Audrey L. Mayer, School of Forest Resources and Environmental Science, Michigan Technological University, Houghton, MI, Rodrigo Medeiros, Department of Environmental Sciences, Federal Rural University of Rio de Janeiro / Conservation International, Americas Center for Sustainability, Camila Ortolan F. de Oliveira, UNICAMP/University of Campinas, Campinas, Brazil, Gerd Sparovek, University of Campinas (UniCamp), Campinas, Brazil, Arnaldo Walter, University of Campinas-Unicamp, Campinas, Brazil and Lisa Venier, Canadian Forest Service, Natural Resources Canada, Sault Ste. Marie, ON, Canada

Abstract:
Understanding how large-scale bioenergy production can affect biodiversity and ecosystems is important if society is to meet current and future sustainable development goals. A variety of bioenergy production systems have been established within different contexts throughout the Pan American region, with wide-ranging results in terms of documented and projected effects on biodiversity and ecosystems. The Pan American region is home to the majority of commercial bioenergy production and therefore the region offers a broad set of experiences and insights on both conflicts and opportunities for biodiversity and bioenergy. This paper synthesizes lessons learned from experiences in Canada, the United States, and Brazil regarding the land use conflicts that can arise between bioenergy production and ecological conservation and benefits that can be derived when bioenergy policies promote planning and more sustainable land management systems. We propose a research agenda to address priority information gaps that are relevant to biodiversity concerns and related policy challenges in the Pan American region

8:55 AM Land Sparing Versus Land Sharing: How Might Biodiversity and Bioenergy Coexist?
Audrey L. Mayer, School of Forest Resources and Environmental Science, Michigan Technological University, Houghton, MI

Abstract:
Biodiversity has been threatened at a global scale by the increasing spatial extent of human land use, particularly agricultural production. Approaches to mitigate the impact of land use on biodiversity generally represent one of two opposing approaches: land sparing versus land sharing. In the land sparing approach, human land use is intensified so that the least amount of area is impacted. In the case of agriculture, including the production of biomass for bioenergy, heavy applications of fertilizers, pesticides, and the use of technologies such as genetically modified organisms can generate very high yields in very small but highly modified areas. In the land sparing approach, land management techniques that mimic natural systems are used to allow for productive areas that support high amounts of biodiversity. These methods include permaculture, agroforestry, shifting agriculture, and interspersion of crop areas with natural habitat features. I will review the experiences thus far with these two approaches in agriculture, and suggest lessons learned for biomass-based bioenergy systems that may be compatible with high biodiversity systems.

9:20 AM Integrating Biodiversity Metrics in Life-Cycle Analysis of Intensive Biomass Production in North American Forests: Challenges and Considerations

Jake Verschuyl, Western Wildlife Program, National Council for Air and Stream Improvement, Anacortes, WA, T. Bently Wigley, Forestry, National Council for Air and Stream Improvement, Clemson, SC, Caroline Gaudreault, Canadian Operations National Council for Air and Stream Improvement, Montreal, QC, Canada, Manuele Margni, Polytechnique Montreal, Montreal, Canada, Darren Miller, Southern Environmental Research, Weyerhaeuser NR Company, Columbus, MS, Sam Riffell, Department of Wildlife, Fisheries, and Aquaculture, Mississippi State University, Mississippi State, MS, Brian Titus, Pacific Forestry Centre, Natural Resources Canada, Victoria, BC, Canada and Kirsten Vice, Canadian Operations, National Council for Air and Stream Improvement, Montreal, QC, Canada

Abstract:
Energy policy in the United States and Canada has increasingly promoted developing plant-based biofuels to complement, and potentially provide alternatives to, fossil fuels. This has resulted in more interest in intensive biomass production to meet anticipated growth in demand. Native grasses, woody species, and forestry residues currently show promise as a local energy source for wood products facilities and for producing marketable biofuels. Large scale adoption of intensive biomass production in forests, however, has potential to alter management, species composition, physical structure, and landscape configuration of forests in some regions of North America. Because forest lands support a large proportion of biodiversity in many regions, it is important to understand how biodiversity may respond to practices associated with biomass production systems and what additional information is needed by forest managers and policymakers. Additionally, it has been argued by many that it is necessary to examine the full life cycle of biomass-derived fuels to understand implications of their production and use using a comprehensive set of environmental indicators, including land use and biodiversity. Existing Life Cycle Analysis (LCA) studies, however, often focus only on greenhouse gasses and energy.

We use results of a review of documented relationships between intensive production of forest biomass and forest biodiversity in North America to highlight challenges and applications of biodiversity as an indicator for biomass harvesting systems within Life Cycle Impact Assessment (LCIA), one of the phases of LCA. We searched the literature for papers that characterized biodiversity responses to at least one of four treatments related to biomass harvesting: removal of forest harvest residues (coarse woody debris [CWD] manipulations), thinning, intercropping and short-rotation woody crops. Three levels of biodiversity (ecosystem, species, and genetic diversity) have been considered in LCIA approaches, but only information on species diversity offers enough depth or rigor to provide inference. Biodiversity responses from reviewed literature included species richness, diversity, abundance of taxa or groups of species (guilds) and abundance of individual species for birds, mammals, reptiles, amphibians, and invertebrates. We used meta-analyses to summarize biodiversity response to the four biomass harvest treatments.

We found a wealth of literature reporting effect on birds, small mammals and invertebrates. Few studies were found investigating response of amphibians and reptiles to biomass removal. We found that removal of snags and CWD may have more significance for birds than for other taxa. A decrease in abundance of invertebrates in CWD or snag removal plots is a possible mechanistic explanation for the reported lower bird abundance and diversity. Forest thinning treatments had generally positive effects on diversity and abundance across all taxa. We found biodiversity response to biomass harvest at least somewhat dependent on harvest intensity. More research is needed to determine effects of short

rotation woody crops, intercropping, fine woody debris removal and geographic variability. Our review highlights the need for manipulative experiments designed to test biomass removal hypotheses.

Existing literature confirms that biodiversity response to biomass production is complex, influenced by site-specific factors temporal and spatial scale of analyses, taxa being considered, and other factors. Challenges for biodiversity assessment within the LCA framework for biomass harvesting include those inherent to the multi-dimensional complexity of biodiversity itself and several complications related to the non-linear responses of biodiversity to biomass harvesting. Thus, generic LCAs that do not account for complexities such as these likely offer limited insight into actual implication of biomass production for biodiversity.

9:45 AM The Sustainability of Forest Residue for Bioenergy in Canada: What Can Biodiversity Tell Us?
Lisa Venier[1], Isabelle Aubin[1], Kara Webster[1], Rob Fleming[1], Paul Hazlett[1], Brian Titus[2] and Han Chen[3], (1)Canadian Forest Service, Natural Resources Canada, Sault Ste. Marie, ON, Canada, (2)Pacific Forestry Centre, Natural Resources Canada, Victoria, BC, Canada, (3)Faculty of Natural Resources Management, Lakehead University, Thunder Bay, ON, Canada

Abstract:
The federal and provincial governments in Canada are becoming increasingly interested in biomass harvesting, in part because of recently declining markets for traditional products and associated job losses, as well as heightened public and policy debate over climate change and the need to reduce Canada's growing greenhouse gas emissions. In a recent national scan of regulations relevant to biomass harvesting by the World Wildlife Fund and the Forest Products Association of Canada (2010), every province surveyed had made some sort of overarching policy commitment to a greater reliance on renewable fuels; the scan also found that forest biomass harvesting and related concerns about resulting environmental impacts are becoming increasingly discussed and debated across all provinces. All provinces assessed have also indicated that biomass harvesting must be conducted within existing forest management policies and guidelines. Concerns have been raised about the scientific credibility and social acceptance of the developing bioenergy sector. The report entitled "Fuelling the BioMess" by Greenpeace Canada (2011) and an internal Environment Canada report on eNGO (environmental non-government organization) and conservation group views on forest biomass harvesting in Canada (Dagg et al. 2011) highlight concerns about ecological impacts of biomass harvest including impacts on biodiversity and wildlife habitat as well as soil fertility and forest productivity. It was the opinion of many organizations that forest residue is not an acceptable biomass resource because of its importance to biodiversity and productivity (Dagg et al. 2011). There is, however, very little scientific evidence, particularly within North American forest ecosystems, to either support or deny this statement. In this paper we will review the research in Canada related to the impacts of biomass removal for bioenergy on biodiversity and describe current projects designed to address the question of how much biomass can be removed while maintaining forest ecosystem integrity as measured by biodiversity. In particular, we will describe a recent study in Chapleau, Ontario that is attempting to integrate data from a variety of taxonomic groups using a multi-trophic, ecosystem approach.

10:10 AM Assessing the Impacts of Pan American Bioenergy Development on Birds and Insect Pollinators

Jessie Knowlton, School of Forest Resources and Environmental Science, Michigan Technological University, Houghton, MI

Abstract:
Bioenergy has the potential to help meet worldwide energy demands while reducing dependence on fossil fuels and mitigating climate change. As a result, global energy use from biomass is expected to increase two to six fold by 2050. In the U.S. and Argentina, biomass power plants require dedicated woody crops, and aspen and eucalyptus are possible fuel sources for each country, respectively. Brazil and Mexico are considering meeting increased bioenergy production goals through biodiesel made from palm oil. However, few studies have addressed the ecological impacts of the expansion and harvesting of these feedstocks. The biodiversity subteam of the National Science Foundation Partnerships for International Research and Education "Sustainability, Ecosystem Services, and Bioenergy Development across the Americas" grant will examine some of the impacts of the expansion bioenergy feedstocks on birds and insect pollinators in these four countries (Brazil, Mexico, Argentina and the US). One of the most challenging questions for conservation is how species move in human-modified landscapes (HMLs) and select habitats, since species unwilling or unable to move through HMLs risk population decline and extinction. Many models attempting to predict the long-term persistence of species in HMLs rely on accurate estimates of the permeability of different landscape elements. The permeability of different agroforestry plantations is still poorly understood, even for well-studied species such as birds and insects. We will use radio-telemetry, point counts and pan traps to study bird and insect pollinator movements and habitat preferences within bioenergy plantations and surrounding lands in all four countries. In each country we will compare species' richness, abundances, movement behaviors and habitat choice in the relevant possible feedstock plantation type (i.e., aspen, eucalyptus or oil palm) and two most likely alternative land-uses (e.g., cattle pasture and cropland), as well as native forest or grassland as a control. Both birds and insects deliver essential ecosystem services to native vegetation and agricultural crops, including pest control, pollination and seed dispersal. Further, birds and insects are commonly used as bio-indicators and proxies of overall biodiversity. This research is a vital part of the larger team's effort to determine the socio-ecological impacts of Pan American bioenergy development that will serve as a foundation for sustainability modeling of complex systems.

Wednesday, July 23, 2014: 08:30 AM - 11:30 AM, Imperial Room
Policies for the Sustainable Development of Biofuels in Pan America
Chair: Barry Solomon, Department of Social Sciences, Michigan Technological University
Co-Chair: Alberto Acevedo, Natural Resources Research Center, National Agricultural Technology Institute (INTA)

Session Overview:
Rapid growth of biofuel production in the United States and Brazil over the past decade has increased interest in replicating this development in other nations of the Pan American region. A key biofuel policy research question is "are national biofuel policies achieving their goals?" This session welcomes abstracts covering analyses of biofuel and bioenergy policies in different Pan American countries. Abstracts addressing alternative international governance regimes for biofuel sustainability are also welcomed.

Wednesday, July 23, 2014: Policies for the Sustainable Development of Biofuels in Pan America **08:30 AM - 11:30 AM** (Imperial Room)	
Chairs:	Barry Solomon, Michigan Technological University, Michigan, USA Alberto Acevedo, National Agricultural Technology Institute (INTA), Buenos Aires Argentina
8:30 AM	Policies for the Sustainable Development of Biofuels in Pan America: A Review and Synthesis of Five Countries . **B. Solomon**, A. Banerjee, A. Acevedo, K. Halvorsen, and A. Eastmond
8:50 AM	Climate Change, Decarbonisation, and Bioenergy Production: Integrating Policy Science into a Broader Context . **K. E. Halvorsen**
9:10 AM	A Blueprint for Sustainability Certification Implementation in the U.S. and Brazil . **J. Endres** and **R. Aguiar**
9:30 AM	Indirect Effects of Bioenergy: International Standards and Science . **M. Davis**, K. Kline, F. Ghatala, and D. Goldin
9:50 AM	Biofuel Sustainability in Latin America and the Caribbean: A Review of Recent Experiences and Future Prospects . **R. Bailis**, **B. Solomon**, C. Moser, and T. Hildebrandt
10:10 AM	Trajectory of Wood Energy Policies in the United States: Sustainability and Governance in Global Markets . **D. Becker**
10:30 AM	Roundtable Discussion of Key Research Issues and Challenges

8:30 AM Policies for the Sustainable Development of Biofuels in Pan America: A Review and Synthesis of Five Countries

Barry Solomon, Department of Social Sciences, Michigan Technological University, Houghton, MI, Aparajita Banerjee, Michigan Technological University, Houghton, Alberto Acevedo, Natural Resources Research Center, National Agricultural Technology Institute (INTA), Buenos Aires, Argentina, Kathleen Halvorsen, School of Forest Resourses and Environmental Science and Department of Social Sciences, Michigan Technological University, Houghton, MI and Amarella Eastmond, CIR, UADY, Merida, Mexico

Abstract:
Rapid growth of biofuel production in the United States and Brazil over the past decade has increased interest in replicating this success in other nations of the Pan American region. However, the continuing production of food-based feedstock is widely seen as unsustainable and is in some cases linked to deforestation and increased greenhouse gas emissions, raising further doubts about long-term sustainability. As a result, many nations are exploring the production and use of cellulosic feedstock, though progress has been extremely slow. In this paper we will review the North-South axis of biofuel production in Pan America and its linkage with the agricultural sectors in five countries in Pan American. The key research question is "are national biofuel policies achieving their goals?" Policy goals and results will be highlighted for the main biofuel policies that have been enacted at the national level. The geographic focus will be given to the two largest producers - the United States and Brazil; two smaller emerging producers – Argentina and Canada; and one stalled program - Mexico. However, several additional countries in the region are either producing or planning to produce biofuels. We will also review alternative international governance regimes for biofuel sustainability that have been recently developed, and whether the biofuel programs are being managed to achieve improved environmental quality and sustainable development.

8:50 AM Climate Change, Decarbonisation, and Bioenergy Production: Integrating Policy Science into a Broader Context

Kathleen E Halvorsen, Michigan Technological University, Houghton, MI

Abstract:
The primary value of bioenergy production is as a potential tool to mitigate climate change. This brings us into a larger policy science context of energy production and consumption, decarbonisation, and climate change policies. Understanding how these arenas will move forward and help us to transform societies in order to mitigate climate change requires new, integrated policy science research that integrates across these areas. This presentation focuses on describing an interdisciplinary, international social science research agenda that can meet these goals.

9:10 AM A Blueprint for Sustainability Certification Implementation in the U.S. and Brazil

Jody Endres, Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign, Champaign, IL and **Rayane Aguiar**, Energy Biosciences Institute, University of Illinois at Urbana Champaign, Champaign, IL

9:30 AM Indirect Effects of Bioenergy: International Standards and Science

Maggie Davis[1], Keith Kline[1], Fred Ghatala[2] and Diego Goldin[3], (1)Environmental Science Division, Climate Change Science Institute and Center for Bioenergy Sustainability, Oak Ridge National Laboratory, Oak Ridge, TN, (2)Waterfall Group, Canada, Vancouver, BC, Canada, (3)The Argentine Standards Institute (IRAM), Buenos Aires, Argentina

Abstract:
In 2009 the International Organization for Standardization (ISO) created a project committee to develop an international standard to provide guidance on Sustainability Criteria for Bioenergy. Four working groups were assigned specific tasks. This paper summarizes the results of the working group created to critically assess and present results on "indirect effects," beginning with the topic of food security impacts from bioenergy production. From May 2011 to July 2013, this group reviewed and critically assessed over 160 publications on indirect effects (e.g., approaches to model indirect land use change) published between 2004 and 2013. The working group delivered a total of four reports, which were presented to the larger project committee to guide the development of the standard based on consensus. The report submitted in February 2012 contained a consensus statement by the working group members on the current state of science of indirect effects, which guided discussions within the project committee. The report highlighted that the science on indirect effects is "nascent and rapidly evolving" and summarized the conclusions and recommendations, based on the literature reviewed and the expertise of the work group, as follows:
"(T)he state of science, in terms of evidence based research, is inconclusive or contradictory regarding indirect effects of bioenergy. … An economic operator should not be held responsible for indirect effects and variables that are outside the operator's control." "Recent modeling (of indirect effects) has highlighted potential impacts as well as the high variability in results though much of the modeling thus far has relied on assumptions that may not be supported by empirical evidence. To date, there has been limited causal analysis to support assumptions underlying indirect effects modeling." "There needs to be equitable treatment of direct and indirect effects for any energy options being analyzed including baseline fuel(s) that would be replaced by proposed bioenergy sources."
This paper is authored by the co-convenor and secretariat of this working group and for the first time presents its findings outside of an ISO context. In this paper the authors discuss the process to reach the above conclusions and the use of ILUC in other standards, provide a literature review based on contributions by experts participating in the working group, and offer some conclusions about indirect effects as they relate to bioenergy production.

Financial Support: IRAM, ORNL, U.S. Department of Energy, Waterfall Group

9:50 AM Trajectory of Wood Energy Policies in the United States: Sustainability and Governance in Global Markets

Dennis Becker, Forest Resources, University of Minnesota, Saint Paul, MN

Abstract:
Expanded wood energy production in the United States would accomplish many societal and economic objectives. It could also contribute significantly to efforts to restore forests and reduce the risk of catastrophic wildfire. But not all biomass is created equal. Concerns exist domestically and globally about the procurement of woody biomass and market-driven impacts on forest ecology, water quality, air emissions, and global greenhouse gas concentrations. A policy analysis framework is presented that couples sustainability concerns with multi-jurisdictional governance mechanisms intended to neutralize

negative impacts. Policy gaps are highlighted along the supply chain to illustrate areas for improved coordination and policy development.

10:10 AM Biofuel Sustainability in Latin America and the Caribbean: A Review of Recent Experiences and Future Prospects

Robert Bailis[1], Barry Solomon[2], Christine Moser[3] and Tina Hildebrandt[3], (1)School of Forestry and Environmental Studies, Yale University, New Haven, CT, (2)Department of Social Sciences, Michigan Technological University, Houghton, MI, (3)Leuphana Universitat, Luneburg, Germany

Abstract:
The Latin American and Caribbean (LAC) region is a leader in global biofuel production, accounting for 27% of supply. This is driven by a proliferation of mandates and targets calling for increased use of biofuels around the world. While biofuels are theoretically renewable, unsustainable production can alter landscapes and stress social-ecological systems. To mitigate impacts, different types of governance mechanisms have been introduced including national regulations, voluntary certification schemes, sustainability standards, meta-standards, and codes of conduct. Voluntary certification has gained prominence in the region, with nearly 200 producers and processors in 13 LAC countries obtaining certification . However, given the potential social and environmental impacts evident in the region, voluntary certification may be insufficient and stronger sustainability mechanisms may be justified.

RCN Conference on Pan American Biofuels & Bioenergy Sustainability

Golden Tulip Recife Palace, Recife, Brazil
July 22-25, 2014

Technical Program
Wednesday, July 23, 2014: 01:00 PM - 04:00 PM

Wednesday, July 23, 2014: 01:00 PM - 04:00 PM, Boa Viagem Room
Biogeochemical Research Priorities for Sustainable Biofuels and Bioenergy Feedstock Development in the Pan America Region
Chair: Brian Titus, Pacific Forestry Centre, Natural Resources Canada, Victoria, BC, Canada
Co-Chair: Hero Gollany, US Dept of Agriculture, Oregon, USA

Session Overview:
Rapid expansion in biomass production for biofuels and bioenergy in the Pan America region is increasing demands on ecosystem resources required to sustain it. This rapid expansion has outpaced scientific knowledge of biogeochemical processes related to ecosystem sustainability. Abstracts are sought in topics such as the effects of biomass removal on soil organic matter and macro- and micro-nutrients, cation exchange capacity, pH, soil structure and compaction, long-term soil productivity and crop growth, effects of biomass management systems on greenhouse gas emissions, implications on other soil ecosystem services (e.g., contaminant degradation, water purification), and sustainability indicators of soil productivity and their application in land management.

1:00 PM	Biogeochemical Research Priorities for Sustainable Biofuel and Bioenergy Feedstock Production in Pan-America . **H. Gollany**, **B. Titus**, A. Scott, H. Asbjornsen, S. Resh, R. Chimner, D. Kaczmarek, L. Leite, A. Ferreira, K. Rod, J. Hilbert, M. V. Galdos, and M. Cisz
1:25 PM	Soil Organic Carbon Measurement Protocols: A USA and Brazilian Comparison and Recommendation . **M. Davis**, D. Abulebdeh, B. J. R. Alves, M. V. Galdos, D. L. Karlen, and K. Kline
1:50 PM	Advances in the Knowledge on the Impacts of Waste Management Forest Harvesting on Soil Quality of the NE in Argentina . **A. M. Lupi**, R. Fernández, R. Martiarena, N. Pahr, A. Von Wallis, M. D. L. A. Garcia, and J. Aparicio
2:15 PM	Lipid Accumulation and Nitrogen Removal for Chlorella vulgaris and Scenedesmus Obliquus Using Wastewater . **A. Ruiz Marin Sr.** and Y. Canedo Lopez Sr.
2:40 PM	Forest Biomass Harvesting and Site Productivity: Is Policy Ahead of Biogeochemical Science? . **E. D. Vance**, W. M. Aust, B. D. Strahm, R. E. Froese, R. B. Harrison, and L. A. Morris
3:05 PM	Roundtable Discussion of Key Research Issues and Challenges

1:00 PM Biogeochemical Research Priorities for Sustainable Biofuel and Bioenergy Feedstock Production in Pan-America

Hero Gollany[1], **Brian Titus**[2], Andrew Scott[3], Heidi Asbjornsen[4], Sigrid Resh[5], Rodney Chimner[5], Donald Kaczmarek[6], Luiz Leite[7], Ann Ferreira[7], Kenton Rod[8], Jorge Hilbert[9], Marcelo Valadares Galdos[10] and Michelle Cisz[5], (1)USDA, ARS, Pendleton, OR, (2)Pacific Forestry Centre, Natural Resources Canada, Victoria, BC, Canada, (3)USDA-FS, (4)Department of Natural Resources and Environment, University of New Hampshire, (5)School of Forest Resources and Environmental Sciences, Michigan Technological University, (6)Forestry Consultant, (7)EMBRAPA, Brazil, (8)Department of Crop and Soil Sciences, Washington State University, (9)INTA, National Agricultural Technology Institute, Buenos Aires, Argentina, (10)Brazilian Bioethanol Science and Technology (CTBE), Campinas, Brazil

Abstract:
Rapid expansion in biomass production for biofuels and bioenergy in the Pan-American region is increasing demands on the ecosystem resources required to sustain soil and site productivity. We review the current state of knowledge and highlight gaps in research on biogeochemical processes and ecosystem sustainability related to biomass production. Biomass production systems incrementally remove greater quantities of site organic matter, which in turn affects soil organic matter and associated carbon and nutrient storage (and hence long-term soil productivity) and off-site impacts. While these consequences have been extensively studied for some crops and sites, the ongoing and impending impacts of biomass removal require management strategies for ensuring that soil properties and functions are sustained for all combinations of crops, soils, sites, climates and management systems, and that impacts of biomass management (including off-site impacts) are environmentally acceptable. In a changing global environment, knowledge of cumulative impacts will also become increasingly important. Long-term experiments are essential for key crops, soils and management systems because short-term results do not necessarily reflect long-term impacts, although improved modeling capability may help to predict these impacts. Identification and validation of soil sustainability indicators for both site prescriptions and spatial applications would better inform commercial and policy decisions. In an increasingly inter-related but constrained global context, researchers should engage across inter-disciplinary, inter-agency, and international lines to better ensure long-term soil productivity across a range of scales, from site to landscape.

1:25 PM Soil Organic Carbon Measurement Protocols: A USA and Brazilian Comparison and Recommendation

Maggie Davis[1], Dana Abulebdeh[2], Bruno José Rodrigues Alves[3], Marcelo Valadares Galdos[4], Douglas L. Karlen[5] and Keith Kline[1], (1)Environmental Science Division, Climate Change Science Institute and Center for Bioenergy Sustainability, Oak Ridge National Laboratory, Oak Ridge, TN, (2)Systems Engineering & Engineering Management, University of North Carolina at Charlotte, Charlotte, NC, (3)Embrapa Agrobiologia, The Brazilian Agricultural Research Corporation (EMBRAPA), Brasilia, Brazil, (4)Brazilian Bioethanol Science and Technology (CTBE), Campinas, Brazil, (5)USDA-ARS National Soil Tilth Laboratory, Ames, IA

Abstract:
Measuring changes in soil organic carbon (SOC) has received significant attention not only from researchers and policy makers striving to develop climate change mitigation strategies, but also by those focused on the increasing global demand for food, feed, fiber, and most recently feedstocks for bioenergy and bio-product industries. Both efforts have intensified concerns regarding SOC depletion, but there is a lack of consensus on sampling strategies, measurement techniques, and verification

methods. This has created an urgent need for standardized, practical measurement protocols for SOC (Post et al. 2001, Jandl et al. 2014) that will provide a consistent assessment and a comparable product regardless of where studies are conducted (Panagos 2012). Even with a documented lack of consensus on the protocols for measuring, processing, and estimating SOC, this parameter is being used to estimate CO2 flux from agricultural practices and has become a component of lifecycle analyses (LCA) for bioenergy systems (Doran and Jones 1996; Reeves, 1997; USDA, 2006; McBride et al. 2011; Jandl et al. 2014). Bioenergy producers that can show a GHG offset for their fuel could have an advantage in the increasingly competitive global bioenergy market (Cerri et al., 2013). Therefore, LCA results are extremely important to biofuel producers and end-users seeking the most sustainable bioenergy options.

This presentation focuses on SOC studies conducted in two major bioenergy producing countries with the two primary ethanol feedstock crops – corn (*Zea mays* L.) in the U.S. and sugarcane (*Saccharum officinarum*) in Brazil. We conducted a literature review and have provided a comparison of sampling protocols for measuring SOC to identify and address inconsistencies in SOC assessment between the two countries. In this comparison, we draw significantly on research by Cerri et al. (2013) which identified appropriate methodologies for determining SOC for sugarcane, the US Department of Agriculture's (USDA) Greenhouse gas Reduction through Agricultural Carbon Enhancement network (GRACENet) protocols for soil sampling (Liebig et al. 2010), and the closely aligned Resilient Economic Agricultural Practices (formerly the Renewable Energy Assessment Project) (REAP) protocols (Karlen 2010, Karlen et al. 2011) for assessing sustainability of corn stover production and harvest. We identify sources of significant variance due to methods and discuss options to build consensus for a common SOC assessment approach that could be implemented for future studies.

1:50 PM Advances in the Knowledge on the Impacts of Waste Management Forest Harvesting on Soil Quality of the NE in Argentina

Ana Maria Lupi[1], Roberto Fernández[2], Rodolfo Martiarena[2], Norberto Pahr[2], Alejandra Von Wallis[2], Maria de Los Angeles Garcia[3] and Jorge Aparicio[4], (1)Instituto de Suelos, INTA-CIRN, Buenos Aires, Argentina, (2)INTA EEA, Montecarlo, Misiones, Argentina, (3)INTA EEA, Concordia, Entre Ríos, Argentina, (4)INTA EEA, Bella Vista, Corrientes, Argentina

Abstract:
There is a global debate regarding the effects of the crop residues management on the soil quality in the short and long term. In Argentina this concern has focused on the Mesopotamian region (25 ° 36' 18" and 33 º 54' 51" southern latitude), where is the 75% of the country's forest production. In the last 18 years, the National Institute of Agricultural Technology (Instituto Nacional deTecnología Agropecuaria, INTA) has addressed to evaluate the impacts of forest harvesting and establishment on soil fertility parameters. Until the late 90s, the type of harvesting and traditional land preparation in Mesopotamia was stem extraction and waste burning. During the 2000s, burning and remains conservation were common practices while in the last five years some companies have been incorporated the harvesting of the entire tree. This practice aims to remove some of the residual biomass of the cup for dendro-energetic purposes, which considerably avoids the organic inputs to the soil.

The main issues analyzed include the impact of nutrients, the organic matter (OM), and the physical condition of the soil in a lesser extent. Some of the studies are developed on subtropical red clay soils (Ultisols and Alfisols) in the Misiones region, using Pinus taeda and Araucaria angustifolia plantations. Quantifications performed by Fernández et al, (2000) and Martiarena et al, (2004) indicate that the

amount of the remaining forest residues ranges between 29.1 to 41.1 Mg ha-1 (mulch, leaves, and up to 15 cm length branches). This amount rises to 58-66 Mg ha-1 in Eucalyptus grandis in the Entre Rios region (Lupi et al., under evaluation). From the harvesting of the whole tree in this region, Frangi et al, (1999) estimated that 234, 38 and 119 Kg.ha-1 of N, P and K respectively are obtained. Recently, Fernandez et al. (2014) estimated that a stand of P. taeda generated 25 Mg.ha-1 more residues when the whole tree is harvested than when only the stem is extracted. Under the first system, an additional loss of N, P, and K of 129.5, 7.6, and 33.3 Kg.ha-1 is expected, respectively. Other studies that simulated different harvesting scenarios conclude that the whole tree harvesting contributes the most to the major negative effects. Also, phosphorous (P) and potassium (K) are the are the nutrients that could be critical in future rotations (Goya et al, 2003;. Martiarena et al, 2010;. Martiarena et al, 2011ab; Fernandez et al, 2012ab). Other experiments at regional level analyzed the effect of different alternatives for crop residues management on the levels of total organic carbon (TOC), quality, total nitrogen (TN), and forms of P in soil. Studies under temperate conditions in the Entre Rios region compared the residues and litter removal (ER), residues conservation (CR), and residues burning (QR) considering Vertisols and Molisols. In the short term (<2 years) the CR did not increase the TOC, the Nt, or the TOC fraction associated with the supply of nutrients (particulate OM). Other treatments under the subtropical clay soils of the Misiones region showed similar trends. However, there will be short-term differential effects that are lost with time. Some analyses concluded that after the treatments were applied by 4 years, the ER and QR showed the lowest values of TOC and light carbon (Cl) (Giufre et al.2002; Lupi et al., 2007).

Another study did not detect changes in the TOC when comparing the QR vs. the CR in a similar period (Von Wallis, 2013). However, the chemical fractionation of humus evidenced the existence of changes in the TOC quality, which expose the potential consequences on the nutrient cycle linked to the organic matter. Both the QR and the ER showed an increase in the degree of MO stabilization due to the increase of the humic C-acids to fulvic C-acids ratio and the rise of CO in the most resistant fraction (humins) (Lupi et al., 2012). Recently, a short-term study on a sandy soil in the Corrientes region reported also changes in the MO quality due to the removal of crop residues (Lupi et al., 2013). The analysis of the molecular structure of the MO through the 13C NMR technique showed higher aromaticity and stability of humic acids in treatments without residues (QR or CAC), being the most marked effect on QR. The temporal evolution of chemical fertility parameters in Ultisols after 12 years of applying treatments, did not present enough evidence to conclude that the disposal of waste leads to a decrease in the levels of TOC, N, pH, and available P (Fernández et al., 2010 and Lupi et al., 2014). The input of fresh organic matter that was generated after the close of the cups and corresponding to atmospheric deposition might have offset the observed differences among treatments in the short-term assessments.

P-dynamics on the soils were also analyzed by its separation into fractions of different lability (Lupi et al. Mórtola 2012b and 2013). It was observed that the ER, QR or CR did not produce changes in the total P contained in the studied soils (Ultisol> Mollisol> Vertisol>Entisol). The organic fractions of P in Molisols, Vertisols and Entisols were not affected. The most prominent change in the Vertisols and Entisols was the increase of the available P generated by the burning without modifying the organic fractions. Controlled burning resulted to be tool for rapid nutrients transfer from the biomass residues to the first 5-10 cm of soil. On the other hand, Mortola (2013) concluded that after 9 years, the ER negatively affected the organic P fractions in Ultisols, which affects one of the sources of available P. Author did not consider the adverse effects of QR.

Regarding the physical variables, some studies (Lupi et al., 2012; Von Wallis 2013) examined the effect of different waste managements on the aggregate size in wet, the saturated hydraulic conductivity (Ksat), and the size distribution of the aggregates. It was observed that the distribution pattern of aggregate size depended upon the type of soil (Vertisol, Mollisol or Ultisol). In general, it was observed that regardless of the treatment, during the period prior to crown closure the waste conservation plays a key role on the soil protection against erosion, and on the profile of the soil-water-recharge process. In high-natural stability Ultisols, the QR, and ER in a lesser extent, affected the stability of the largest macro-aggregates, which was negatively correlated with the light fraction of the OM. In soils of the temperate region, the size distribution of aggregates did not change in the Vertisols in less than 2 years of applying the treatments. The opposite situation occurred in Molisols, where the largest macroaggregates were less stable in the ER treatments. In Vertisols the Ksat was higher than in Molisols. Additionally, the Ksat was higher in CR than in ER and QR. This was associated with a higher proportion of continuous and stable macropores, which protects the soil-atmosphere interface. On the other hand, the Molisol was naturally less stable and presented a lower Ksat regardless the presence or absence of soil cover.

Beyond the results presented here, and based on a small number of experiments, our knowledge about the effects of crop residues management on the soil productivity remains limited. However, our results provide trends of the short-term effects. Determination of the degree and extent of the impact of waste management on soil quality requires establishing long-term studies that consider different environments and species of greatest relevance. Such studies must focus on the organic carbon and nutrients dynamics and balances, soil microbiology, soil compaction.

2:15 PM Lipid Accumulation and Nitrogen Removal for Chlorella vulgaris and Scenedesmus Obliquus Using Wastewater

Alejandro Ruiz Marin Sr., biotechnology, Universidad Autonoma del Carmen, Mexico, Campeche, Mexico and Yunuen Canedo Lopez Sr., Chemical, Universidad Autonoma del Carmen, Campeche, Mexico

Abstract:
Nitrogen limitation has been widely proposed as a method to increase lipid content of microalgae in biodiesel-oriented processes. However, this is typically accompanied by a reduction on the growth rate, and as a result, the overall lipid productivity does not necessarily increase. In this study a novel multi-stage nitrogen-reduction process is proposed, in order to promote a balance between growth rate and lipid accumulation which could result in a net increase of lipid-productivity in microalgae, while simultaneously reducing nitrogen concentrations in wastewater. *Chlorella vulgaris* and *Scenedesmus obliquus* were grown initially in nitrogen-rich (90 mg L^{-1}) artificial-wastewater medium, followed by sequential dilutions (50% v/v) in fresh medium with N-NH_4 concentrations of 60, 40, and 20 mg L^{-1}, respectively. The overall lipid productivity was compared to those obtained in various two-stage nitrogen reduction processes, wherein the nitrogen-rich culture was followed by a 50% v/v dilution in fresh medium containing 30, 20, or 10 mg L^{-1} N-NH_4 in the second stage. Increased net lipid-productivity was observed for both species in the two-stage mode, although nitrogen depletion was not achieved in these cases. On the other hand, in the sequential mode only *C. vulgaris* exhibited a net lipid-productivity increment. The highest lipid productivities occurred in the two-stage mode for both *S. obliquus* and *C. vulgaris* (194.9 and 133.5 mg L^{-1} d^{-1}, respectively). The lipid productivities achieved in this study are among the highest reported in the open literature to date, and the fatty-acid profiles are adequate for biodiesel production.

2:40 PM Forest Biomass Harvesting and Site Productivity: Is Policy Ahead of Biogeochemical Science?
Eric D. Vance, National Council for Air and Stream Improvement, Inc. (NCASI), Research Triangle Park, NC, W. Michael Aust, Department of Forest Resources and Environmental Conservation, Virginia Tech, Blacksburg, VA, Brian D. Strahm, Department of Forest Resources and Enviornmental Conservation, Virginia Tech, Blacksburg, VA, Robert E. Froese, School of Forest Resources and Environmental Science, Michigan Technological University, Houghton, MI, Robert B. Harrison, School of Environmental and Forest Sciences, University of Washington, Seattle, WA and Larry A. Morris, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA

Abstract:
Emerging bioproduct and energy markets provide incentives for harvesting greater quantities of biomass at shorter intervals and have raised environmental concerns, including effects on the productive capacity of forested sites. In response to these concerns, governments and non-governmental organizations have developed biomass harvesting guidelines (BHGs) with provisions for retaining specific proportions or quantities of biomass on site and restricting harvests on sites deemed sensitive. These guidelines are largely voluntary but may be incorporated in some form into forest practice mandates and certification systems. BHGs are well intentioned and based on a reasoned, conceptual understanding of the role of harvest residues in sustaining soil organic matter, nutrient availability, and future site productivity. Management restrictions come with economic and environmental costs, however, and the science supporting them deserves greater scrutiny. Field experiments show that forest responses to biomass harvesting vary widely and are often counterintuitive. With site-specific data lacking, BHGs tend to rely on default assumptions supported by best professional judgment. These include (i) the natural or unmanaged state is an ideal frame of reference, (ii) conventional harvesting retains and distributes most residues across the site, (iii) biomass harvesting removes virtually all residues, (iv) decomposing residues always enhance soil C and site productivity, (v) biomass harvesting is conducted without operational practices that alleviate site deficiencies and sustain productivity, and (vi) changes in forest state are equivalent to changes in forest function. While harvesting-induced nutrient deficiencies can be prevented or corrected with fertilizers or other soil amendments, soil disturbance and exposure may warrant greater attention. Effective BHGs are science-based, operationally feasible, and protect values of interest while allowing managers the flexibility to prevent or mitigate potential impacts within constraints imposed by existing forest practice rules, best management practices, and forest certification provisions.

Wednesday, July 23, 2014: 01:00 PM - 04:00 PM, Candeiras Room
Standardization of Environmental Life Cycle Assessments of Biofuels in the Pan America Region
Chair: David R. Shonnard, Michigan Technological University
Co-Chair: Julio Sacramento, Department of Chemical Engineering, Univ Autônoma de Yucatan, Merida Mexico

Session Overview:
Biomass supply chains that are economically feasible, energy efficient, and compatible with environmental and social goals are a requirement for sustainable biofuels and bioenergy development. This session seeks integrated analyses of biomass supply chains for biofuels and bioenergy production utilizing diverse types of biomass and from many different locations in the Pan American region.

1:00 PM	Standardization of Environmental Life Cycle Assessments of Biofuels in the Pan America Region . **D. R. Shonnard**, J. A. Hilbert Sr., B. Klemetsrud, J. Sacramento, F. Navarro, R. Handler, N. Suppen, and R. Donovan
1:20 PM	Biofuel Life-Cycle Analysis: Possible for Standardization? . M. Q. Wang, J. B. Dunn, and **H. Cai**
1:40 PM	Nest Experience in Life Cycle Assessment (LCA) Research and Development Projects Related with Biofuels and Residues Energy Conversion . **M. H. Rocha**, E. E. Silva Lora, and M. M. Vicente Leme
2:00 PM	Environmental Implications of Jatropha Biofuel from a Silvi-Pastoral Production System in Central-West Brazil . **R. Bailis** and G. Kavlak
2:20 PM	Life Cycle Assessment Study on a Soybean Complex Transformation Chain over Three Years of Production of Biodiesel As a Coproduct . **J. A. Hilbert Sr.** and S. Galbusera
2:40 PM	Incorporating Bioenergy into Sustainable Landscape Designs . **V. H. Dale**, K. Kline, J. K. Costanza, C. T. Smith, I. Stupak, A. Walter, and C. O. F. D. Oliveira
3:05 PM	Roundtable Discussion of Key Research Issues and Challenges

1:00 PM Standardization of Environmental Life Cycle Assessments of Biofuels in the Pan America Region

David R. Shonnard[1], Jorge Antonio Hilbert Sr.[2], Bethany Klemetsrud[3], Julio Sacramento[4], Freddy Navarro[5], Robert Handler[1], Nydia Suppen[6] and Richard Donovan[7], (1)Sustainable Futures Institute, Michigan Technological University, Houghton, MI, (2)Ingeniería Rural, Instituto Nacional de Tecnología Agropecuaria, Villa Tesei, Argentina, (3)Chemical Engineering, Michigan Technological University, Houghton, MI, (4)Department of Chemical Engineering, Univ Autônoma de Yucatan, Merida, Mexico, (5)Universidad Autonoma de Yucatan, Merida, Mexico, (6)CADIS • Centro de Análisis de Ciclo de Vida y Diseño Sustentable, Mexico City, Mexico, (7)Henry Samueli School of Engineering, University of California-Irvine, Irvine, CA

Abstract:
One of the key challenges for the evaluation of large-scale biofuels and bioenergy systems is understanding the environmental impacts of these renewable energy systems compared to a continued reliance on fossil energy. Life Cycle Assessment (LCA) provides a comprehensive analysis of potential environmental effects across the entire production and utilization chain, yet there are many challenges and a wide variability in methodology such as data quality, impact indicators (environmental performance and impact categories), scale of production, system boundaries, co-product allocation, and other study features. The purpose of this article is to conduct a critical evaluation comparing environmental LCA of biofuels and bioenergy from several conversion pathways and in several countries in the Pan America region, and to make recommendations on a standardized guidance of LCA methodology with respect to inventory data, impact indicators, study assumptions and reporting practices. The environmental management implications of the proposed guidance will be discussed within the context of different national regulatory environments using case studies. The results from this study will help focus LCA research on gaps in knowledge and on high priority inputs and inventory data, and will lead to analyses of biofuel and bioenergy pathways with greater accuracy, transparency, and comparability across regions.

1:20 PM Biofuel Life-Cycle Analysis: Possible for Standardization?

Michael Q. Wang, Jennifer B. Dunn and **Hao Cai**, Energy Systems Division, Argonne National Laboratory, Argonne, IL

Abstract:
Biofuels are being promoted worldwide to reduce fossil energy use and greenhouse gas (GHG) emissions and to promote rural economic development. Regulations in North America and Europe are in place to regulate biofuel GHG emissions on the basis of life-cycle analysis (LCA). Numerous studies have been conducted to address biofuel GHG emissions. Attempts are being made globally to reconcile different studies, harmonize key assumptions, and possibly standardize biofuel LCAs.

In the past several years, Argonne National Laboratory has been addressing some of the key issues for biofuel life-cycle analysis with its Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET™) model. Such issues include different generations of biofuels with a variety of feedstocks, technology changes over time, LCA system boundary, treatment of co-products in biofuel LCAs, and land use change carbon emissions. This presentation will propose potential reconciliation and harmonization for biofuel LCAs. It will discuss the difficulty of biofuel LCA standardization. Finally, it will summarize updated GREET biofuel LCA results with these issues and their LCA impacts considered.

1:40 PM Nest Experience in Life Cycle Assessment (LCA) Research and Development Projects Related with Biofuels and Residues Energy Conversion

Mateus H. Rocha[1], Electo Eduardo Silva Lora[2] and Marcio Montagnana Vicente Leme[2], (1)Institute of Mechanical Engineering, Federal University of Itajubá (UNIFEI), Itajubá, Brazil, (2)Federal University of Itajubá (UNIFEI)

Abstract:
There is an increasing interest in intensifying the production and use of biomass and wastes (residues) to replace fossil fuels for the production of heat, electricity, transportation fuels (biofuels), and various types of chemicals, plastics and other materials (Koçar and Civaş 2013, Limayem and Ricke 2012, Rabelo et al. 2011). The use of biomass, biofuels and wastes (agricultural and municipal) for energy production is encouraged because it can generate profit, contribute to the mitigation of climate change, can help countries diversify their energy sources and achieve energy security, can promote the creation of new options for agriculture and wastes disposal, also including the appeal of new jobs and improved work conditions, all factors that can be associated with food security without any remarkable negative impact on food availability (Castanheira et al. 2014, Nogueira and Capaz 2013). Currently, there is a recent trend to integrate economic, environmental and social aspects in the assessment and optimization of biomass, biofuels and wastes energy conversion supply chains. In regards to the environmental impacts assessment of renewable energy systems the Life Cycle Assessment (LCA) methodology represents an important methodology, to determine quantitatively the environmental impacts comparison of the different types of renewable energy production. The LCA could be used to estimate the positive or negative impacts, in all the stages of the biomass, biofuels and wastes energy recovery utilization life cycles (Carvalho et al. 2014, Chiaramonti and Recchia 2010).

In this sense, the main goal of this presentation is to discuss the major technological changes related to renewable energy production through biofuels and wastes energy conversion. The results presented in this presentation were obtained from the Excellence Group in Thermal Power and Distributed Generation (NEST) from the Federal University of Itajubá (UNIFEI) located in Minas Gerais State in Brazil. Since 2004 NEST/UNIFEI has been carrying out different Research and Developments (R&D) projects related to LCA of biomass and biofuels production and utilization and Municipal Solid Wastes (MSW) energy recovery. A important overview of the programs, projects and technologies related to the use of biofuels in Brazil, as well as, the evaluation of the availability of biomass to electricity generation potential for different industrial and agricultural sectors in Brazil is presented by Lora and Andrade 2009.

Lora et al. 2011 and Escobar et al. 2009 analyzed the main environmental impacts of programs that encourage biofuels production, farmland land requirements and the impacts on food security. The key aim of these studies was to establish what is the level of sustainability of biofuels, through the development of a framework for sustainability indicators as a tool for performance assessment. The most used indicators to measure the biofuels sustainability was indicated as net energy relations, land use utilization and environmental impacts categories. Rocha et al. 2014 carried out a study to evaluate and compare the main environmental life cycle impacts and energy balance (net energy ratio) of ethanol from sugarcane and biodiesel from soybean and palm oil using the LCA tool. A process based on cradle-to-gate attribution LCA method, was applied as the technique to assess the health and environmental impacts of ethanol and biodiesel production systems. The assumed functional unit was 1.0 MJ of energy released by combustion of the analyzed biofuels. The biofuel production systems with higher agricultural yields and extensive use of co-products in its life cycle provided the best environmental results.

In relation to ethanol production currently the technological changes and sustainability concerns of sugarcane ethanol industry is undergoing a huge transition due to recent innovations that could be defined as new paradigms. A detailed description of this trends was included in Lora et al. 2014a and Lora et al. 2014b. The generation and use of co-products in the ethanol production process can grant to the bioenergetics system good indicators in energetic, economic and environmental terms. In ethanol production, it can be observed the generation of bagasse, stillage, filter cake and ashes. The application of the stillage on the sugarcane plantation is influenced by environmental issues and the high cost of fertilizers. In this sense, Rocha et al. 2010 and Rocha et al. 2008 carried out a LCA to evaluate the mass and energy balance of stillage treatment and disposal, showing a fertilizer mass savings of 100% for the potassium, 35% for nitrogen and 20% for phosphorus in the manure, when stillage is applied to 40% of the area of plant and ratoon. In addition, the sugar and alcohol sector has great potential for increasing overall production efficiency in the future by the combined production of ethanol and other biofuels such as methanol from thermochemical pathway through the bagasse gasification for synthesis gas production and subsequent utilization in a Biomass-to-Liquid (BtL) route. Renó et al. 2011 carried out a study to evaluate the environmental impacts of the methanol production from sugarcane bagasse, taking into consideration the balance of the energy life cycle and its net environmental impacts, both are included in a LCA approach. The evaluation was done as a case study of a 100,000 ton/year methanol plant, using sugarcane bagasse as raw material.

Biodiesel, another important biofuel, is also currently the focus of intense research. The use of biodiesel produced from the transesterification of vegetable oils with methanol is currently seen as an interesting alternative to diesel fuel. Yáñez et al. 2009 carried out a study to evaluate the life cycle energy assessment to quantify the total energy flow and assess the overall efficiency of the process of biodiesel production from palm oil in Brazil and Colombia. The authors used the Output/Input energy indicator to analyze the life cycle biodiesel production. The calculated results showed differences between the values attained for the two cases. The Output/Input energy relation for the evaluated cases ranged from 3.8 to 5.7, with an average value of 4.8.

In relation to waste energy recovery, Leme et al. 2014 carried out a study to evaluate the environmental assessment for MSW energy recovery in Brazilian. Four scenarios were designed current situation without any energy recovery, mass burning system in a waste-to-energy facility, landfill biogas utilization in internal combustion engines and landfill biogas utilization in gas turbines, whose environmental behavior were studied applying the LCA approach. The results show the landfill systems as the worst waste management option and that a significant environmental savings is achieved when a wasted energy recovery is done. The best option, which presented the best performance based on considered indicators, is the direct combustion of waste as fuel for electricity generation.

Financial Support: The authors wish to thank the Brazilian National Research and Development Council (CNPq). The Research Support Foundation of the Minas Gerais State (FAPEMIG) and the Coordinating Body for the Improvement of Postgraduate Studies in Higher Education (CAPES) for the funding of Research and Development (R&D) projects. The support of graduate students and the production grants that allowed the accomplishment of the research projects whose results are included in this paper.

2:00 PM Environmental Implications of Jatropha Biofuel from a Silvi-Pastoral Production System in Central-West Brazil

Robert Bailis, School of Forestry and Environmental Studies, Yale University, New Haven, CT and Goksin Kavlak, Engineering Systems Division, MIT

Abstract:
We present a life cycle assessment of synthetic paraffinic kerosene produced from *Jatropha curcas*. The feedstock is grown in an intercropping arrangement with pasture grasses so that Jatropha is coproduced with cattle. Additional innovations are introduced including hybrid seeds, detoxification of *Jatropha* seedcake, and cogeneration. Two fuel pathways are examined including a newly developed catalytic decarboxylation process. Sensitivities are examined including higher planting density at the expense of cattle production as well as 50% lower yields. Intercropping with pasture and detoxifying seedcake yield co-products that are expected to relieve pressure on Brazil's forests and indirectly reduce environmental impacts of biofuel production. Other innovations also reduce impacts. Results of the baseline assessment indicate that innovations would reduce impacts relative to the fossil fuel reference scenario in most categories including 62–75% reduction in greenhouse gas emissions, 64-82% reduction in release of ozone depleting chemicals, 33-52% reduction in smog-forming pollutants, 6-25% reduction in acidification, and 60-72% reduction in use of nonrenewable energy. System expansion, which explicitly accounts for avoided deforestation, results in larger improvements. Results are robust across allocation methodologies, improve with higher planting density, and persist if yield is reduced by half.

2:20 PM Life Cycle Assesment Study on a Soybean Complex Transformation Chain over Three Years of Production of Biodiesel As a Coproduct

Jorge Antonio Hilbert Sr., Ingenieria Rural, Instituto Nacional de Tecnología Agropecuaria, Villa Tesei, Argentina and Sebastian Galbusera, COmunicacion Nacional, Sec Medio Ambiente, Bienos Aires, Argentina

Abstract:
The objective of the study was to use a develop tool that enable the calculation follow up and evaluation of improvement in the different stages of production of biodiesel and other products in an integrated plant placed in Frias in the province of Santiago del Estero during three years. This case had special interest since it is not placed in the core of soybean and industrial process area in Santa Fe over the Parana River. Santiago del Estero is a lower income province and needs to increase its industrialization and generation of products that can enlarge the end value of products being produced and exported.

The areas ofproduction in the north west region of the country are exposed to grater climate variations that reflects in higher difference in yields between years. Since yield values can alter the final GHG savings of the different products a three year period was chosen.

For the calculations the 2006 IPCC directives for national GHG inventories, DIRECTIVE 2009/28/CE European Union Parliament and council April 23 2009, EB 50 – Executive MDL board "Guidelines on apportioning emissions from production processes between main product and co-and by-products " and ACM0017 Methodology "Approved consolidated baseline and monitoring methodology Production of biodiesel for use as fuel" were used. The system covered the farm production of crops, short and long transport to the crushing facilities, all the industrial stages and the end transport to port and overseas.

The data entered in the tool was provided by the company electronic database that runs under a SAP system were every step in the company is entered and can be verified and audited. The source of the raw material came primarily by own farms placed in the provinces of Salta, Tucuman and Santiago del

Estero. The analysis and presentation of the results were devided into the different stages included in the overall process (farm production, freights of raw material, production of biodiesel and co products and final freight. The final results were calculated in three different ways according to how the final allocation of emissions was considered: energy content, mass balance and price of the different products and co products. The differences in numbers between the three alternatives reached a maximum of 20 %. The overall emission reduction of the integrated process reached a value of 73 % in Grs.CO2eq/Mj well above the default value included in the European Union Directive. This results were heavily affected during the last years of poor field yields producing an important decrease in GHG savings. If the whole soybean biodiesel chain of Viluco is considered the total emissions reach 88.860 Tons de CO2eq per year (including the industrial stage). Of the total emissions 69% belong to the industrial phase, 14% to the production in own farms, 13% from soybean purchased to other farmers and 4 % to transport and freights.

At the industrial stage the emissions associated with energy use were responsible of 65 % and key input materials as methanol has a weight of 32 % in the overall analysis. s per year.

Although there are still several uncertainties in the methodologies there is strong work in progress in order to improve the estimation factors of the agricultural phase of production mainly looking at nitrogen oxide emissions and organic matter balance.

Final numbers are very important since they have relations to present regulations in the international markets. The study showed that single studies don't cover one of the main important factors in agricultural production as the variation between each year crop yield. In order to obtain more realistic figures a certain amount of statistical information on crop behavior in each region must be taken into account.

2:40 PM Incorporating Bioenergy into Sustainable Landscape Designs

Virginia H. Dale, Center for BioEnergy Sustainability, Oak Ridge National Laboratory, Oak Ridge, TN, Keith Kline, Environmental Science Division, Climate Change Science Institute and Center for Bioenergy Sustainability, Oak Ridge National Laboratory, Oak Ridge, TN, Jennifer K. Costanza, North Carolina State University, Raleigh, NC, C. Tat Smith, University of Toronto, Toronto, ON, Canada, Ingrid Stupak, Univeristy of Copenhagen,, Copenhagen, Denmark, Arnaldo Walter, University of Campinas-Unicamp, Campinas, Brazil and Camila Ortolan F. de Oliveira, UNICAMP/University of Campinas, Campinas, Brazil

Abstract:
An approach for landscape design that focuses on bioenergy production systems and integrates it into other components of the land, environment and socioeconomic system is described. Landscape design is a spatially explicit collaborative plan for integrating sustainable management of landscapes and supply chains. Landscape design involves multiple scales, fits into existing land and resource allocation systems, and maintains or enhances social, economic and ecosystem services. The design for a particular area is developed with the involvement of key stakeholders including both private and public land owners and those benefitting from or impacted by services provided by resource use. Appropriately applied, landscape design can guide choices toward more sustainable provision of bioenergy and other services. This approach encapsulates monitoring and assessment of a suite of indicators for soil quality, water quality and quantity, greenhouse gases, biodiversity, air quality, and productivity as well as socioeconomic considerations. The landscape design approach requires attention to site selection and environmental effects when making choices about locations, type(s) of feedstock, transport of feedstock

to the refinery, refinery processing, and distribution of bioenergy products and services. The approach includes monitoring and reporting of measures of sustainability along the bioenergy supply chain within specific contexts. Examples of the landscape design are presented. Key barriers are that up-front planning is required, coordination is complex and requires much effort, initial costs may be higher, and the process may be stymied by insufficient data and communication across the supply chain. Landscape designs should be coordinated by a planning team in a way that is doable from the perspective of producers along the supply chain. An impetus for coordination is critical, and that incentive may be demand from the private sector. Hence it requires clear communication of environmental and socioeconomic opportunities and concerns to both the participants in production and stakeholders.

Wednesday, July 23, 2014: 01:00 PM - 04:00 PM, Piedade Room
Opportunities and Challenges for Biomass Supply Chains in the Pan-American Region
Chair: Pasi Lautala, Rail Transportation Center, Michigan Technological University, MI USA
Co-Chair: J. Richard Hess, Idaho National Laboratory, Idaho Falls, ID, USA

Session Overview:
Life Cycle Assessment (LCA) provides a comprehensive analysis of potential environmental effects across the entire production and utilization chain, yet there are many challenges and a wide variability in methodology such as data quality, impact indicators, scale of production, system boundaries, co-product allocation, and other study features. This session seeks abstracts addressing the standardization of biofuel and bioenergy life cycle assessments in the Pan American region, how study assumptions affect study results, and importance of biofuel and bioenergy policy on LCA methodology.

1:00 PM	Opportunities and Challenges in the Design and Analysis of Biomass Supply Chains . **P. Lautala**, T. Laitinen, R. Bittencourt, A. M. Valente, M. R. Hilliard, E. Webb, I. Busch, R. Handler, J. R. Hess, M. Roni, and J. A. Hilbert Sr.
1:25 PM	Biomass Transportation Systems in Brazil: The Cases of the Ethanol Industry and the Constrains for Exporting Pellets . **A. Walter**
1:50 PM	Tropical Maize and Lipid Cane As Sustainable New Bioenergy Crops . **V. Singh**
2:15 PM	Lignocellulosic Biomass Residues Identification and Selection in Five Countries of Latin America, As a Feedstock for Second Generation Ethanol Production . **E. Ruz**
2:40 PM	Uncovering System Behaviors in Biofuels Supply Chain Network Using an Agent-Based Simulation Approach . **D. B. Agusdinata**
3:05 PM	Roundtable Discussion of Key Research Issues and Challenges

1:00 PM Opportunities and Challenges in the Design and Analysis of Biomass Supply Chains
Sangpil Ko[1], **Pasi Lautala**[2], Tuuli Laitinen[3], Roger Bittencourt[4], Amir Mattar Valente[4], Michael R. Hilliard[5], Erin Webb[5], Ingrid Busch[5], Robert Handler[6], J. Richard Hess[7], Mohammad Roni[8] and Jorge Antonio Hilbert Sr.[9], (1)Michigan Technological University, Houghton, MI, (2)Rail Transportation Center, Michigan Technological University, Houghton, MI, (3)Lappeenranta University of Technology, (4)LabTrans, Universidade Federal de Santa Catarina, (5)Oak Ridge National Laboratory, (6)Sustainable Futures Institute, Michigan Technological University, Houghton, MI, (7)Idaho National Laboratory, Idaho Falls, ID, (8)Biological and Chemical Processing, Idaho National Laboratory, Idaho Falls, ID, (9)Ingenieria Rural, Instituto Nacional de Tecnología Agropecuaria, Villa Tesei, Argentina

Abstract:
The biomass supply chain is one of the most critical elements of large scale bioenergy production and in many cases a key barrier for procuring initial funding for new developments on specific energy crops. Most of the large scale productions of liquid biofuels rely on complex transforming chains linked to feed and food markets. The term 'supply chain' covers various aspects from cultivation and harvesting of the biomass, to treatment, transportation and storage. After the energy conversion, the product must be delivered to final consumption, whether it is in the form of electricity, heat, or more tangible products, such as pellets or ethanol. Effective supply chains are of utmost importance for bioenergy production, as biomass tends to possess challenging spatial distribution and low mass, energy and bulk densities. Additionally, the demand for final products is often dispersed, further complicating the supply chain.

The goal of this presentation is to introduce key components of biomass supply chains and provide examples of modeling applications available for supply chain investigations. The paper will introduce a concept of integrated supply systems for sustainable biomass trade, followed by three modeling tools developed to help users to understand the factors influencing the biofuel supply chain landscape. The final section will concentrate on various aspects of transportation logistics, ranging from alternative modal / multimodal arrangements to introduction of two analytical support tools, one from U.S. and one from Brazil. Conclusions and research recommendations are also outlined to facilitate the future direction for this area of study.

1:25 PM Biomass Transportation Systems in Brazil: The Cases of the Ethanol Industry and the Constrains for Exporting Pellets
Arnaldo Walter, University of Campinas-Unicamp, Campinas, Brazil

Abstract:
Brazil is worldwide the second largest producer of fuel ethanol, which is totally produced from sugarcane. Large-scale production has started in the late 1970s and the supply chain is well established in the Southeast (where is the bulk of the production) and in the Northeast (the most traditional area) regions. Recently, sugarcane and ethanol production has expanded towards the Central region, and the lack of adequate infrastructure has been a constraint for reducing costs and accessing international markets.

On the other hand, despite the fact that Brazil has a large potential for pellets production, due to the large land availability, adequate weather conditions and the available know-how for planting and harvesting short-rotation coppices, the production itself is very small. A big constrain has been the logistics that implies high final costs and no feasibility in the European market (the largest consumer and importer).

In this paper some issues related with the supply-chain of ethanol and pellets production in Brazil are analyzed. Figures of the current supply chain in both economic sectors, transportation costs and the available infrastructure are presented. The challenges for enhancing the production and exports are presented and discussed.

Along the paper, the points of view of the public and private sectors are presented. Recently, some of the investments in Brazil have been done by companies that want to be in a solid position in short term to medium term.

1:50 PM Tropical Maize and Lipid Cane As Sustainable New Bioenergy Crops
Vijay Singh, Agricultural and Biological Engineering, University of Illinois at Urbana-Champaign, Urbana, IL

Abstract:
Two new sustainable bioenergy crops have been recently developed for the US. One is Tropical maize, a high-biomass, high-sugar corn hybrid that accumulates sucrose in the stalk and produces negligible grain. Second one is Lipid cane, a sugarcane engineered to produce non-food oil, as drop-in fuels, in place of sugar. Both these crops present excellent potential to serve as a renewable fuel crops.

Tropical maize can produce large amounts of biomass (9-11 ton/acre, dry weight) and accumulate high levels of sugar (10% sucrose) when grown without supplemental nitrogen (N). Theoretical ethanol yield from combined plant components is very impressive: 1500 gal/acre when grown with supplemental N (180 lb/acre) and 1175 gal/acre when produced without supplemental N. Additionally, tropical maize is well-adapted to many regions of the U.S., unlike sugarcane. Because tropical maize grows vigorously with little or no N fertilizer, it also provides excellent nitrogen use efficiency, making it very positive from an agricultural sustainability perspective. The subequatorial origins of tropical maize's genetic background provide the photo-period sensitivity trait. When grown under the short-night environment of our Midwestern latitudes, tropical maize displays delayed flowering and remains in the vegetative state much longer than commercially grown U.S. corn hybrids, resulting in very tall (15 ft.) plants that produce little, if any, grain. Reduced grain production is offset by accumulation of sucrose in the stalk and also decreases the need for nitrogen fertilizer.

Lipid cane is a crop suitable for land in the South Eastern US that is marginal, or unsuited, for food crop production. At the current yields of sugarcane in the SE US, this would produce about 33 barrels of oil per acre, compared to about 1 from soybean. By increasing the photosynthesis, even higher barrels of oil per acre can be produced. Sugarcane is far less demanding on soils and fertilizers than food crops in general, and can be grown on land unsuited to food/feed crops. The US south-east has large areas of land that have dropped out of food and fiber crops agriculture, a decline that continues to this day. Yet this area receives high rainfall, sufficient to avoid the need for irrigation, and the long growing season maximizes the amount of sunlight these crops can capture over the year. By modifying the plant's own triaclyglyceride (oil, TAG) pathway to up-regulate synthesis in the mature stem and down regulate consumption, so causing accumulation. TAGs, in lipid cane are similar to those of soybean and can be easily converted to biodiesel. Preliminary estimates indicate that using the 23 billion acres of marginal land in the SE US that is not in food production, more than 50 billion gallons of oil could be produced with these crops. Fermentation data of tropical maize and techno-economic evaluation of lipid cane as biofuel crops will be presented.

2:15 PM Lignocellulosic Biomass Residues Identification and Selection in Five Countries of Latin America, As a Feedstock for Second Generation Ethanol Production
Emilio Ruz, PROCISUR, Montevideo, Uruguay

Abstract:
This presentation is part of a recently completed project: "New feedstock and innovative transformation process for a more sustainable development and production of lignocellulosic ethanol" (BABETHANOL) www.babethanol.com, a collaborative project for specific international cooperation actions SICA, Grant agreement N° 227498 of the 7th framework program of the European Commission.

The main objective of the BABETHANOL project was to develop new solutions for a more sustainable approach of second generation ethanol production, based on a "moderate, environmental-friendly and integrated" pre-treatment process of lignocellulosic biomasses. This pre-treatment of the biomass has been the main barrier to overcome in second generation ethanol. The new process, called CES (Combined Extrusion-Saccharification), is an alternative to the current pre-treatments of the state-of-the-art, requiring much energy, water, chemical products, detoxification and waste treatments. It has been developed and tested up to TRL 5 (Technology Readiness Level) from laboratory to pilot scales with seven selected biomasses covering a large range of diversified feedstock.

In parallel to the process development, a feedstock catalogue of diversified crop and agroindustrial wastes was built along the project from investigations run in Argentina, Brazil, Chile, France, Germany, Italy, Paraguay, Spain, United Kingdom and Uruguay, by one partner in each continent. The main idea was to identify concentrated amounts of indigenous lignocellulosic wastes currently available at local/regional scales for the prompt deployment of small, medium or large size second generation ethanol plants near the biomass production sites once the new process will be ready for industrialization.

We are hereby presenting the results of IICA-PROCISUR research in five countries of South America: Argentina, Brazil, Chile, Paraguay and Uruguay.
The final selection of the feedstock was performed after investigating: 1) the biomass availability taking into account current situation with competition for other uses (soil cover, animal feeding and/or bedding and energy); 2) the chemical compositions of the preselected biomasses; and 3) the concentration of feedstock at local level (within 100 km radius) to supply at least 30,000 t dry matter/year.

Argentina
Although Argentina is one of the largest producers and exporters of agricultural goods generating large amounts of residues, originated by the agricultural and agro-industrial sector, only a few were selected according to the required characteristics, availability and geographical dispersion. Precautious measures were taken into account for agricultural production systems since there are most under no tillage, and therefore, cover and organic material and nutrients must be reserved in the soils in order to avoid a rapid deterioration. In the case of agro-industrial products, competitiveness with other uses, physical and chemical characteristics and availability in volume and dispersion during the year were the main concerns. The biomasses found as the most suitable feedstock for the production of ethanol with the CES process were: corn cobs, vineyard pruning, sugar cane field residues (tops and leaves) and bagasse, and eucalyptus field and industrial residues. Less important was wheat straw because of its relatively low amount of cellulose.

For corn cob, three departments in the province of Cordoba: Marco Juarez, Unión and Río Cuarto, producing each of them over 100,000 t/year corn cob, were highlighted since they could match with minimum volume availability requirements. For vineyard pruning, the provinces with higher volumes of residues were San Juan and Mendoza. Two supply basins in a 25 km radius were detected at San Martin (100,000 t/year) and Maipu (35,000 t/year) departments in the province of Mendoza. For sugar cane field residues, two supply areas for ethanol plants were identified: the north, with 260,000 t/year and the south, with 220,000 t/year, both in a 20 km radius. For sugar cane bagasse, a main supply basin was identified around Concepción sugar cane mill in the province of Tucuman with 100,000 t/year bagasse available in 5 km radius and almost 200,000 t/year in a 30 km radius. Eucalyptus residues are concentrated in the provinces of Corrientes and Entre Rios. Forest residues amount to 170,000 and 230,000 t/year respectively.

Brazil
With regards to chemical composition and availability, sugarcane residues (bagasse and trash) are the only feedstock convenient and currently available for ethanol production. The residues from the production chains of soybeans, maize, banana, wheat, coffee and pineapple, with suitable chemical composition which are not available now-a-days under current uses, may offer a second list of additional feedstock that have the potential of being used in the future if the production of second generation ethanol picks up. In Brazil, the most logical alternative would be to locate a production unit of second generation ethanol, in an already existing or close to a processing unit of sugarcane. In this respect, there is a high concentration of industrial plants in the following states: Alagoas and Pernambuco (Northeast region), Goiás and Mato Grosso do Sul (Centre-West region), Sao Paulo and Minas Gerais (Southeast region) and Paraná (South region).
The minimum amount of residues required for the operation of a 30,000 tons of dry material per year processing capacity plant is guaranteed in the following situations: if the trash is not used (or if it is unavailable), in industrial plants with processing capacity of over 2 M tons of sugarcane per season and with the use of trash, in industrial plants with processing capacity over 0.5 and 2.0 million tons of sugarcane per season. There are several industrial plants of sugarcane in Brazil with processing capacities in these ranges, located in the CO/SE/S and N/NE regions. Moreover, there are areas with high concentration of industries in these regions.

Chile
From all the materials originally considered and assessed wheat straw and corn stover field residues as well as vineyard and orchard pruning residues were selected as potential feedstock suitable for the production of ethanol under the CES process. Best residues supplying basins were identified in the following areas: wheat straw in the Araucania region with over 500,000 t/year; corn stover in the O'Higgins region with over 500,000 t/year; apple and vineyard pruning residues in five regions (Coquimbo, Valparaíso, Metropolitana, O'Higgins and Maule) with amounts varying from 150,000 to 280,000 t/year in each region.

Paraguay
In general, the climate of Paraguay characterized for high temperatures and humidity all year round, influences the dynamic of the degradation of organic matter left in the fields, accelerating the decomposition process which requires that most of the crop residues should not be removed from the soil for sustainability reasons. For this reason, field residues from major cultures like sugar cane, soya, wheat and corn are not collected and therefore not available for other uses. Sugarcane bagasse is the only residue produced in large quantity which is available and suitable for ethanol production and the CES process. Although it is already used to produce energy, there are seasons when there would be

sufficient surplus to supply 2nd generation ethanol plants. The province of Guaira appears as the best location for the supply of bagasse with 54,000 t/year in a 30 km radius.

Uruguay
Among a wide variety of residues of the Uruguayan agro-industry, the ones that apparently were most suitable as feedstock for the CES process were wheat, rice and forestry field residues, as well as rice and forestry industrial residues. During the chemical screening both rice residues presented a chemical composition that was not suitable for the production of ethanol with the CES process: for straw the cellulose was too low, for the hull the lignin was too high and for both of them the mineral content was too high. Although wheat straw had better chemical composition, cellulose content was slightly under the limit. So wheat straw was considered as a second choice feedstock. Among the forestry residues, Eucalyptus presented very high cellulose content and good content for all the other compounds, except for forestry industrial residues with lignin slightly above the limit. Several country departments produce sufficient biomass to supply ethanol production plant, especially Rivera, Paysandú, Río Negro and Rocha with amount available ranging from 90,000 to 140,000 t/year within a 30 km radius or less in some zones. So Eucalyptus forestry residues are considered first choice feedstock for the production of ethanol and for the CES process in Uruguay.

2:40 PM Uncovering System Behaviors in Biofuels Supply Chain Network Using an Agent-Based Simulation Approach
Datu B. Agusdinata, Industrial & Systems Engineering and Environmental Studies, Northern Illinois University, DeKalb, IL

Abstract:
The second generation biofuel feedstocks such as camelina, short rotation woody crops, algae, and switchgrass have been investigated to minimize the impact on the food chain. In order to achieve a significant market penetration of the second generation biofuels, some significant challenges must be addressed. These include improving feedstock yield and conversion efficiency. Another critical challenge, which is the focus of this study, is a viable and well-functioning supply chain (SC). To add to these challenges, some undesirable behaviors at a system level have been observed in the corn-based ethanol industry. For instance, as a result of the Energy Independent and Security Act of 2007 mandating ethanol production, refining capacity was added at a faster rate resulting in high ethanol inventories. Increased price of corn has squeezed refineries' profit margin below the sustainable level. A stabilizing price of oil has made ethanol less economically attractive. For producers, the financial pressure has been exacerbated by dried up capital due to the credit crunch and the recent expiration of a federal subsidy for ethanol blenders. Natural factor plays a role too. Recent drought has caused a spike in corn price leading to temporary shut down or scale back production of many ethanol refineries
An agent-based simulation approach is pursued to understand the dynamics of biofuels SC network. The approach treats each actor along the life cycle stages as an entity with distinct decision rules. The approach can deal better with the fact that some actors do not always act rationally due to bounded rationality. Actors also often use heuristics to generate solutions. It can also factor in the fact that actors learn over time and may change their decision rules as a result. This approach is in contrast to most equation-based models such as system dynamics or utility-based methods, which are based on the assumption that actors are rational and share common interests.

The interests of three supply chain actors are represented: users, biorefineries, and farmers. Each actor type has a binary decision option: adoption or non-adoption of biofuels. This SC network model is characterized by distributed control, time asynchrony, and resource contention among actors and who

make decisions based on incomplete knowledge and delayed information. The decision dynamics of these actors are modeled using a computational ecosystem construct. A preliminary set of coupled payoff function for each actor type and each decision is developed to represent interdependencies among SC actors. The SC network behavior is observed in terms of fraction of actors adopting the biofuel option. The SC network shows behaviors ranging from fixed point equilibrium under no delay and perfect knowledge to periodic and chaotic oscillations.

The simulation model was used to evaluate three sets of simple and straightforward subsidy policy. The first policy setup involves a constant subsidy level across the simulation period of 120 months or 10 years. Second type of policy is a subsidy scheme that is evaluated periodically. In the model, every 2 years, the relative payoff between biofuels and non-biofuels options is compared. When biofuels are at disadvantage, the subsidy is implemented. Otherwise, no subsidy is put in place. This policy setting is similar to a situation in which regulators like the U.S. Congress deciding whether or not to continue a certain subsidy scheme. The last type of policy is the subsidy that will be phased out over time. This arrangement is similar to special feed-in tariffs established to incentivize adoption of solar energy.

When Constant subsidy policy is implemented during the 120 months of simulation period, the SC network shows a steady increase in the adoption of biofuel options and reaches equilibrium in about 48 months. As a result of the assumed coupled payoff functions, each actor type arrives at different equilibrium states. At most times past year 4, all 1000 farmers adopt biofuel crops whereas the fraction of refineries dedicating for biofuels (out of 100) fluctuate from about 80% to 100%. The fraction of motorist users hovers at around 42%.

Next, Policy2: Declining subsidy, provide incentives for actors to take biofuel options similar to the effect of Policy1. After around year 6, however, the decreased subsidy level starts to take effect. Biorefineries and users begin to drop biofuel options followed by farmers 2 years later. The attractiveness of biofuel options temporarily picks up again afterwards but eventually drops further at lower level when the subsidy has been completely terminated. Lastly, Policy3: Periodic interval subsidy results in periodic pattern of SC network behavior. For the 10 years period, there is a trend that the peak of each cycle of biofuels adoption increases as time progresses.

A sensitivity analysis reveals that the following parameter impacts on system behavior can be observed: Reduced payoff uncertainty lowers the actual number of actors opting for biofuel options. As actors know with more certainty about the payoff, their preference will be slightly downgraded and hence the slightly lower adoption level. However, the pattern of system behavior does not change significantly. Reduced re-evaluation rate results in a smoother transition to biofuel options for the three actors. Reduced delay time leads to quicker action by actors to take biofuel options as they become favorable. Lastly, the combined effect of reduced values of the three parameters results in a quicker and smooth transition and stable equilibrium.

One major implication of these findings is that when supply chain actors have more updated information about the decision of other actors and less uncertain knowledge about the payoff of their decisions, they can reduce the oscillations in the SC network. Overall, the simulation model framework provides a basis for further development including identification and assessment of policies to control undesirable behaviors in a supply chain network. The modeling framework can be adapted and applied to other renewable energy applications such as wind and solar energy.

RCN Conference on Pan American Biofuels & Bioenergy Sustainability

Golden Tulip Recife Palace, Recife, Brazil

July 22-25, 2014

Poster Session: Pan American Biofuel and Bioenergy Sustainability

Wednesday, July 23, 2014: 04:30 PM - 06:30 PM – Meeting Foyer

Chair: David R. Shonnard, Michigan Technological University, MI, USA

1	Effects of Maize Weevil Infestation on Corn and Utilization of Infested Corn for Ethanol Production **G. A. Corrêa**
2	Assessment of an Power Generation Industrial Unit from Vinasse Treatment in Uasb Reactor . **A. F. D. M. S. Santos**, M. A. D. M. Sobrinho, and A. C. V. Handel
3	Energy-Water Nexus: An Optimal Control Model . **G. A. D. Oliveira** and **F. M. C. D. Souza**
4	Comparison of Anaerobic Reactors for Electricity Production in PILOT Scale from Vinasse . **A. F. D. M. S. Santos**, **M. A. D. Motta Sobrinho Sr.**, and A. C. van Handel
5	Switchgrass Genotype Study As a Bioenergy Crop in Kansas, USA . **D. Min** and V. Prasad
6	Utilization of Crab Shells As Heterogeneous Catalyst in the Synthesis of Methyl and Ethyl Biodiesel **G. Reis**, F. D. S. Medeiros, J. B. S. Costa, A. S.Moura, R. Oliveira DA Silva, V. M.D. Pasa, and C. C. C. Bejan
7	Poverty in the Pirapama Basin: The Role of Management of Hydrological Resources . **J. H. N. Viana** and M. M. G. A. Moraes
8	Maximizing Ethanol Production from Genetically Modified Cyanobacteria Grown Autotrophically . C. Delpino, V. Estrada, and **M. S. Diaz**
9	Water Allocation and Resources Management Using a Hydro-Economic Optimization Model: The Case Study of the Sub-Middle São Francisco Watershed . **G. Souza da Silva** and M. M. G. A. Moraes
10	Considering Water Quality and Energy Efficiency to Define Optimum Operation of Integrated Systems of Water Supply and Value of Use of Water Quality . **L. Rodella**, C. A. G. de Amorim Filho, and M. M. G. A. Moraes
11	Enhanced Pyrolysis Oil Properties through Pretreatment of Aspen with Controlled Torrefaction . **B. Klemetsrud**, J. Klinger, D. R. Shonnard, and E. Bar Ziv
12	Sorghum As an Advanced Biofuel: Price Effect on Wheat, Corn and Soybean Markets . **K. Pokharel**, R. P. Wibowo, and F. Nti
13	A Prototype Methodology for Incorporating Sustainability Indicators in Biorefinery Process Design . **J. C. Sacramento Rivero** and L. E. Vilchiz Bravo
14	Optimal Control Strategies for Different Stabilization Pond Systems . **M. P. Ochoa**, V. Estrada, and P. M. Hoch
15	Analysis of the Solid Waste Management of the Sugarcane Industry in Pernambuco . M. G. Souza Melo, **M. D. C. M. Sobral**, and A. L. N. Ferreira
16	Polymeric Membranes and Gas Separation: Homogenous Blends of Matrimid®5218 and P84 . **J. Carson**
17	Incorporation of Sweet Sorghum Juice into Current Dry-Grind Ethanol Process . **K. Saul**
18	Biogas in the Brewery: An Exploration of Practice and Sustainability . **J. Jurado**

Session Overview:

This session will include all relevant topics pertaining to the sustainability of biofuels and bioenergy development in Pan America. Abstracts are welcome from academia, industry, government agencies, and non-governmental organizations.

Posters:

1. Effects of Maize Weevil Infestation on Corn and Utilization of Infested Corn for Ethanol Production
G. Adolfo Corrêa, Kansas State University, Manhattan, KS

Abstract:
The maize weevil, *Sitophilus zeamais* (Motschulsky) (Coleoptera: Curculionidae), is a cosmopolitan pest of stored cereal grains, especially maize in tropical and subtropical regions. The focus of our laboratory study was to characterize physical and chemical damage caused by *S. zemais* to corn over a six month period, and to determine ethanol yield from infested corn.

Clean, certified organic whole yellow corn (5 kg) of 11.9% moisture in 20-L round plastic with ventilated lids was infested with 20 unsexed adults of mixed ages of *S. zeamais*. There were a total of 36 buckets, of which 18 were infested and 18 were uninfested (controls). It was stored for periods of 1, 2, 3, 4, 5 and 6 months. The moisture content, test weight, dead and live insects, and proximate analysis were conducted using the AOAC (Association of Official Analytical Chemists) and Ankom methods, were measured monthly. The ethanol production was evaluated using two procedures, the enzyme digestion and fermentation processes, to measure the amount of glucose at initial time of the experiment and evaluated the glucose complete conversion into ethanol and its amount, respectively. The amount of glucose and ethanol was analyzed using the High Performance Liquid Chromatography (HPLC) technique.

The corn moisture content of uninfested corn fluctuated between 10.6 and 11.9% during the six-month study period, whereas that of infested corn increased from 11.9 to 14.8% at the end of the study. The number of live insects increased exponentially in infested corn and reached a maximum of 6,985 by the end of the study. Dockage in 1000 g of uninfested corn was 1.2 to 2.2 g but steadily increased in infested corn from 1.2 g to a maximum of 154 g at the end of six months. The weight of 100 uninfested corn kernels normalized to 11.0% wet moisture basis remained unchanged (35.8 g) but this weight in infested corn decreased gradually to 22.6 g at six months. However, dry matter losses were marginal for both uninfested and infested corn over the study period. The crude protein, crude fat, crude fiber, and ash of uninfested and infested corn over time showed minor variation that are not biologically significant. The starch content of uninfested and infested corn ranged from 58 to 61%, and these values were lower by about 10%, probably due to the official standard method used (glucoamylase method) or use of aged enzymes. It was demonstrated that during the first four months with a high level of infestation it was possible to obtain a profitable level of ethanol production, and it begins to decline after the fifth month, and over the sixth month it was not profitable because the amounts of glucose declined dramatically. In conclusion, it was possible to obtain profitable levels of ethanol from infested corn even under a high density of infestation by maize weevil, and it will optimize the use of corn as raw material for worldwide ethanol production.

2. Assessment of an Power Generation Industrial Unit from Vinasse Treatment in Uasb Reactor
André Felipe de Melo Sales Santos, Cetrel, Recife, Brazil, Maurício Alves da Mota Sobrinho, Department of Chemical Engineering, UFPE, Recife, Brazil and Adrianus Cornelius van Handel, Department of Civil and Environmental Engineering, UFCG, Campina Grande, Brazil

Abstract:
The UASB reactors (upflow anaerobic sludge bed) represent the type most widely disseminated and applied in the world of high rate anaerobic system. They have the advantage of treating wastewater diluted or concentrated, dissolved or particulate material, and simple or complex, with high efficiency under conditions of relatively simplified operation.Are applicable to sanitary sewers and industrial effluents that have organic nature, biodegradable, with low concentrations of oil and grease, and toxic compounds. Their cost/benefit ratio make it attractive for industrial uses with advantages of high biomass retention, low sludge production, high efficiency and the biogas exploitation possibility.The anaerobic digestion of vinasse, particularly in the case of Brazil, represents great opportunities for expanding the national energy matrix,taking views of the large volumes produced alcohol. Each liter of alcohol produced can generate from 10 to 18 L of vinasse with a BOD of around 15,000 to 50,000 mg O_2/L. Cetrel, from a research project in its program of Technological Innovation in 2009 startedthe project Energy appreciation of vinasse for the generation of decentralized electricity obtained from biogas through anaerobic biodegradation. The project has evolved from the laboratory scale, pilot reaching an industrial unit currently operating in the state of Pernambuco, in Vitória de Santo Antão. The project consists of a modified anaerobic UASB reactor for the treatment of vinasse, with capacity of 1000m^3, with organic loading volume (COV) projected in the range from 16 to 20 kg COD/m^3.d, and maximum flow rate of 60m3 / h of raw vinasse. The production of electricity is approximately 0.87 MWh using a power generator biogas GUASCOR, SFG-LD 480, which connects directly with the local utility.The plant started operation at the end of the year 2012, with the data presented in this article concerning the 2012-2013 and 2013-2014 harvests. At the beginning of the operation was necessary to inoculate anaerobic flocculent sludge originating from UASBused in urban sewage treatment, but this was not appropriate to the high organic loads applied, especially when applied loads above 4 kg COD/m^3. In this case it was necessary to acquire industrial granular anaerobic sludge of high activity (0.44 kg COD/kg TSS.d) to increase the treatment capacity.The unit began operating with low VOC of approximately 1 kg COD / m3.d in increments of 0.5kg COD / m3.d to promote the process of acclimatization of the anaerobic biomass. The performance of the unit in the second harvest has exceeded expectations of project reaching about 91% in COD removal (daily average), reaching levels of 71% methane in biogas. However, when using the vinasseoriginated from the dilution of molasses, there was great difficulty in their treatment compared to vinasse coming directly from sugar cane juice.This problem was due to the presence of sulfatewith concentrations in the range of 700-900 mg / L, which may interfere with the microbiological equilibrium of the system. Sulfate is used in control of indigenous bacteria in the fermentation of the must, and when in an anaerobic environment, the sulfidogenesis competes with methanogenesis interfering with the balance of alkalinity and volatile fatty acids (ratio AT / AGV) leading to operating instability. The vinasse broth does not present as great challenges.Another drawback of the sulfate is your anaerobic degradation leads to H_2S, which is highly toxic and corrosive. Were detected sulphate content of the order of 2000-5000 mg/L in the biogas removal system is required to prevent deterioration and shortening the life of equipment. The technology proved to be technically feasible even requiring optimization step.Challenges of economic viability also point to the energy market taking into view that this type of sustainable energy is not encouraged by the government, and the amounts paid by the MWh currently prohibitive to enable the business. However in other applications such as generating isolated systems or other applications can be economically viable.

3. Energy-Water Nexus: An Optimal Control Model

Geraldo A. de Oliveira, DASE, IFPE - Instituto Federal de Educação, Ciência e Tecnologia de Pernambuco, RECIFE, Brazil and **Fernando M. Campello de Souza**, PPGEE, UFPE - Universidade Federal de Pernambuco, Recife, Brazil

Abstract:

One may say that economics is the study of the allocation of scarce resources between competing uses. Scarcity is a characteristic of exhaustible resources.

Most of the world's energy sources known today are finite i.e., exhaustible, or limited.

In the global energy matrix, oil comes first, followed by coal and natural gas. These sources together account for approximately 80% of the world's energy supply. Coal is the source most used to generate electricity. It accounts for generating 41% of the world's electricity supply. The United States and China are examples of countries that are highly dependent on this resource. In Brazil, water is the resource most used to generate electricity and is followed by biomass. These resources, although renewable, are limited.

What oil, coal, natural gas, water and biomass have in common is that they are conventional. Conventional resources, represent stored energy; are found in specific and unchangeable locations; and offer a limited supply. Their scarcity and high demand create a capitalizable commodity and an avid and impatient market, i.e., these sources are goods with high marketability in the international market and thus subject to price variations.

The issue is that these natural resources are allocated both for producing energy and for producing non-energy goods. Therefore, they are used as an input for production and as an input to produce a different kind of input, namely power.

Energy and water are at the heart of any country's economy and way of life. National defense, food production, human health, manufacturing, recreation, tourism, and the daily functioning of households all rely on a clean and affordable supply of one or both of them.

It is known that the production and consumption of energy and water are closely intertwined. They are diversified. Energy includes electric energy, and fuels like gasoline, diesel, nafta, kerosene, alcohol, fuel oil, uranium, and the like. Water includes drinkable water (potable), water for irrigation, water for cooling, water for industrial processes, and so on. The end users of both, energy and water, are many. There are also several producers of both.

Energy and water are, for their turn, intrinsically related to the production and consumption of food and transport.

Keeping electric power plants cool requires lots of water. Keeping water safe takes lots of energy. Apparently this potentially forces a choice between the two.

Water is needed to generate energy. Energy is needed to deliver water. Both resources are limiting the other --- and both may be running short. Is there a way out? What would be the rational to deal with this problem?

In some countries, the two greatest users of freshwater are agriculture and power plants. Thermal power plants --- those that consume coal, oil, natural gas or uranium --- generate more than 90 percent of U.S. electricity, and they are water hogs. The sheer amount required to cool the plants impacts the available supply to everyone else. In other countries, like Brazil, for example, hydroelectric energy plays a major role, and it has been found that water to be used directly as water, as in agriculture, industrial processes, and human consumption, for example, worths twice the economic value it has after it has been transformed into electricity in a hydroelectric power plant.

At the same time, one uses a lot of energy to move and treat water, sometimes across vast distances. Health standards typically get stricter with time, too, so the degree of energy that needs to be spent per gallon will only increase.

A mathematical model is proposed here formulated in terms of an optimal control problem representing an evolving economy; an optimal economic growth model. It is written as a maximization of an intertemporal social welfare function, subject to constraints defined by income and investment identities, production technologies, the reserves consumption dynamics, the labor force growth dynamics, the energy balance and the labor force balance. The policy instruments are the investments in each sector, the consumption rate for the energy resources, the water usage rate, and the labor force growth rate. The model is treated via the Pontryagin maximum principle. The results obtained from the model are useful in the understanding of the sector as a whole, and as a support in establishing integrated policies in the context of the energy-water nexus.

4. Comparison of Anaerobic Reactors for Electricity Production in PILOT Scale from Vinasse

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Abstract:
Among the liquid effluents of the sugarcane industry, the vinasse is which has higher pollution potential. In terms of BOD value ranges can range from 15,000 to 50,000 $mg.L^{-1}$, and its production in conventional distilleries can reach 10-18 L of vinasse per liter of ethanol produced, according to the process and quality of sugarcane. The high amounts of biodegradable organic matter in the raw vinasse indicate its potential for use in biological processes using more rationally this energetic potential. One of the most promising technologies is the anaerobic digestion, which produces methane that can be applied in decentralized generation of electric power or burning processes in the unit. In this work three models of anaerobic reactors were evaluated in pilot scale, verifying the increase of the volumetric organic load on the stability of the reactor in its ability to withstand shock loading and its repercussion on the quality of the biogas generated. Were compared to the UASB reactor (R-11) two other models of anaerobic reactors: reactor IC (internal circulation) (R-21) and reactor (external settler) (R31) that present changes in concept and design in relation to reactor UASB.The reactors were built in fiberglass, in a cylindrical shape with a diameter of 1 m and 4m height (working volume 3.5 m^3). Was utilized industrial granular anaerobic sludge of high activity (SMA = 0.7 $kg.COD.CH_4/kg.VTS.d$) as inoculum to reduce the adaptation time of the anaerobic microbiotafor vinasse. As alkalizing, was made use of agronomic urea in aqueous

solution, dosed at the entrance of the reactor by a metering pump. Recirculation of treated effluent (of the order of 1:3) was also used to reduce the consumption of alkalizing the use of alkalinity generated in the reactor.The criterion of stability and load increase was the maintenance of the relationship TA/VFA around 3.5 -. 4.0 with load increments of 0.5 to 1.0 kg.COD/m^3.d until it reaches the design load of 20 kg COD.m^3/d. The reactors operated continuously for 2 consecutive harvest seasons, with the first harvest (January 2011) the maximum load was reached only after 6 months for the three reactors, which presented similar behavior. In the first harvest the average removal efficiencies of COD were respectively 75%, 79% and 79% and the concentration of methane in the biogas on average 88%, 84%, 84% for R-11, R-21 and R-31 reactors, respectively. In the second harvest (August 2011 to April 2012) the maximum load was achieved in only 1 month.This rapid staggering load is due, probably,the adaptation of anaerobic sludge to the vinasse,reducing by one sixth the time required in the previous harvest. The average removal efficiencies of COD were respectively 85%, 87% and 88% and the concentration of methane in the biogas was on average 82%, 65%, 77% for R-11, R-21 and R-31 reactors, respectively in the second harvest. It was found that, in terms of applied load,that the second season the R-21 and R-31 reactors exceeded the design load reaching 30 kg COD.m^3/d,however for the reactor R-11 reached only the load of 25 kg.COD.m^3/d.Despite this load shedding, the reactor R-11 proved to be robust shown very satisfactory performance with respect to COD removal efficiency, stability and quality of the generated biogas (high methane content). Compared to the other two models tested, although these present technological improvements over contact sludge-substrate and sludge retention, the UASB technology was adequate for the treatment of vinasse, with lower cost to other models of anaerobic reactors studied.

5. Switchgrass Genotype Study As a Bioenergy Crop in Kansas, USA
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Abstract:
Due to increasing fuel costs and uncertainty of fossil fuel supply on the planet, developing bioenergy crop such as switchgrass might play an important role in terms of diversifying energy sources and increasing energy sustainability. There are many potential bioenergy crops and switchgrass is one of them. Switchgrass is a native warm-season grass and once it's established, it can last several years with low inputs and maintenance. The objectives of this study were to: 1) assess the best performing switchgrass genotype suitable for Kansas soil and climatic condition in the USA, and 2) determine the correlation between plant height or tiller numbers per plant and dry biomass of various switchgrass genotypes. Seeds of twenty accessions of switchgrass were sown in trays under greenhouse conditions and transferred into cones after emergence. Twenty two different genotypes (i.e., Alamo, Cave-in-Rock, Kanlow, SL 93 C2-1, SL 93 C2-2, SL 93 C2-3, SL 93 C2-4, NL 94 C2-1, NL 94 C2-2, NL 94 C2-3, NL 94 C2-4, NSL 2009-1, NSL 2009-2, NSL 2009-3, NSL 2009-4, SWG 2007-1, SWG 2007-2, SWG 2007-3, SWG 2007-4, SNU 98 LMBP C1-1, SNU 98 LMBP C1-2, SNU 98 EMBP C1-1) of seedlings were allowed to grow in cones for 30 days under controlled environments. Thereafter, the seedlings were transplanted into the field at the Kansas State University North Research Farm in Manhattan, Kansas, USA. The growth and yield components of various switch grass genotypes were measured. Plant height and number of tillers per plant was measured in five randomly selected plants from each replication. Single plant was harvested and dried in oven at 50°C for a week and dry weight was recorded and expressed as g $plant^{-1}$. Plants in a meter square were hand harvested and dried in oven at 50°C for a week and dry weight was recorded and expressed as g m^{-2}. Significant difference in plant height was observed among the genotypes. The genotypes, SL 93 C2-2 was the tallest (193.9 cm) and there was no significant difference between SL 93 C2-2 and NL 94 C2-1, NL 94 C2-2, NL 94 C2-3, NL 94 C2-4, NSL 2009-1, NSL 2009-3, NSL 2009-4, SL 93 C2-

1, SL 93 C2-3 and SWG 2007-2. The genotype Cave-in-Rock was the shortest (124.2 cm) among the genotypes. Significant difference in number of tillers per plant was observed among the genotypes. The genotypes Alamo recorded the highest numbers of tiller plant^{-1} (24.4) which was on par with NL 94 C2-1, NL 94 C2-4, NSL 2009-2, NSL 2009-3, SL 93 C2-1, SL 93 C2-2, SL 93 C2-3, SL 93 C2-4, SWG 2007-1 and SWG 2007-2. The genotype Cave-in-Rock had the lowest numbers of tiller plant^{-1} (14.3) compared with other genotypes. The genotypes Alamo, NL 94 C2-2, NL 94 C2-3, NSL 2009-1 and NSL 2009-1 had increased above ground biomass compared with other genotypes. The genotypes SWG 2007-3, SNU 98 LMBP C1-2, SNU 98 EMBP C1-1, Cave-in-Rock and SWG 2007-4 had lower above ground biomass than other genotypes of switchgrass. The correlation study indicates that there was a significant positive correlation between number of tillers per plant and per plant dry weight (R^2=0.93), number of tillers per plant and plant height (R^2=0.94), and plant height and per plant dry weight (R^2=0.82). This study might help bioenergy crop breeders develop certain genotypes that can have high biomass with both high number of tillers per plant and taller plant characteristics.

6. Utilization of Crab Shells As Heterogeneous Catalyst in the Synthesis of Methyl and Ethyl Biodiesel

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Abstract:
Biodiesel is biodegradable and renewable fuel obtained through a chemical process called transesterification in which vegetable oil or animal fat (triglycerides) is reacted with an alcohol in the presence of a catalyst, and glycerin as a major co-product (Figure 1) is removed by decantation. Biodiesel has emerged as an alternative to replacing diesel oil by presenting similar combustion properties[1] and minimize environmental pollution.[2]

Among the catalysts, the mostly used in homogeneous phase is alkaline due to faster reaction and higher yields, requiring lower pressures, temperatures and molar ratio alcohol: oil.[3] Nevertheless, the presence of free fatty acid (over 1.0 mg KOH/g) and water in the oil feedstock implies in soap formation, reducing the ester yield and inhibiting the biodiesel purification.[3]

As an alternative method of biodiesel production, the use of heterogeneous catalysts presents some advantages, such as easy separation from the reaction medium and reusability. The heterogeneous catalyst is separated by a filtration process instead of exhaustive washing, when homogeneous catalysis is used, reducing the volume of residual water and environmental impact.[4] Nevertheless, heterogeneous catalysts have been proposed as a high operating cost.[3, 5] Due to that, the biggest challenge in this area is to search for catalyst with a high performance and lower costs.

High interest has been shown regarding the use of CaO due to its economic advantages, high alkalinity, low solubility and easy handling.[6] Despite recent and few numbers of papers published in this area, some of them presents as sources of CaO, the waste of natural products such as egg shells, bones, oyster shells of molluscs,[7-9] resulted from a calcination process since the bark of these species are composed of about 40-55% of $CaCO_3$.[10]

Another challenge given to the productive sector of biodiesel takes place regarding the use of alcohol used in the transesterification reaction. On an industrial scale, methanol is the alcohol used for presenting a lower cost, and improved handling of the final product because of its low homogeneity biodiesel, thus allowing easy separation by settling.[3] However it is a toxic alcohol, lethal, non-renewable, offers high risk of explosion and needs to be handled with great caution. Alternatively, ethanol has been studied as a promising possibility for not presenting these unwanted properties of methanol, furthermore ethanol is a renewable, providing greater environmental benefit to biodiesel.[11]

According to that, in this work we propose an environmentally friendly alternative for biodiesel production sector, studying the use of CaO obtained from food residue from crab shell as heterogeneous catalyst. A study of the kinetic of the reaction while using this catalyst in the synthesis of biodiesel, is done comparing both methyl and ethyl alcohol.

7. Poverty in the Pirapama Basin: The Role of Management of Hydrological Resources

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Abstract:
The sustainable use of water resources has become a very popular theme in scientific literature along with a broader discussion about the sustainable use of natural resources. More specifically, there is an increased interest in how climate change may affect water availability. The social and economic impact of different water allocation strategies has recently been modeled and measured (Bhatia et al, 2006, Moraes et al, 2009, CALZADILLAA et al, 2013). Many studies have shown that the anthropogenic emissions of greenhouse gases may be responsible for changes in weather conditions on the planet (IPCC, 2007 COMOU; ROBINSON & Rahmstorf, 2013). The economic impact resulting from these changes is likely to be strongly influenced by the increased water availability for agricultural production.

Water availability for agriculture is related not only to the natural conditions of the climate, but also to water resources management practices that define supply and demand conditions. Thus, the rational and efficient use of water mainly through demand management – using water allocation policies - becomes urgent. There are many benefits that can be derived from the application of adequate water allocation policies, such as: environmental, for example, an improvement in water quality; or economic, for example higher economic returns from activities that use water, such as agriculture.

The probable diminishing of rainfall rates, resulting from climate change, is potentially disastrous. This is true especially for individuals living in regions already in a socioeconomic context of poverty and whose incomes are closely linked to the availability of natural resources.

This study aims to develop an integrated framework to assess the effects of different management practices of water resources on the economy of the Pirapama Riverbasin, especially the effects on the poorest strata of the population.This will be done by joining the hydro-economic model for this region already developed at the Federal University of Pernambuco (UFPE) with a Computable General Equilibrium Model (CGEM) being formulated for the same hydrographic region.

Starting from the results obtained from the first model, concerning water allocation for agricultural users and their resulting crop production, the effects on all sectors of the regional economy including

possible changes in the condition of poor families will be measured . These results are expected to support decision-making about different allocation policies in the region.

The Pirapama River basin was mainly chosen as the area of study because of its economic importance for Pernambuco, since one hand is the most important water source for the metropolitan region of Recife, capital of Pernambuco and supplies water for others major users such as alcohol distilleries and sugar cane irrigation. Thus, there are already many existing conflicts between different uses in the region, such as electricity generation, irrigation, and human consumption.

Water quality is also a major concern in the Pirapama basin since throughout the length of the river most currently monitored water quality standards cannot be met, mostly because of sugarcane production together with fertirrigation, which is a process of irrigation and fertilization that uses water to carry and distribute fertilizers to the sugar cane. On top of that, two recently constructed reservoirs on the basin (the last one completed in 2010) might also contribute to further water quality deterioration through eutrophication processes (MORAES ET AL, 2010).

Furthermore, the region where the Pirapama River basin is located (*Zona da Mata*) is not associated with the climate variability and drought as the semi-arid regions in northeastern Brazil, therefore the basin is less used to extreme drought periods making it particularly vulnerable to future climate changes (ENGLE & LEMOS, 2010). These conditions make good water management practices in the region indispensable

Given the main goal highlighted above we have the following specific objectives:

- To build a Social Accounting Matrix for the Pirapama River basin;
- To develop and calibrate a CGEM for the Pirapama River basin with different types of representative families;
- To include the results from the hydro-economic model in the general equilibrium model;
- To simulate through the integrated framework how different decisions on water management might affect the Regional Economy, especially those areas with poorest population.

8. Maximizing Ethanol Production from Genetically Modified Cyanobacteria Grown Autotrophically

Claudio Delpino, Chemical Engineering, Planta Piloto de Ingeniería Química (PLAPIQUI), Universidad Nacional del Sur-CONICET, Bahía Blanca, Argentina, Vanina Estrada, Chemical Engineering, Planta Piloto de Ingenieria Quimica (PLAPIQUI), Universidad Nacional del Sur - CONICET, Bahia Blanca, Argentina and **Maria Soledad Diaz**, Chemical Engineering, Planta Piloto de Ingenieria Quimica (PLAPIQUI), CONICET - Universidad Nacional del Sur, Bahia Blanca, Argentina

Abstract:
In this work we address the optimization of ethanol production from a mutant strain of the cyanobacterium Synechocystis sp. PCC 6803 (Vidal Vidal, 2009), growing on carbon dioxide as carbon source. This modified strain harbors the genes pdc and adhB from Zymomonas mobilis under the control of the gene PetE promoter for ethanol production. We carry out dynamic flux balance analysis by integrating photobioreactor nonlinear dynamic models and metabolic network linear models. Basically, the model includes two major components: (a) a dynamic model with mass balances for biomass, ethanol, nitrate, phosphate, internal nitrogen and phosphorus, and (b) a steady state metabolic Linear Programming (LP) model. The biomass equation includes limiting functions for light, temperature and nutrients, kinetics of growth inhibition by ethanol toxicity and the decrease in the available light by

biomass concentration increase. The control variables of the dynamic optimization problem are batch temperature, light intensity and phosphate concentration in the culture medium.

The resulting dynamic optimization problem for ethanol production maximization is a bilevel optimization problem, with an embedded LP. The problem is reformulated to a single level one, by replacing the LP by its optimality conditions. The dynamic optimization problem is fully discretized by orthogonal collocation on finite elements, rendering a large-scale nonlinear programming (NLP) problem. Complementarity constraints associated to first order optimality conditions in the inner LP are efficiently dealt with the Interior Point algorithm within the IPOPT solver (Waechter & Biegler, 2006) in GAMS (Brooke et al., 2013). The discretized model has 88337 constraints and 58063 variables (73 finite elements and two collocation points). The model has been previously calibrated with experimental data (Laiglecia et al., 2013). In these experiments, performed over 73 hours, the runs have been carried out using the genetic modified strain, and activating the Pet promoter from the very beginning of the runs (with copper); i.e., enabling ethanol production path throughout the entire time horizon.

Numerical results obtained in this work suggest modifications in the metabolic network during the fermentation, with the consequent increase in ethanol production. The optimal pdc pathway should be activated after 20 hours of fermentation, with a consequent 26% increase in ethanol production. Another important issue is that ethanol production increase does not affect biomass growth, as it has been previously shown in experiments carried out by Vidal (2009). Optimal profiles for light intensity, suggest keeping it constant at 80 µE/(m2.s) up to 40 h and increasing to double its value by the end of the fermentation. In this way, alternatives are suggested for the enhancement of ethanol production from a genetically modified cyanobacterium strain.

9. Water Allocation and Resources Management Using a Hydro-Economic Optimization Model: The Case Study of the Sub-Middle São Francisco Watershed

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Abstract:
The Northeastern semiarid region of Brazil is known of its irregular rainfalls and water scarcity. Reservoirs and perennialized rivers are the only water source in the dry season. Water disponibility is limited, already causing several conflicts between different water users and uses, like hydropower, irrigation, human consumption, animal consumption, industrial and aquaculture. Furthermore efforts are taken to exploit this region economically with some irrigation sites using mainly crops with a high water need and high drought sensitivity, like sugar cane. Conflicts can get even more challenging with the Integration Project of the San Francisco River (PISF), where two lines of water channels are being built to deliver water to the north and the northeast of the region. Water allocation rules and decision making based on land use change and climate change becomes more important. The aim of the research, linked with the INNOVATE project, is the development of a hydro economic model which uses optimization algorithms to determine the hydro-economical optimum for water allocation in the middle São Francisco River Basin. The hydro-economic optimization model is written in GAMS. Expected results are optimal water storage in reservoirs and allocation rules for irrigated production under different scenarios of water transfers, land use and climate changes.

10. Considering Water Quality and Energy Efficiency to Define Optimum Operation of Integrated Systems of Water Supply and Value of Use of Water Quality

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Abstract:

According to Gunkel et al. (2007), all rivers in the coastal region of Pernambuco´s state are influenced by sugarcane cultivation. Effects are often magnified as these same rivers supply cities as well and are generally heavily dammed for both urban water supply and electrical power generation. These reservoirs might also contribute to further water quality deterioration through eutrophication processes. Seeking to contribute with a decision support tool in the water supply area with this kind of problem, this study presents an optimization model that identifies the volume of water to be distributed from a set of integrated water supply systems monthly to each municipality in the Recife's metropolitan region (Pernambuco´s state), in order to minimize expenses with electric power and water treatment. The optimization problem presented uses the linear programming techniques with constraints on the maximum supply capacity of each integrated water system, the installed pipeline network and the minimum volume of water to be distributed to each city. The model results showed that the optimization leads to a reduction of 4.82% of the costs, particularly from an increase of 20.73% in volume produced by Pirapama system, the newest and largest supply system of the state of Pernambuco, the standstill in some months of the smallest integrated systems in the region (Caixa D'Água and Marcos Freire), which also have the m^3 of treated water more expensive in the region. At the same time requires a reduction of 15.38% in the activities of Tapacurá system, which suffers from eutrophication problems in the dam of the same name, its main source. By the reduced cost is possible to know how much the cost of the systems that do not operate at the optimal solution must be reduced so that they start to be considered as an option for use in catchment. Indeed, it may identify the opportunity cost of each of these systems, which is an important concept of economic theory. One of the scenarios studied considered the opportunity cost of Tapacurá system and the results showed a reduction in the value of the objective function of 6.98% (R$ 3,138,175.76) in relation to the optimal solution in scenario 1 (current conditions) and 11.47% (R$ 5,414,987.10) compared with that achieved by COMPESA in 2013. These results show the economy that the supply company would have for a year if invested in Tapacurá system to achieve lower energy and treatment costs, by installing more efficient pumps or policies to improve the water quality of the Tapacurá basin, for example. From the analysis of scenarios that consider different conditions of water quality of the main reservoirs of water catchment for integrated systems in the region, Pirapama and Tapacurá, the study estimates the direct use value of water quality for the company responsible for supplying water in the region, presenting a proposal for value the quality of water based on the avoided cost method. The direct use value of water quality from the Tapacurá system to the company responsible for the supply is R$ 3,874,662.18/year, which represents 8.21% of current expenses of the company on electricity and chemical products. The water quality of the dam Pirapama has a higher value, R$ 5,468,122.15/year, corresponding to 11.58% of the expenses of the company in 2013 with electricity and chemical products. The difference between these values results from the differentiated proportional share of them in the water supply of the metropolitan region of Recife.

11. Enhanced Pyrolysis Oil Properties through Pretreatment of Aspen with Controlled Torrefaction

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Abstract:
Pyrolysis oil produced from thermochemical conversion of woody biomass has great potential as renewable fuels and feedstocks in chemical production. Perhaps one of the most exciting ways to utilize biomass resources is in the production of transportation fuels through fast pyrolysis and catalytic upgrading. Pyrolysis oil, however, has several disadvantages such as high oxygen content, acidity, corrosivity, low storage stability, and high water content. Our results indicate that these problems can be, at least partially, addressed through the use of torrefaction as a pretreatment method. During torrefaction, mainly the hemicelluloses fraction of biomass degrades resulting in a more uniform and desirable feedstock for pyrolysis. This poster presents preliminary data demonstrating that through careful control of torrefaction conditions, the oils formed during a subsequent fast pyrolysis step of aspen have significantly improved acidity (>40% reduction), corrosivity, water content(>25% removal), oxygen content(chromatographic shift), and thus improved storage stability and energy content. Pyrolysis (500°C for 20 seconds) and torrefaction (300°C for between 5 to 90 minutes) experiments were carried out in a high purity helium atmosphere on a 5200HP Pyroprobe (CDS Analytical), and the chemical analysis performed with a Trace GC coupled with a DSQII mass spectrometer (both Thermo-Fisher Scientific).

12. Sorghum As an Advanced Biofuel: Price Effect on Wheat, Corn and Soybean Markets
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Abstract:
BACKGROUND: The 2007 US Biofuel mandate requires total biofuel production to increase to 36 billion gallons by 2022. The Energy Independence and Security Act further specify that more than 55% of total biofuel production in 2022 must come from sources – grain, sorghum, wheat, etc – other than cornstarch. In 2012, the EPA announced that grain sorghum-based ethanol qualifies as a renewable fuel with more carbon credits than the corn-based ethanol. This may result in land use changing from the planting of wheat and other grains to planting grain sorghum. However, the problem of increasing sorghum production could cause a decrease in food supply leading to an upward pressure on grain prices. This study examines impact of the biofuel mandate on wheat, corn, soybean and sorghum prices considering the new situation where sorghum is considered an advanced biofuel feedstock.

METHOD: A stochastic partial equilibrium model is used to evaluate the short-run implications from demand and supply shocks from having grain sorghum approved as a advanced biofuel feedstock on corn, wheat, sorghum, and soybean prices in the USA. Different scenarios are simulated and compared to a counterfactual and the simulated results are compared with results obtained from the observed data.

EXPECTED OUTCOME: The use of sorghum as an input for biofuel production could alter grain prices in USA. With higher competitive prices from sorghum, the possibility of decrease production in wheat and other grains is inevitable. Since the USA is a leading wheat producer, any decline in its production will have effect on the global wheat market.

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13. A Prototype Methodology for Incorporating Sustainability Indicators in Biorefinery Process Design

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Abstract:
Biorefineries are industrial plants that integrate equipment and processes to transform biomass into a range of biofuels, platform chemicals, end-use products, and energy. The biorefinery concept rises to address two concerns, mainly: assuring energy security (by displacing fossil fuels usage, and adequate stewardship of biomass resources) and reducing greenhouse gases emissions (to meet well specified targets). Traditional methodologies for chemical processing plants are commonly used to design biorefineries, but these fall short on considering these basic criteria systematically during the design process. In this work, a methodology for including various sustainability indicators into the traditional design of biorefinery plants. The two main drivers of biorefineries are included, along with other sustainability indicators, so that a quantitative 'sustainability footprint' can be calculated for each design as a standalone evaluation. This methodology consists of 9 indicators for the design stage, and 5 more for the ex-post evaluation of existing biorefineries. For its application it requires performing a Life Cycle Assessment during the conceptual design stage, and a techno-economical pre-feasibility study during the basic engineering stage. A normalized scale is proposed for all the indicators, requiring the identification of the 'ideal sustainability' and 'critical' states for each one. A case study illustrating the resulting sustainability footprint is presented and discussed.

14. Optimal Control Strategies for Different Stabilization Pond Systems

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Abstract:
Wastewater generation is inevitable and its discharge into surface waters leads to environmental problems and health risks. To avoid this, standards for wastewater discharge have been enforced and are expected to become stricter, this resulting in a growing interest area of study [1]. Wastewater treatment in stabilization ponds mainly results from settling and complex symbiosis of bacteria and algae where the oxidation of organic matter is accomplished by bacteria in presence of dissolved oxygen supplied by algal photosynthesis and surface re-aeration [2].

In this work different configurations of stabilization ponds are considered. Dynamic modeling of each pond was implemented within a dynamic optimization environment and the whole system was simulated during a fixed time horizon. A detailed mechanistic model is constructed, based on first principles of mass conservation, of different types of systems of anaerobic, aerobic and facultative ponds in series.

We address the control problem of wastewater stabilization ponds of the differents systems by formulating an optimal control problem considering electrical motor power for mixers in the aereted pond and nutrient addition rate as control variables (degrees of freedom of the problem)[3]. Constraints are embedded in the DAE model and boundaries on the control variables. As the specification on chemical oxygen demand (COD) in the outlet stream is far from the target one, the objective is to minimize the offset between the desired value and the current one, along a time horizon of a year. As a result of the dynamic optimization problem the optimal time profiles of motor power and nutrient addition rates are obtained for the time horizon. The main objective of the work is to compare the performance of the different configuration pond system under different control strategies, by the amount of organic matter in the effluent of the treatment plant.

The model takes into account dynamic mass balances of biomass of algae, the main groups of bacteria: heterotrophic bacteria, autotrophic bacteria, fermenting bacteria, acetotrophicsulphate reducing bacteria and acetotrophicmethanogenic bacteria. Also, mass balances for organic load are formulated, such as slowly biodegradable particulate COD, inert particulate COD, fermentation products, inert soluble COD, and fermentable readily biodegradable soluble COD. For nutrients, ammonium and ammonia nitrogen, nitrate and nitrite nitrogen, sulphatesulphur and dissolved oxygen. Finally, molecular nitrogen and methane emissions are considered in the model.

The results provide useful information on the complex relationship among micro-organisms, nutrients and organic matter concentration, as well as information about the impact of modification in the pond system that can be used to improve the control of the effluent composition.

15. Analysis of the Solid Waste Management of the Sugarcane Industry in Pernambuco

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Abstract:
The sugarcane agribusiness stands out due to the large amount of solid waste generated in their production processes. One of the main problems caused by industrialization is precisely the disposal of waste resulting from the production process, which affect the natural environment and human health.

Most of the sugarcane waste activity needs an adequate destination; it cannot be accumulated indefinitely at the site where it was produced. The disposal of waste in the environment, by means of matter and energy emissions released into the atmosphere, waters, or soil must occur after being treated and must be framed on standards established in environmental legislation in order not to cause pollution (AQUARONE, 1990 *apud* PELIZER, 2007).

On the other hand, the processes of production and processing of sugarcane have special features, because their residues are not considered as waste, but as byproducts and thus are valued by the industrial sector (BNDES, 2008).

In this sense, the purpose of this work is to describe the legislation on solid waste management in Pernambuco and analyze how it is being applied to the sugarcane sector of the state. The methodology consisted of both bibliographic and documentary research.

16. Polymeric Membranes and Gas Separation: Homogenous Blends of Matrimid®5218 and P84
Jared Carson, Chemical Engineering, Kansas State University, Manhattan, KS; Chemical Engineering, Kansas State University, Manhattan, KS

Abstract:
A study has been conducted to determine if a polymeric membrane consisting of a homogenous blend of the polyimides Matrmid® 5218 and P84 can be created, and if the H_2/N_2 selectivity of this membrane would compare to that of pure Matrimid® 5218. This research shows that by using NMP as a common solvent, a homogenous blend of both polyimides can be achieved. The experiment outlined in this report achieved a maximum H_2/N_2 selectivity of 50.4 using a 50/50wt% blended membrane, and a maximum H_2/N_2 selectivity of 51.6 for a pure Matrimid® membrane. Further investigation was conducted into the effects of annealing and cross-linking these membranes, though the results are inconclusive.

17. Incorporation of Sweet Sorghum Juice into Current Dry-Grind Ethanol Process
Kaelin Saul, Biological and Agricultural, Kansas State University, Manhattan, KS

Abstract:
With an increase in demand for ethanol as a source of biofuel, there are many different biomass solutions being explored, such as utilizing grain sorghum and sweet sorghum juice as opposed to corn and water, for the dry-grind process. This paper conveys the optimum conditions for flour loading as well as for the hydrolysis time that will result in high ethanol yield and high fermentation efficiency. Two sets of experiments were conducted. The first consisted of varying the quantities of grain sorghum flour of 6 grams, 9 grams, 12 grams, and 15 grams whiles maintaining a constant amount of sweet sorghum juice concentrate. The results of the first study showed that the best flour loading was 6 grams of flour added to 100 milliliters (mL) of sweet sorghum juice. With optimal flour to juice ratio, the hydrolysis time can be significantly reduced from 60 min to 30 min. Future research will study the effectiveness of different enzymes (e.g. Stargen 002, alpha-amylase, etc.) on the ethanol yield and the fermentation efficiency.

18. Biogas in the Brewery: An Exploration of Practice and Sustainability
Jaime Jurado, Abita Brewing Company, Abita Springs, LA

Abstract:
In recent years, more breweries in the USA have installed anaerobic waste water treatment plants as an alternative to traditional aerobic plants. The biogas byproduct can be used as boiler or CHP fuel, and one brewery evaluated its use in fuel cell electricity generation. Admittedly, a 'micro-' scale biofuel solution which, at best, supplies 20% of the energy required by the brewery... yet which is like PV and solar heating applications in that individual adaptation may seem to be inconsequential, but industry-wide, it is additive and helps change energy benchmarks. A challenge has been to deploy anaerobic treatment systems for the burgeoning artisanal breweries. Once this technological approach was only viable for very large breweries, but then smaller regional breweries had successes with their implementations. The proliferation of new, very small breweries suggests that there exists a genuine opportunity for small-scale anaerobic digester systems. An exploration of successful existing installations lends a framework of what makes sense for smaller, unitized systems that must be more affordable for the small brewery. ROI is the final determinant which will be discussed from the lens of the brewery owner.

RCN Conference on Pan American Biofuels & Bioenergy Sustainability

Golden Tulip Recife Palace, Recife, Brazil
July 22-25, 2014

Technical Program
Thursday, July 24, 2014: 08:30 AM - 11:30 AM

Thursday, July 24, 2014: 08:30 AM - 11:30 AM, Boa Viagem Room
Technological Innovation in Biofuel and Bioenergy Sustainability
Chair: Mark Mba Wright, Mechanical Engineering, Iowa State University, IA, USA
Co-Chair: Michael T. Timko, Chemical Engineering, Worcester Polytechnic Institute, MA, USA

8:30 AM	Small Is Better: Fostering Growth in the Biofuels Industry with Energy Manufacturing . **M. Mba Wright**, R. C. Brown, and P. Componation
8:50 AM	Small-Scale Biorefineries: Towards the Biofuel and Bioenergy Sustainability at Local Basis . R. Souza Aguiar, P. H. Sousa Baudel, R. A. Jose, C. A. M. de Abreu, and **H. M. Baudel**
9:10 AM	Alcoholic Fermentation Using Immobilized Cells in Calcium Alginate . J. C. Duarte, **J. R. Nunhez**, J. A. R. Rodrigues, P. J. S. Moran, and G. P. Valença
9:30 AM	Incorporation of Sweet Sorghum Juice into Current Dry-Grind Ethanol Process for Improved Ethanol Yields, Energy Saving, and Water Efficiency . **N. B. Appiah-Nkansah**, K. Saul, W. Rooney, and D. Wang
9:50 AM	The Continuous-Flow Solid Acid Catalyst Hydrothermal Biorefinery . **M. T. Timko** and G. Tompsett
10:10 AM	Biodiesel Production from Used Cooking Oil Using Calcined Sodium Silicate Catalyst . M. O. Daramola, **D. Nkazi**, and K. Mtshali
10:30 AM	Roundtable Discussion of Key Research Issues and Challenges

8:30 AM Small Is Better: Fostering Growth in the Biofuels Industry with Energy Manufacturing
Mark Mba Wright, Mechanical Engineering, Iowa State University, Ames, IA, Robert C. Brown, Center for Sustainable Environmental Technologies, Iowa State University, Ames, IA and Paul Componation, Industrial and Manufacturing Systems Engineering, Iowa State University, Ames, IA

Abstract:
The 2013 Intergovernmental Panel on Climate Change (IPCC) report stresses the need to reduce atmospheric carbon levels to avoid disastrous changes in global climate. Lignocellulosic biofuels are part of emerging strategies to reduce carbon emissions by replacing fossil-derived transportation fuels. We need an industry paradigm shift to have a meaningful impact on the transportation fuel market. Energy manufacturing could foster growth in the biofuels industry by enabling the economic production of small, modular biorefineries.

The topic of this presentation is the role of energy manufacturing in technological innovation for sustainable biofuel production. Energy manufacturing enables faster learning rates. Increasing learning rates has led to drastic cost reductions in feedstock production and conversion to ethanol both in the U.S. and Brazil. Sugarcane production costs have decreased by more than 60% since 1971, and U.S. corn costs have seen a similar reduction. Sugarcane ethanol production costs decreased by about 70% over a similar time period. These cost reductions occurred during a period of rapid expansion in biofuel production. We project that a similar effect will boost the nascent lignocellulosic biofuel industry. Furthermore, investing in energy manufacturing strategies could amplify the impact of learning rates on industry growth.

Most of the biofuel industry growth has been driven by first generation biofuel technologies. In the span of 10 years, global biofuel production increased from 238 thousand barrels per day of oil equivalent (BPDOE) to 1206 thousand BPDOE in 2012. Ethanol production accounted for 78.7% of 2011 global biofuel production, and biodiesel accounted for almost all of the remaining fuel. First generation biorefineries from either corn grain or sugarcane produce virtually all the commercially available ethanol.

The continued growth of the biofuel industry will substantially depend on the commercialization of advanced biofuel technologies, which face significant techno-economic challenges. Advanced biofuel technologies are those capable of converting a wide range of lignocellulosic feedstock into a variety of transportation fuels such as ethanol, gasoline, diesel, and dimethyl-ether. There has been significant investment in research and development of these technologies. However, biofuel production from advanced biorefineries has yet to meet the goals established by government policies. This lack of advanced biofuel production has prompted the U.S. EPA to reduce the annual advanced biofuel targets by more than 90% from the original mandates due to a lack of eligible supply. Recent industry developments suggest that companies may be able to increase production of advanced biofuels albeit at quantities far below the mandated targets. Two of the main constraints limiting advanced biorefinery adoption are high capital and feedstock costs.

Innovative and energy efficient technologies could overcome the high costs of pioneer facilities with sufficient commercial experience. These technologies require significant initial investments that are difficult to justify without knowledge of their earning potential. Increasing their earning potential will depend on cost reductions enabled by the deployment of facilities at their optimal scale and cost reductions from technological learning. Despite the significant literature contributions on biorefinery optimal facility sizes and learning rates, there is scarce information on their interaction particularly for

the biofuel industry. This study could lead to coordinated strategies that would result in significant economic savings and rapid technological growth.

We evaluated the impact of learning rates on the optimal scale and production costs of lignocellulosic biorefineries. Results from this study indicate that increasing biorefinery capital and feedstock learning rates could significantly reduce the optimal size and production costs of biorefineries. This analysis compares predictions of learning-based economies of scale, S-Curve, and Stanford-B models. The Stanford-B model predicts biofuel cost reductions of 55 to 73% compared to base case estimates. For example, optimal costs for Fischer-Tropsch diesel decrease from $4.42/gallon to $2.00/gallon. The optimal capacities range from small-scale (grain ethanol and fast pyrolysis) producing 16 million gallons per year to large-scale gasification facilities with 210 million gallons per year capacity. Sensitivity analysis shows that improving capital and feedstock delivery learning rates has a stronger impact on reducing costs than increasing industry experience suggesting that there is an economic incentive to invest in strategies that increase the learning rate for advanced biofuel production.

During this presentation, we will 1) describe the role of energy manufacturing in technological innovation, 2) discuss the impact of learning rates on the lignocellulosic biofuel industry, and 3) identify advanced energy manufacturing strategies with the greatest impact on biofuel production growth. The outcome of this work could lead to effective recommendations for engineering investments that accelerate the growth of the lignocellulosic biofuel industry.

8:50 AM Small-Scale Biorefineries: Towards the Biofuel and Bioenergy Sustainability at Local Basis
Rodrigo Souza Aguiar[1], Paulo Henrique Sousa Baudel[2], Reginaldo A. Jose[3], Cesar A.M. de Abreu[4] and **Henrique M. Baudel**[3,4], (1)Chemical Engineering, UFSC, FLORIANOPOLIS, Brazil, (2)Materials Engineering, UFSC, FLORIANOPOLIS, Brazil, (3)AMERICA BIOMASS TECHNOLOGIES, PIRACICABA, Brazil, (4)Chemical Engineering, UFPE, RECIFE, Brazil

Abstract:
Small to medium- scale biomass biorefineries have been identified as a promising route to the creation of local and regional agroindustrial clusters in Brazil. By delivering multiple products from starchy and lignocellulosic biomasses, a biorefinery constituted by integrated plants and processes can make feasible the economic exploitation of a myriad of low-value agricultural and industrial residues. In principle, different biomass components can be converted into sugars and other carbon-rich products, which in turn can be transformed into high-valued chemical products and high-volume biofuels, while generating electricity and process heat for self-consumption. In this scenario, the high-value products enhance profitability, the high-volume fuels contribute to support energy needs, and the power production reduces costs while avoiding greenhouse gas emissions. Hence, the biorefinery concept envisages the maximal value derived from the biomass feedstock at minimal impact to the environment. This paper describes a biorefinery constituted by integrated plants that produce ethanol, active carbon, food-grade carbon dioxide and protein extract (for cattle feed). Agricultural residues such as rice shells and straw as well as non-food energy-rice were used as starchy and lignocellulosic feedstocks. The mentioned biorefinery concept has been built on two different biomass-to-products platforms. The "sugar platform" is based on chemical and biochemical conversion processes, particularly the fermentation of sugars extracted from cellulosics, while the "carbon platform" is based on thermochemical routes with emphasis on the carbonisation of the cellulignin fractions.

9:10 AM Alcoholic Fermentation Using Immobilized Cells in Calcium Alginate

Juliana Canto Duarte[1], **José Roberto Nunhez**[2], José Augusto Rosário Rodrigues[3], Paulo José Samenho Moran[4] and Gustavo Paim Valença[2], (1)Faculty of Chemical Engineering, UNICAMP - State University of Campinas, CAMPINAS, Brazil, (2)Departamento de Engenharia de Processos, UNICAMP, Campinas, Brazil, (3)Chemistry Institute, UNICAMP - State University of Campinas, Campinas, Brazil, (4)Chemistry Institute, UNICAMP - State University of Campinas, CAMPINAS, Brazil

Abstract:
This work refers to alcoholic fermentation carried out using immobilized cells. The Saccharomyces cerevisiae cells were immobilized in calcium alginate and in chitosan-covered calcium alginate beads. Ethanol was obtained for the fermentation of both glucose or sucrose. The batch fermentations were carried out in an orbital shaker. The reaction was monitored with the use of an HPLC that assessed the concentration of products and substrate. Results show that both calcium alginate immobilized beads and chitosan-covered calcium alginate immobilized beads could be used in eight sequential fermentation cycles of 10 h each. The final concentration of ethanol using free cells was 40 g L-1 and the yields using glucose and sucrose as carbon sources were 78% and 74.3%, respectively. For immobilized cells in calcium alginate beads, the final ethanol concentration in the glucose fermentation was 32.9 ± 1.7 g L-1 with a 64.5 ± 3.4% yield. The final ethanol concentration for the sucrose fermentation was 33.5 ± 4.6 g L-1 with a 64.5 ± 8.6% yield. For immobilized cells in chitosan-covered calcium alginate beads, the ethanol concentration from glucose was 30.7 ± 1.4 g L-1 with a 61.1 ± 2.8% yield. The final ethanol concentration from sucrose was 31.8 ± 6.9 g L-1 with a 62.1 ± 12.8% yield. There was no need to use antibiotics and no contamination was observed in the batches. After the eighth cycle, a significant rupture of the beads was observed thus making them inappropriate for use in another cycle.

9:30 AM Incorporation of Sweet Sorghum Juice into Current Dry-Grind Ethanol Process for Improved Ethanol Yields, Energy Saving, and Water Efficiency

Nana Baah Appiah-Nkansah, Biological and Agricultural, Kansas State University, Manhattan, KS, Kealin Saul, Biological and Agricultural, North Carolina State University, Raleigh, NC, William Rooney, Soil & Crop Sciences, Texas A&M University, College Station, TX and Donghai Wang, Biological and Agricultural Engineering, Kansas State University, Manhattan, KS

Abstract:
Sweet sorghum is a promising energy crop due to his low fertilizers and water requirements, short grow period, and high biomass yield. However, the challenge for sweet sorghum as a feedstock for ethanol production is its short harvest period and the extreme instability of the juice. At current situation, it is difficult for sweet sorghum based ethanol industry to achieve a year-round production process. One possible way to solve this challenge and to meet the growing demand of bio-renewable ethanol is to incorporate sweet sorghum juice into current dry-grind ethanol process.

In this study, sweet sorghum juice with varying content of grain sorghum flour were liquefied, saccharified, fermented, and distilled to produce ethanol. Ethanol yield from the optimum grain sorghum flour loading with sweet sorghum juice achieved was about 28% higher than that from conventional ethanol process. It was also found that enzymatic hydrolysis with this process could be reduced by 30 minutes. The fermentation performance of sweet sorghum juice with grain flour using raw starch hydrolyzing enzyme was also investigated. The results showed that an ethanol yield was about 21% higher than that from the conventional process. This innovative technology of ethanol production by sweet sorghum juice could improve ethanol yield, save energy, and significantly decrease the use of water in the current dry-grind ethanol process.

9:50 AM The Continuous-Flow Solid Acid Catalyst Hydrothermal Biorefinery
Michael T. Timko and Geoffrey Tompsett, Chemical Engineering, Worcester Polytechnic Institute, Worcester, MA

Abstract:
A major challenges for sustainable biorefineries include adoption of continuous flow processing of whole biomasses and development of new technologies to catalyze selective biomass conversion reactions at mild conditions. Solving these problems will reduce biorefinery capital and operating costs, improve energy balances, and reduce water use. In this talk, I will share recent developments on continuous biomass processing in a hydrothermal reactor and synthesis of hydrothermally stable solid acid catalysts.

In terms of continuous hydrothermal processing, many engineering challenges remain unsolved, including how to deal with reactor plugging, whole biomass utilization, and high-pressure slurry pumping. Here, we have focused our efforts on developing a continuous flow reactor to achieve rapid heating rates in a turbulent mixer to break-up the lignocellulosic matrix, followed by reaction in a secondary zone to maximize simple carbohydrate production. We present time-on-stream data for the prototype reactor with different model feeds.

Solid acid catalysts can play important roles in economically competitive biorefineries, ranging from upstream biomass pre-treatment, to carbohydrate conversion, to bio-ethanol upgrading. A key feature of all these applications is the need for both activity and stability in water-rich aqueous environments. In this talk, I will highlight some early work to develop solid catalysts that retain activity and stability in biorefinery applications. I will describe research to synthesize and characterize bio-char catalyst supports, a class of materials that can be functionalized into strong Bronsted acids. Specifically, my lab has used a two-step hydrothermal-mechanochemical method to synthesize bio-chars for catalytic applications and characterized them using Raman spectroscopy. In a second line of work, I will share research on organic functionalized zeolites. Recent work elsewhere has shown that organic coatings can increase hydrothermal stability of zeolites; however, less work has been performed to characterize diffusion limitations associated with the organic coating. In my lab, we have synthesized several organic functionalized zeolites, characterized them using a suite of standard techniques, and performed dynamic uptake measurements to investigate molecular diffusion rates. These two catalyst vignettes showcase the range of strategies being adopted to develop solid acid catalysts suitable for biorefinery applications.

10:10 AM Biodiesel Production from Used Cooking Oil Using Calcined Sodium Silicate Catalyst
Michael O Daramola, **Diakanua Nkazi** and K Mtshali, University of the Witwatersrand, Johannesburg, South Africa

Abstract:
The recent oil crises and growing public awareness of global warming and greenhouse emissions are creating major technological, as well as social and political challenges worldwide. These challenges are related closely to energy generation and exploitation. The aforementioned problems have prompted the consideration of alternative and renewable types of energy. One of the expected key technologies for building sustainable societies and thus mitigating global warming due to CO_2emission is the production of renewable fuels and chemicals from the conversion of biomass [1]. An alternative type of energy

source that is highly favoured from an environmental perspective is biofuel of which biodiesel is a member.

Homogeneous acid and base catalysts have been extensively studied for the production of biodiesel [2,3]. But homogeneous catalysts cannot be reused or regenerated, because the catalysts are partly consumed in the reaction (during saponification). Also, separation of the catalyst from products is difficult and requires additional equipment which could result in higher production costs [4]. In addition, the process is not environmentally friendly because a large amount of wastewater is produced in the separation step [5]. Developing new solid catalysts seems to be an appropriate solution to overcome problems associated with the use of homogeneous catalysts for biodiesel production. Against this background, this study investigated biodiesel production from used cooking oil (UCO) using heterogeneous sodium silicate catalyst. The conversion of UCO to biodiesel exploited the potential of the catalyst to convert high free fatty acid (FFA) content feedstock to biodiesel directly, thereby by-passing the esterification state whereby FFA content of the feedstock is reduced prior to transesterification reaction.

The transesterification reaction was conducted in a batch reactor with 2.51 g of the catalysts and at UCO to methanol ratio of 1:6. In addition, the reaction temperature was varied between 25^{o}C to 63^{o}C, and the reaction time was varied from 0 to 180 minutes at a 30 minute step increase to understand their effects on the activity of the catalyst during transesterification of UCO to biodiesel. The fatty acid methyl ester (FAME) yield increased with reaction time and reaction temperature and the highest FAME yield of ~30% was obtained at 63^{o}C after 180 minutes. Furthermore, results of this study compare favourably with literature. However, further studies are required for in-depth understanding of the activity and kinetics of the catalyst for biodiesel production from UCO. As far as could be ascertained, this is the first open report on the conversion of UCO to biodiesel over a calcined heterogeneous solid sodium silicate catalyst. However, a more in-depth study on the activity of the catalyst and the kinetics in transforming UCO to biodiesel is required. At the same time, improvement of the synthesis protocol of the catalyst via optimization study is required. Evaluation of performance stability and optimization of the transesterification operating conditions are essential.

Thursday, July 24, 2014: 08:30 AM - 11:30 AM, Piedade Room
Bioenergy and Social Justice
Chair: Theresa Selfa, SUNY – ESF, Syracuse, NY, USA

8:30 AM	Food Security and Biofuels: Can Policy Flexibility Reduce Food Price Crises for the Poor? Part One: Global Markets and Brazil Sugar Cane Production Case . **M. R. L. V. Leal** and K. Kline
8:55 AM	Food Security and Biofuels: Can Policy Flexibility Reduce Food Price Crises for the Poor? Part Two: US Maize Production System Case . **K. Kline** and M. R. L. V. Leal
9:20 AM	Questioning the Social Dimensions of Sustainability: The Biofuel Industry and the Weakening of Traditional Communities in Brazil . **A. L. de Campos Paula** and V. Zuchetto
9:45 AM	The Sugarcane Industry and the Global Economic Crisis . **M. L. Mendonça**
10:10 AM	Roundtable Discussion of Key Research Issues and Challenges

8:30 AM Food Security and Biofuels: Can Policy Flexibility Reduce Food Price Crises for the Poor? Part One: Global Markets and Brazil Sugar Cane Production Case

M. Regis L.V. Leal, Brazil Bioethanol Science and Technology Lab, Campinas, Brazil and Keith Kline, Environmental Science Division, Climate Change Science Institute and Center for Bioenergy Sustainability, Oak Ridge National Laboratory, Oak Ridge, TN

Abstract:
Food crises are created by sudden loss of supply or, more often, sharp increases in the prices of foodstuffs on which poor populations rely for daily nourishment. Any mechanism with the potential to alleviate suffering caused by spikes in food prices is worthy of consideration. Several studies and agencies have recommended introducing flexibility into policy driven demand for agricultural biofuel feedstocks to address food price crises (e.g., report of the FAO, IFAD, IMF, OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI, and the UN High Level Task Force, 2011). These proposals suggest that feedstock such as sugarcane can be diverted from biofuel production to food in order to dampen the impact of volatile cereals prices on the poor. This presentation reviews the evidence for and against temporary shifting of policies to reduce biofuel output in response to food price crises. This talk considers the experiences and data associated with the second largest producer of biofuel in the world, Brazil. The behavior of prices for Brazil sugar, food baskets (consumer price indices for food), and energy are considered along with other drivers identified to influence food price spikes. Special attention is given to periods of price volatility, including responses of the modernized sugarcane milling industry to sudden price signals such as a sharp spike in sugar prices in 2010-2011. We review data for how much time was required for industry to respond, the magnitude of the response, the effects on global prices, and a discussion of the factors that govern the flexibility and responsiveness of the industry to price signals. These data are analyzed to examine if and when biofuel feedstock could be diverted and to assess what the implications would be of such diversion in time of food price crisis. The evidence identifies many caveats to consider before implementing diversion proposals. Recommendations are offered for development pathways that could simultaneously improve food security and energy security and thereby address the needs of the populations most vulnerable to food price crises.

8:55 AM Food Security and Biofuels: Can Policy Flexibility Reduce Food Price Crises for the Poor? Part Two: US Maize Production System Case

Keith Kline, Environmental Science Division, Climate Change Science Institute and Center for Bioenergy Sustainability, Oak Ridge National Laboratory, Oak Ridge, TN and M. Regis L.V. Leal, Brazil Bioethanol Science and Technology Lab, Campinas, Brazil

Abstract:
Food crises are created by sudden increases in the prices of foodstuffs on which poor populations rely for daily nourishment. Any mechanism with the potential to alleviate suffering caused by spikes in food prices is worthy of consideration. Several studies and agencies have recommended introducing flexibility into policy driven demand for agricultural biofuel feedstocks to address food price crises (e.g., report of the FAO, IFAD, IMF, OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI, and the UN High Level Task Force, 2011). These proposals suggest that grain can be diverted from biofuel production to dampen the impact of volatile cereals prices on the poor. This presentation reviews the evidence for and against temporary lifting of incentives to produce biofuels in response to food price crises. This talk will focus on the experiences and data associated with the largest producer of biofuel in the world, the USA and its corn-ethanol production system. The behavior of prices for US maize, food baskets (consumer price

indices for food), and energy are considered along with other drivers identified to influence food price spikes. Special attention is given to periods of price volatility, including the rapid rise in prices in 2007-2008 and 2010-2011, and the US drought of 2012. Relevant prior research is summarized and recent data are analyzed to examine if and when US biofuel feedstock could be diverted with beneficial results. Diversion proposals sound logical and are widely assumed to be the "right and moral thing to do." The evidence identifies many caveats to consider. Otherwise, temporary market interventions to divert feedstocks from biofuels could have significant costs and make matters worse in the long run. Areas of future research are identified and recommendations are offered for development pathways that could simultaneously improve food security and energy security and thereby address the needs of the populations most vulnerable to food price crises.

9:20 AM Questioning the Social Dimensions of Sustainability: The Biofuel Industry and the Weakening of Traditional Communities in Brazil

Ana Luiza de Campos Paula, Sociology, Kansas State University, Manhattan, KS and Vanessa Zuchetto, University of Alberta, Edmonton, AB, Canada

Abstract:
This paper focuses on the impacts on traditional Brazilian communities resulting from the expansion of the biofuel industry in the country (primarily ethanol from sugarcane and biodiesel from soy). These impacts can take the form of community displacement, dispossession of land, or loss of autonomy and control over land. Some communities have shown resistance in the face of these large-scale changes. This paper explores the vulnerability and resilience of these traditional communities, and the implications for the sustainability dimension of the ethanol and biodiesel industry.

Traditional communities in Brazil are represented by indigenous peoples, river and delta dwellers, rubber tappers, grazers, fisher-folk, peasants, and the quilombolas (descendants of runaway slave communities of African origins). They have been part of a historical process of expropriation and exploitation resulting from the development of the Eurocentric capitalist system, and they are described as 'traditional' because of their "cultural resilience and their persistence in maintaining a symbiotic relationship with nature, despite the pressures to change imposed by various modernization projects" (Fernandes et al. 2012:43). Among these projects is the biofuel industry that has been growing in the country since the beginning of 1980's (Schlesinger 2013; Tamir 2013).

Brazil is among the world leaders in ethanol and biodiesel production, most of it coming from sugarcane and soy plantations. While most of the ethanol is produced in the southeastern region, with Sao Paulo state alone producing more than half (Schlesinger 2013), production is rapidly expanding in the central west region of the Cerrado, an area that the National Energy Agency predicts will contribute to a 200% increase in the nation's current biofuels production in about 20 years (Automotive Business 2014). The central west is a region already accounting for the largest production of soy in Brazil, 32% (or 9% of the world's production) coming from only one state - Mato Grosso (Schlesinger 2013). And the preference for this region to be the center of the biofuel industry expansion concerns the substantial availability of 'idle' lands (Filho and Horridge 2014), which often involve lands occupied by those who do not have formal title to it.

Land conflicts have long been a problem in Brazil (Tamir 2013). Concerns have recently risen due to the worldwide 'land grabbing' phenomenon. As agribusiness occupies (territorializes) sparsely populated areas with sugarcane or soy, they force out (de-territorialize) traditional peoples who lose autonomy

and control over territorial access or uses (Fernanded et al. 2012). According to Tamir (2013), indigenous people and quilombolas represent more than a quarter of all people in Brazil affected by land conflicts. In this way, it makes necessary a "sociological intervention," as described by Geisler and Makki (2014:28), "to contextualize and concretize this burgeoning alienation of land rights and power contingencies across communities and continents" (p.28).

There is no standard definition of sustainability; it means different things for different people. Due to its fluidity, discourses on sustainability of biofuel systems vary. For example, while agribusiness discourses create a dominant ideology of biofuels as sustainable fuels; monocultures feed biofuel industries with their lack of biodiversity, reliance on non-renewable natural resources, and inefficient employment of rural populations. Meanwhile, those concerned with social justice issues question the centralization of these kinds of systems and their inability to include small farmers and traditional communities in biofuels markets. Contrary, many of these populations might actually be displaced by the expansion of these markets.

Food, energy, and climate issues of our time seem to be following the neoliberal model (McMichael 2014) where the dominant ideology of sustainability brought by the agribusiness world undermines the vision of an alternative, more self-reliant, environmentally friendly, and just, economic system. Many of the environmental negative consequences inherent in biofuel production can be improved by the use of technologies, but sustainability requires more diverse and less concentrated productive systems, one that difficultly will emerge without the inclusion of small farmers, peasants, and traditional communities who are deeply connected to the land and the natural resources surrounding them.

9:45 AM The Sugarcane Industry and the Global Economic Crisis

Maria Luisa Mendonça, International Relations Department, University of Rio de Janeiro (UERJ), Rio de Janeiro, Brazil

Abstract:
The presentation analyzes recent tendencies in the sugarcane sector in Brazil, and evaluates the increasing process of monopolization, particularly with the participation of multinational corporations. The study observes that the larger concentration of capital coincides with the increasing territorial expansion of sugarcane monocropping, especially in areas with access to infrastructure, in the Southeast region, and in regions with vast water resources in the Cerrado. This process of apparent "growth" is determined by the international economic crisis, in a moment of predominance of financial capital. In this context, the study shows a constant dependency of the sugarcane industry on subsidies and state credit, in addition to the permanence of labor exploitation.

Maria Luisa Mendonca is the director of Rede Social (Network for Social Justice and Human Rights) in Brazil. She has a PhD in Philosophy and Social Sciences with a focus in Human Geography from University of Sao Paolo (USP) and is currently teaching at the International Relations Department of University of Rio de Janeiro (UERJ). Her work focuses on agricultural models, rural movements and geopolitical land and natural resource systems. She is the editor of the book "Human Rights in Brazil," which has been published annually by Rede Social for the past 14 years.

Thursday, July 24, 2014: 08:30 AM - 11:30 AM, Imperial Room
Sustainability Issues in Biofuel and Bioenergy Industries
Chair: Marcelo Cunha, TBA

8:30 AM	Looking for Sustainability in Biofuel and Bioenergy Industries: Some Challenges and Opportunities . **M. Cunha, State University of Campinas**
8:48 am	Achieving Sustainable Biodiesel Production in Brazil: Challenges and Opportunities . **J. Minelli**
9:06 AM	Green House Gas Savings Produced By Argentine Biodiesel Use . **J. A. Hilbert Sr.** and S. Galbusera
9:24 AM	Bioethanol Dehydration Assessment with Environmental Issues . **M. Colombo**, F. D. Mele, M. R. Hernández, M. Kahwaji Janho, and J. E. Gatica
9:42 AM	Opportunities and Challenges Considering the Socioeconomic Dimension for Brazilian Ethanol Industries in the Recent Past . **A. Marques**
10:00 AM	Diesel Displacement in the Sugarcane Ethanol Life-Cycle: A Comparative Analysis of Different Integrated Systems . **S. P. Souza** and J. E. A. Seabra
10:18 AM	Direct and Indirect Impacts of Agricultural Land-Use Due to Increased Production of Grain-Based Ethanol in Kansas, USA: A County-Level Analysis . **J. Bergtold** and B. Lauer
10:36 AM	Roundtable Discussion of Key Research Issues and Challenges

8:30 AM Looking for Sustainability in Biofuel and Bioenergy Industries: Some Challenges and Opportunities
Marcelo Cunha, Institute of Economics, University of Campinas, Campinas, Brazil

Abstract:
The adoption of biofuels and bioenergy have been recognized as a possible sustainable alternative for replacing fossil fuels, mainly from the beginning of this century. Several countries have set policies to implement and to enlarge the use of those sustainable options. Bioethanol and biodiesel are the most important biofuels produced and used in North America and South America – United States, Brazil and Argentina are among the main countries in this field. Cosidering that there are many differences in the regulation, development, agricultural conditions and the markets in the American countries, the opportunities and challenges faced in the biofuels and bioenergy industries are regionally dependent. The objective of this presentation is to display some opportunities and challenges in this industry considering the three pillars of sustainability. In economic terms, energy policy and regulation can be an incentive to replace part of fossil fuels in domestic or international markets; on the other hand, changes on them (and sometimes the near absence of them) can create barriers to enlarge the bioenergy adoption. In this aspect, the current situation of ethanol in Brazil competing in unfavorable conditions with gasoline is an example. Still in the economic dimension, the limits of how industries of the sector can explore the production of co-products need to be careful analyzed. Considering the social pillar, special attention has to be placed on the business model adopted by a bioenergy company because there are different implications on sustainability depending on it. For example, the possible positive impacts in jobs and income generation, mainly in the agricultural phase, will be influenced by the technological level adopted in agriculture but also on the verticalization (or not) in this key phase of the production chain. A particular analysis is provided in a recent sugarcane ethanol expansion area in Brazil. Another one is the example of how the biodiesel industry has been operating with feedstock supplied by family farmers. Taking into account the environmental issues, the industry has been capable to improve, in many cases, the GHG emissions by through its production process. One of the possibilities is to use biodiesel in the agricultural phase replacing mineral diesel oil in an integrated sugarcane ethanol and biodiesel production. On biodiesel sector, the use of beef tallow (second most important feedstock in Brazil) is another other example of improving environmental benefits, as well as economics. Finally, other important issue is regard to the methods applied over biofuel and bioenergy sustainability assessment, which may (and shall) contribute to evaluate in the best possible way the benefits (or not) of this diversified sector, mainly because biofuels and bioenergy are not the same around the world.

8:48 AM Achieving Sustainable Biodiesel Production in Brazil: Challenges and Opportunities
Julio Minelli, Aprobio – Brazilian Biodiesel Producers Association, São Paulo, Brazil

Abstract:
Governments are searching for renewable energy alternatives to diminish the dependence on fossil fuel, with different commitment levels. They are fostering the use of renewable energy, but this transition has many challenges. Biofuels appears as an alternative energy resource but has, by definition, a limited flow. Moreover, it is important to have positive outcomes in Social, Economic and Ecological aspects. The impacts to the society may be managed by the right regulatory framework and assessed by indicators as employment, prices, ecological benefits, etc.
The Biodiesel production in Brazil generates employment, midland economic growth, social inclusion of more than 80 thousand families, costs comparable to imported diesel. The main raw materials used

today are soybean oil and tallow. The use of biodiesel also reduces GHG emissions and pollutants, as SOx, CO, particulate matter and hydrocarbons.
The food & fuel debate is a gut issue, normally addressed as an incompatible matter. APROBIO would see it as synergistic solution as most oilseed crops produce feed at the same time. In this sense, increasing oilseed crops increases the feed production, important nutrition element for animal protein. The limiting factor for food, feed and bioenergy production may be the land availability. The policies and efforts should seek the best resource allocation and efficiency.
Challenges and opportunities:
To increase the public awareness that bioenergy has benefits in the mid long term, to obtain a consensus on sustainability evaluation schemes, to increase the oil availability with competitive costs and endorsement to run diesel motors on B100 or at least B20.
The average income in the developing countries is rising and so is the demand for animal protein, therefore more feed demand. Excess of vegetal oil are expected to happen, and this surplus may be directed to biofuels with higher mandatory blending.

9:06 AM Green House Savings Produced By Argentine Biodiesel Use
Jorge Antonio Hilbert Sr., Ingenieria Rural, Instituto Nacional de Tecnología Agropecuaria, Villa Tesei, Argentina and Sebastian Galbusera, COmunicacion Nacional, Sec Medio Ambiente, Bienos Aires, Argentina

Abstract:
One answer to the environmental concern regarding Greenhouse gases emitions control has been the promotion of different biofuels as mandatory targets in many countries. Argentina as one of the world main producer of vegetable oils found a great opportunity to use a byproduct of its important seed processing industry to develop efficient biofuels for domestic and international markets.

The Argentinean soybean industry is extremely strong: more than 70,000 producers for 18 million of cultivated hectares and 30 million tons of products (2008-2009). The sector provides 13 billion dollars and represents an important source of foreign exchange for the State. The export taxes were 5% for biofuel and 35% for grain in 2007: this difference prompted soy exporters to invest in biodiesel plants for export. In this way, the first phase of biofuel development started. Economies of scale and the efficiency of the soy chain are exploited to make the Argentinean biodiesel a competitive product. Despite the increase in the biodiesel tax to 20% (2008), the strong international demand encouraged new investments. The production is concentrated around Rosario (province of Santa Fe), on the Paraná River, in the soybean oil exportation complex. Thus, the province of Santa Fe has 80% of the national production, against 8% for Buenos Aires and 7% for Santiago del Estero this gives additional advantages regarding GHG emitions since distances from the production area to the transforming complex and export ports don't exceed 300 km.

Large national companies (the oil manufacturers, General Deheza, Vicentin, and Eurnekian Citrusvil[1]) and transnational corporations (Dreyfus, Glencore and Bunge) build efficient industrial plants followed by medium private investors with smaller facilities in different parts of the country mainly concentrated on domestic market. The capacity 2013 is over 4 million tons per year.. Such volumes can be competitive in the global market. However, biodiesel exportation is fragile due to international and local changes in rules. The internal market is more recent and starts with an obligation to add 5%.

Since the 1970s, (bio) technological changes improve the production and productivity of the soybean chain. Now, biodiesel is diversifying its by-products, customers and locations. It also awakes the interest and creativity of engineers, chemists, and researchers since it offers an opportunity to put old and new industrial plants in operation.

Soybean production is characterized for the employment in more than 82 % of no tilling together with other modern technologies as presition agriculture. This gives an important advantage in GHG emitions savings and energy balance.

The industrial plants responsible for the principal market share of biodiesel are characterized by its high scale and efficiency. Most are located beside the processing complex and ports, which gives enormous advantages from the energy and emitions results. Raw material is coming from a radius no larger than 300 km, which also helps to increase efficiency.

In the last years, new bio refineries were developed in order to get higher value products of the biodiesel process as glycerin and sub products. This enlarges the benefits of the chain and increases the countries income.

The last eight years were characterized by huge investments in biodiesel industry using soybean oil as the main feedstock. The first investments were produced by the new emerging European market and more recently for a growing domestic one, triggered by increasing mandatory blend now reaching 10 % in the country.

In order to give an answer to increasing concerns regarding the green house savings produced by soybean oil biodiesel several international and national studies were performed giving a realistic evaluation of a very efficient transformation chain in the country.

Several studies have been completed in order to clearly calculate the GHG emissions of the Argentine biodiesel sector according to generally accepted international methodologies. Since the country has different agro-ecosystems and distances from the ports, different analyses were completed for different regions of the country. The key element to assess the Greenhouse Emission Saving (GES) was the soybean supply area. (Panichelli, 2012) With respect to GHG emissions (Kg CO2 eq/km), emissions reduction averaged 76% (0.0447 Kg to 0.0464 CO2 eq/km). The scenario that showed more GHG emissions was South East of Bs.As. (0.0447 Kg CO2 eq/km). Comparatively and percentage with conventional diesel, its reductions of GHG emissions were of 75.5 %. The scenario that showed less GHG emissions was placed in South of Córdoba (0.0464 Kg CO2 eq/km). Comparatively and percentage with conventional diesel, its reductions of GHG emissions are of 76.5%.

A deep analysis was performed of the studies looking at criteria, methodology employed, allocation factors, coproducts evaluation and data origin in order to obtain a realistic value of greenhouse savings that could represent soybean oil biodiesel produced under the particular Argentinean conditions.

A comparative analysis showed that the crop yields and the oversea transport are the main sources of variability between studies and years. The industry values are very constant and no significative difference was detected between the differen literature sources.

As methodological framework the ACM0017 (production of biodiesel to be used as a fuel) was used. Specific calculations were performed in order to obtain the total ammount of conventional diesel fuel replaced in each market.

Based on export and domestic market commercialization a national greenhouse savings calculation was performed for the last four years (2010-2013). For each case the total emitions were taken into account savings ranged 4 million tons per year.

[1] This group privileges the installation of a biodiesel plant near its oil factory (at Frías, Province of Santiago del Estero), becoming the only mega-plant located far from Rosario.

9:24 AM Bioethanol Dehydration Assessment with Environmental Issues

Mauricio Colombo[1], Fernando Daniel Mele[1], María Rosa Hernández[2], Michel Kahwaji Janho[3] and Jorge E. Gatica[4], (1)Ingenieria de Procesos y Gestion Industrial, Universidad Nacional de Tucuman, Tucuman, Argentina, (2)Ingeniería de Procesos y Gestión Industrial, Universidad Nacional de Tucuman, Tucuman, Argentina, (3)Chemical And Biomedical Engineering, Cleveland State University, Cleveland, OH, (4)Chemical and Biomedical Engineering, Cleveland State University, Cleveland, OH

Abstract:
Environmental effects and health hazards posed by fossil-fuel based technologies complemented by changes in the global economy have further demanded the need for developing “cleaner” and more efficient technologies that rely on renewable or synthetic resources. An alternative, commonly referred to as bio-fuels, has significantly matured and today’s economy recognizes the significance of being able to produce ethanol from renewable resources such as biomass. Moreover, the potential of ethanol to be further converted to hydrogen makes it a very attractive alternative to replace or complement fossil fuels as sources of energy.

Argentina has recently enacted legislation to promote the use of bio-fuels to ameliorate its ever increasing annual gasoline demand, currently bordering 4 billion liters. This new legislation (*Law 26.093 of Biofuels Promotion*) would result in a demand of over 200 million liters of dehydrated alcohol. This quota would be equivalent to produce ethanol out of all the sugar that is currently exported. With fifteen (15) active Sugar Cane processing plants, a mill capacity of 15 million tons/year, and thirteen (13) distilleries with 1.5 million liters/year of hydrated alcohol, Tucumán (located at North West of Argentina) could meet more than 50% of the ethanol demands for Argentina.

Process simulation allows a systematic analysis that leads to an advantageous combination of all the values of process variables. In particular, since they demand significant energy influx, an important subsystem for analyzing is the separation of alcohol-water mixtures. Though many techniques for ethanol dehydration are known; adsorption, distillation, hybrid processes, and pervaporation, are the most common technologies in practice. Two alternatives for ethanol dehydration technologies are considered in this work. The first is based on the combination of distillation and azeotropic distillation, while the second relies on hybrid distillation and pervaporation processes, so it was necessary to develop a simulation module for calculating the membranes performance, typically not included in commercial process simulators. Both alternatives are simulated and their optimal design and operating parameters are identified by means of rigorous simulation using Aspen Plus®.

To achieve sustainable designs process integration is a critical task. For this, we consider the dehydration step as an integral part of the overall scheme of alcohol / water separation, taking into account potential energy integration scenarios considering different concentrations of the products obtained in the different units, to analyze its impact on global energy consumption and other environmental indicators. Particular attention is given to energetic integration by performing a pinch-analysis to each of the fundamental stages to find minimum energy consumptions.

This paper uses an ad-hoc pervaporation module to assess the production of fuel-grade bio-ethanol in distillery installations complementing a sugar mill. A baseline condition is defined as a case-study to illustrate the effect of structural and parametric changes on membrane separation units.

The user-defined module is integrated in commercial process simulators to study the environmental and energetic impact of different process configurations. Different schemes meeting equivalent performance standards in terms of purity and recovery are examined in this paper. Particular attention is given to energetic demands as comparison metrics.

This paper formulates an approach that accounts for environmental issues in explicit form. The approach makes use of Life Cycle Assessment (LCA) as described by the ISO 14000 series. Unlike most common approaches that consider environmental impact by focusing on reducing effluents, this methodology also considers the impact associated with all the involved processes in the FPD. The software used to evaluate the environmental impact is SimaPro®.

Process alternatives that meets same specifications of purity and recovery in exit streams, are examined in this paper. Of particular relevance is the assessment of costs and environmental impact of these processes. A baseline case is defined in our case-study, and structural and parametric changes are made. Different scenarios with respect to economic and environmental issues taking into account the specifications of the final product are generated. The impact of different operating policies for the production of anhydrous alcohol on the environment is examined in detail.

The membrane area, the number of plates in the distillation units, the heat exchange area, and the pressure manipulators are considered as structural variables. Among the most relevant operational variables considered one can mention reflux ratio, pressure ratio, as well as compositions and flow rates of streams.

One could consider the addition of environmental aspects within energy systems optimization as a promising contribution to the energetic optimization and LCA.

9:42 AM Opportunities and Challenges Considering the Socioeconomic Dimension for Brazilian Ethanol Industries in the Recent Past
Andreia Marques, sustainability, Amarques & Associados, campinas, Brazil

Abstract:
The sugarcane sector in its evolution have a history of ups and downs that was influenced by several factors, sometimes causing structural changes, sometimes superficial in industry dynamics . However, the transformations experienced in the last 10 years have had a significant impact on the sector. In this latest expansion process, new elements and obstacles were put to groups of entrepreneurs and the new

ways to overcome those obstacles have created a new profile for the sector with significant impacts to the communities where the projects are implemented.

Among the variables to be considered on an expansion greenfield project there are elements in the agricultural , industrial and commercial steps that can be more or less aligned with the best practices of sustainability into force . The set of criteria for adoption of these elements often depends on technological factors, endafoclimáticos, legal or even structural elements of the chosen region (topography, availability of manpower).

This paper presents a description of these agricultural, industrial and commercial stages of a sugarcane company with the various technological and procedural options possible. The following focuses attention on one of the fundamental aspects of the business that has impact on the whole processing chain and in the communities where the company operates. This aspect concerns the way how the access to sugar cane has being done

In fact, the format of access to sugarcane (and so to say, land) has changed significantly in the recent expansion cycle (2000-2012). That comes to changing the role of land ownership. Before, the cultivation areas and expansion were the only states in the Northeast and São Paulo, now the crop expands to the Midwest and South. Before, planting on their own land used to be the preference and dominance of the sector who has justified by the dependence of the flow of raw materials, now, other forms of access to cane become the preference of some groups and land ownership becomes a subsidiary or complementary strategy in portfolio of raw material to be processed.

When it analyses the expansion to the state of Goiás where this author worked for 4 years, the differences leap to the eye. A simple implementation of a performance model from São Paulo to the new territory had to undergo several changes. The most striking and impactful to society differences concern the impact on agrarian structure of the region since this element brings to the company and external community consequences of long-term duration.

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This vertical integration strategy, when used for the expansion of the sector in the Midwest, this brings about the concentration of income in the hands of a few producers mill owners. Economic activity in the region decreases due to the increased use of larger suppliers capable of endereças the demands of large-scale owner / mill owner.

On the other hand, the strategy of horizontal coordination, where land acquisition gives rise to new contractual arrangements through the lease and formalizing partnerships production, causes a greater extent, the landowner and agricultural entrepreneur, continue ahead of production, and thus using more intensively local resources as manpower, suppliers of implements, products or services. The economic activity of such regions tends to be more dynamic and diverse.

But the question is what leading the adoption of vertical or horizontal strategy by sucroalcoleiras companies in the process of expanding into the region in southern Goiás? Which specificities found on the sector´s expansion to the Midwest have caused or intensified such behavior?

The hypothesis with which it works is that from the mid-2000s changed the profile of new entrants who favour new contractual arrangements in order to guarantee the flow of sugarcane production, at the expense of the vertical integration model adopted until that time by traditional entrants.

The reasons for this change is based on 2 elements: the change of profile of the owner-investor and prior presence of an established culture of using these institutes of lease and partnership that allows the new business owner to access the areas of planting without necessarily having to acquire the land
But why the new business owner profile do not accept or not prefer land acquisition anymore?
Research shows that this type of investor now has a profile of predominantly large business group , who pay attention on the scale production and at generating business cash flow instead of traditional family business which has in the real estate valuation of the land one of the attractive for the business.

The consequences of these differences for the community that receive the projects are various and belongs to social and economic dimension. To illustrate the two types of situation, the research presents two case studies of mill that expanded to the territory of Goias after 2000s - The Vale do Verdão - family management mill with access to vertical cane (sugarcane own strategy on own land acquired from the owners of the region) and the Tropical Bioenergy, a BP group business that uses horizontalized strategy, ie, does not have its own land for planting sugarcane and its supply is 100 % coming from the partnership , independent leasing and cane supply contracts .

The methodology used for the research was based on analysis of primary data collected from the companies presented, representation of business institutions. In addition, secondary data helped explain some impacts initially planned in the surrounding communities. Such analyzes and conclusions were validated with two field visits where interviews with community members and businesses surveyed supported the conclusions presented here.

10:00 AM Diesel Displacement in the Sugarcane Ethanol Life-Cycle: A Comparative Analysis of Different Integrated Systems

Simone P Souza[1,2] and Joaquim E. A. Seabra[1], (1)Department of Energy, University of Campinas (UNICAMP), Faculty of Mechanical Engineering, Campinas, Brazil, (2)Sustainability Program, Brazilian Bioethanol Science and Technology Laboratory (CTBE) – CNPEM/ABTLuS, Campinas, Brazil

Abstract:
Integrated crop systems have been proposed as an alternative to enhance the efficiency and to improve the interaction among bioenergy, food and chemicals production (Cherubini, 2010). They can be able to produce such products from different raw materials (Taylor, 2008) and, additionally, may reduce the commitment of land for bioenergy production and provide diversification and optimization of agricultural systems (Cavalett et al., 2011; Souza and Seabra, 2013).

The biodiesel and the sucroenergetic sectors in Brazil are already important model of biorefinery due to the diversity of products and the opportunities to use the residues as fertilizer, energy source, irrigation, and others. However, there is still potential for improvement and other integration alternatives for these sectors (Bonomi et al., 2012; Lombardi et al., 2009; Oliverio et al., 2007; Ometto et al., 2007;

Pereira et al., 2014). The integration in the crop and industrial systems can improve the environmental aspects over the life-cycle, such as reducing the GHG emissions and the fossil energy use.

In previous works (Souza and Seabra, 2013; Souza et al., 2013, 2012) we assessed the gains of the integrations between palm-sugarcane (PSIS), soybean-sugarcane (SSIS) and algae-sugarcane (ASIS) in terms of GHG emissions and fossil energy use. In this work, we aim to demonstrate a comparative analysis among these systems and to indicate the advantage and disadvantage of each integrated system, focusing the diesel displacement in the sugarcane ethanol life-cycle.

10:18 AM Direct and Indirect Impacts of Agricultural Land-Use Due to Increased Production of Grain-Based Ethanol in Kansas, USA: A County-Level Analysis
Jason Bergtold and Brian Lauer, Agricultural Economics, Kansas State University, Manhattan, KS

Abstract:
Applied economists have dedicated much literature to the design and specification of acreage allocation models for land use decisions. These models can play an important role in understanding how acreages might shift in the event of new policy or in a changing agricultural landscape, especially with the increasing demand for biofuel production. Furthermore, the increase in ethanol production over the past two decades has impacted markets for corn and grain sorghum in Kansas, USA, especially with the prospect of grain sorghum being classified as an advanced biofuel feedstock. The increased production of the ethanol within Kansas has had an impact on local markets and the intensity of agricultural production in these areas. The presence of an ethanol plant can impact the prices of crops in the local market; the outlets for marketing grain by farmers and elevators; and the intensity of crop production in the vicinity of the plant. The direct changes in land-use production from a stronger ethanol industry in the state will likely lead to indirect changes in the use of agricultural land, as well.

The purpose of this paper is to examine the direct and indirect impact on agricultural land-use from increased ethanol production in Kansas.

The study utilizes acreage allocation models designed in the agricultural economics literature and builds on these previous acreage allocation studies by correcting for spatial autocorrelation; spatial proximity to ethanol refineries using capacity as a function of distance to a refinery as an explanatory factor in the model; and by incorporating changes in agricultural land-use in neighboring counties to capture potential indirect land-use changes. Bioenergy is an important agricultural topic to the state of Kansas, and understanding how the presence of ethanol plants effects producers' acreage decisions is critical as the bioenergy industry moves forward and new policies are developed. This study uses a 1996-2009 Kansas county level dataset for analysis. Variables that will be examined include shifts in acreage allocated to crops in neighboring counties, expected input prices, production costs, livestock populations, government programs, site and soil characteristics, weather, and ethanol plant characteristics such as proximity to a county and size of the plant. Models will be estimated for dryland corn, wheat, sorghum and soybean. The methods in this paper will follow methods proposed by Wu and Brorsen (1995) which extended the HEAR model proposed by Kmenta (1996) to a set of seemingly unrelated equations. These methods will be expanded to take account of spatial dependence.

Results indicate that own- and cross-price effects of crops and the capacity/proximity to an ethanol refinery have had significant impacts on the crop acreage allocated to the production of corn and grain sorghum. In addition, using the spatial lags of shifts in crop production in neighboring counties allows for

the derviation of spillover marginal effects of these on within-county acreage allocation to help capture indirect effects on crop land allocation decisions. Results from the paper will help to assess the agricultural land-use impacts from the expansion of the ethanol markets in the U.S. and the impacts of U.S. bioenergy policies.

RCN Conference on Pan American Biofuels & Bioenergy Sustainability

Golden Tulip Recife Palace, Recife, Brazil
July 22-25, 2014

Technical Program
Thursday, July 24, 2014: 01:00 PM - 04:00 PM

Thursday, July 24, 2014: 01:00 PM - 04:00 PM, Boa Viagem Room
NGO-Government Perspectives on Biofuel and Bioenergy
Chair: Dulce Benke, Conservation International, Americas
Co-Chair: Andre Guimaraes, Conservation International, Brazil

Session Overview:
This session seeks abstracts on case studies or other projects involving non-governmental organizations (NGOs), government organizations, or collaborative actions to address biofuel and bioenergy sustainability.

1:00 PM	Activists Follow As Markets and States Transnationalize Northeast Brazilian Sugarcane, 1954-1989 . **R. Pinto**
1:25 PM	Assessing the Sustainability of Ethanol Production in Mexico from Three Crops . **C. García**
1:50 PM	Sustentability: socioeconomic and environmental considerations . **R. Frazao**
2:15 PM	Market mechanisms for sustainable production . **G. Nardelli**
2:40 PM	Future scenarios for the expansion of bioenergy and its potential impacts . **M. Moreira**
3:05 PM	Roundtable Discussion of Key Research Issues and Challenges

1:00 PM Voluntary Certification: Market Mechanism for Responsible Production
Aurea Maria Brandi Nardelli, Roundtable on Sustainable Biomaterials, Belo Horizonte e Região, Brazil

Abstract:
Certification is a set of activities performed for verifying if a process or product meets the requirements of a standard. It is a mechanism widely used in many sectors of industry. The objective is to provide independent confirmation that defined standard is being achieved. The evaluation process usually results in certified products, which can be labeled and recognized in the market.
The demand for sustainability certification is growing in many sectors. Particularly after 2007, biofuels and biomaterials are being asked to implement standards for responsible production. This is a result of new regulations, in special in Europe and US markets, and also a demand of many other stakeholders. Buyers, investors, workers, communities and customers are concerned about the negative impacts of the production and use of bioenergy and biofuels and are requiring additional guarantees that all operators along the supply chain, from field to final user, are applying responsible practices.

The objective of this presentation is to contribute to the understanding of voluntary certification schemes as a mechanism to improve responsible practices in bioenergy and biofuels sector. Sustainability standard, when effectively implemented by the organizations, is a powerfull tool to consolidate a management system that guarantees best social, environmental and social performance.

The Roundtable on Sustainable Biomaterials (RSB) is an international multi-stakeholder initiative that brings together farmers, companies, non-governmental organizations, experts, governments, and inter-governmental agencies concerned with ensuring the sustainability of biomass and biomaterial production and processing. Its certification system is based on sustainability standards encompassing environmental, social and economic principles and criteria. Originally set up in 2007 to ensure the sustainability of liquid biofuels for transport, the RSB expanded its scope in 2013 to cover biomaterials.

1:25 PM Activists Follow As Markets and States Transnationalize Northeast Brazilian Sugarcane, 1954-1989
Rodrigo Pinto, James Madison College of Public Affairs, Michigan State University, East Lansing, MI

Abstract:
History not only repeats itself in patterns that are again evident in the recent expansion of bioenergy production, but also informs current perspectives of key cause-oriented organizations such as the Pastoral Land Commission (CPT—*Comissão Pastoral da Terra*), whose office for Northeast Brazil remains based in the same city of Recife where this conference takes place. Examples of these historical patterns include commonalities in how Peasant Leagues opposed the expansion of sugarcane production for sugar, alcohol and ethanol during the 1950s-1964 period on the one hand and in how the CPT sharply opposed the recent expansion of sugarcane for ethanol on the other. Both the distant and the recent oppositions are mainly based on a sense that the expansion of sugarcane production has an indirect negative impact on land redistribution. As for how the past informs the present, two terms used in the title of this conference serve to exemplify those historical legacies: CPT's well-known preference to frame bioenergy as 'agro-energy' as well as its distinctively third worldist understanding of 'Pan American.'

Briefly and transnationally, this presentation analyzes how markets and states shaped an activist campaign that shares historical patterns and legacies with more recent bioenergy campaigns following

its own 1954-1989 timing. The campaign initially mobilized after world sugar prices rose in 1945 such that as of the early 1950s landowners increasingly maximized their sugarcane output by pressuring their wage laborers to produce more and by converting to sugarcane land that had previously been allotted or rented to peasant sharecroppers or tenants. Next, the struggle cohered in 1955 during the 1st Peasants' Conference of Pernambuco (*1º Congresso de Camponeses de Pernambuco*) with support from the chairperson of the United Nations Food and Agricultural Organization (FAO)—namely, Josué de Castro. The campaign subsequently grew more intense between a 1959 Cuban revolution that brought foreign communist support to the struggle, a U.S.-supported invasion of Cuba in 1961 that instilled in campaigners the fear of a similar invasion into Brazil, and a U.S.-backed 1964 Brazilian regime transformation—from democracy to autocracy—that demobilized the campaign. The campaign then shrank in quantity and moderated in quality through exile and/or U.S.-funded repression and cooptation of the relatively more radical activists. It later reinvigorated with Brazilian expansion of bioenergy production in response to the 1973 oil shock, eventually leading to the foundation of the aforementioned CPT in the late 1970s. The campaign ultimately dissolved with the 1989 disbanding of the Soviet Union. The northeast Brazilian city of Recife, which harbors the port from which most Brazilian sugar was exported abroad during the campaign, remained the campaign epicenter from 1954 to 1964 and an important campaign hub throughout the 1954-1989 period. This centrality is evident in the prominent international visitors that Recife hosted during these years, including U.S. Secretary of State Henry Kissinger, U.S. politician Edward Kennedy, U.S. bureaucrat Sargent Shriver, U.S. activist Ralph Nader, Pan-American Che Guevara's mother, and fatefully not U.S. president John Kennedy—whose assassination brought to an end plans honoring the statesman's wish to visit Recife in the heart of what he had famously described as "the most dangerous area in world."

The presentation focuses on process-tracing how markets and states shape cause-oriented action in transnational relations. It traces market and state causalities through two processes: one variously known as internalization or defensive transnationalism and to a lesser extent another known as radiation from supply chains certified to be socio-environmentally responsible. These process-tracings tend to feature the activisms of cause-oriented actors such as CPT and sugarcane labor unions getting themselves into some tension with one another.

1:50 PM Assessing the Sustainability of Ethanol Production in Mexico from Three Crops
Carlos García, Environmental Sciences, Escuela Nacional de Estudios Superiores Unidad Morelia-UNAM, Morelia, Mexico

Abstract:
The Mexican transportation sector is the largest energy consumer in the country and depends mostly on gasoline. One of the promising alternative fuels according to the experiences of other countries is ethanol. Despite the increasingly important use of ethanol as an alternative fuel, criticisms have arisen production as researchers have warned of negative effects such as CO_2 emissions, biodiversity loss , high use of water resources, and food security. To study aspects of the sustainability of ethanol production in Mexico, a Sustainabilty Index (ISUS) was defined using the following indicators: GHG reduction, water use, land use, number of jobs created, and economic costs involved in the lifecycle of each ethanol production modality. Then, calculation of ISUS was performed using the named indicators, previously normalized and applied to three different feedstocks, sugar cane, maize and sorghum. Results show that the best option in terms of sustainability was the production of ethanol from sugarcane direct juice with export of electricity.

Thursday, July 24, 2014: 01:00 PM - 04:00 PM, Candeias Room
Brazilian Biofuel and Bioenergy Sustainability Issues and Case Studies
Chair: Arnaldo Walter, University of Campinas-Unicamp, Campinas, SP, Brazil

1:00 PM	Biofuel in Brazil: Soybean and Palm Oil Impacts on Socioecological Systems . **F. Martinelli**, **T. Martins**, and R. Medeiros
1:20 PM	Process Integration Case Study for the Second Generation Ethanol Production . S. Rouzinou, **P. Brito**, and V. Pylkkanen
1:40 PM	Bioenergy Production through Microalgae in Brazil: An Activity Joint with Ethanol Plants of the Country . **L. R. Holanda** and F. S. Ramos
2:00 PM	Socioeconomic Aspects of Sugarcane Producing Municipalities in Brazil . **P. Gerber Machado Sr.**
2:20 PM	Analysis of the Viability of Ethanol Production in Brazil: Economical, Social & Environmental Implications . **I. Alvarez Murillo**
2:40 PM	Socioenvironmental Aspects of the Palm Oil for Biodiesel Production in the Center of Endemism Belém - Brazil . **G. S. Pereira**, **R. Medeiros**, **B. H. Coutinho**, and **T. Martins**
3:00 PM	Roundtable Discussion of Key Research Issues and Challenges

1:00 PM Biofuel in Brazil: Soybean and Palm Oil Impacts on Socioecological Systems

Fernanda Martinelli, Sustainable Development Practices Graduate Program, UFRRJ/ Conservation International Brasil, Rio de Janeiro, Brazil, Tatiana Martins, Sustainable Development Practices Graduate Program, UFRRJ/ International Center of Studies in Sustainable Development, CIEDES, Rio de Janeiro, Brazil and Rodrigo Medeiros, Department of Environmental Sciences, Federal Rural University of Rio de Janeiro / Conservation International, Americas Center for Sustainability

Abstract:
The increasing concern about global warming and the uncertainty of oil prices have generated much interest in alternative fuel sources to petroleum, especially biofuels. Biofuels are liquid fuels produced from biomass, and ethanol and biodiesel are the world primary liquid biofuels used for transportation. In Brazil, more than 70% of biodiesel production is from soybean crops, which is currently the only oil crop available for large-scale biodiesel production. The Brazilian soybean expansion started in the early 1970s driven by global market forces that lead government to heavily subside this crop and invest in transportation infrastructure needed. Since then, Brazil has invested in soybean production and became the world's second biggest producer. Although it brought countless economic benefits, it also ended up in significant impact on biodiversity and ecosystem services, especially if plantations replace Cerrado or Amazon rainforest. Further, highly mechanized large-scale industrial soybean plantations might lead small-scale farmers' displacement into Amazon forested areas to use them for agriculture or cattle ranching

In order to promote rural social and environmental development, government has enacted political measures to support different sources for biodiesel, and oil from palms has the potential to be a major contributor. Although Brazil has not yet reached full-scale production, the country has followed the global trend and doubled its production area during 2001-2009, from 46 to 109 thousand ha and projected scenarios predict major expansion in the next few years. In order to avoid the same impacts of past large-scale soybean expansion, two important measures were set: the Social Fuel Seal Program and the Zoning for palm oil in Amazon. The Seal Program has encouraged partnerships between biodiesel companies and small scale farmers by contractual agreements, where biodiesel refineries buy at least 15% of their total palm oil from small-scale farmers. SFS companies receive tax benefits and priority in biodiesel auctions. The Brazil's agro-ecological zoning for palm oil limits production only to degraded lands without environmental legal restrictions, and the removal of native vegetation for planting palm oil crop is forbidden. From this restriction, suitable areas for oil palm went down from 2.32 million to 704.066 km^2 which represents 14% of Legal Amazon.

Although legal regulation and tax incentives are important to promote a sustainable biodiesel production, they might not achieve the targets they were supposed to. The world biggest palm oil producers Indonesia and Malaysia's experiences suggest that Brazil should expect land use changes challenges and unanticipated effects. Some effects might come from the remoteness for supervision of palm production poles, displacement of farmers who do not accept palm crop, as well as environmental consequences for communities regardless indirect and illegal direct deforestation.

Because soybean and oil palm are most intensively cultivated in high biodiversity sites, any future intensification of these crops without proper mitigation guidelines will likely further threaten the high concentrations of globally endangered species in these areas. Our paper intent to compare soybean and palm oil production impacts on biodiversity, ecosystem services and local community by evaluating 1) Land use change, 2) Agrochemicals use, 3) Soil, Water use and GHG emissions, and 4) Job creation and inclusive growth. These indicators were assessed in a literature-based inventory of the sustainability of

major biofuel production systems, based on current certification and production practices (RSB, RSPO, RTRS) in major production areas.

Since soybean is a consolidated crop in Brazil and the impacts are widely known, we can anticipate the future impacts and promote a more sustainable large-scale palm oil production in Amazon and help stakeholders to set better production practices for both soy and palm. This comparison was taken from available published data through literature research. We analyzed impacts of soybean and palm oil biofuel production systems in different tropical regions where these crops are relevant.

1:20 PM Process Integration Case Study for the Second Generation Ethanol Production

Sophia Rouzinou, American Process Inc, Athens, Greece, **Paulo Brito**, Granbio, Sao Paulo, Brazil and Vesa Pylkkanen, American Process Inc., Atlanta, GA

Abstract:
Co-location and integration of sugar mills and first generation ethanol mills with flexible bio-refineries can enhance biofuel and biochemical's production sustainability. Integrating second generation biorefineries to existing sugarcane mills represents a promising opportunity to reduce both capital and product cost.
The decisions of converting an existing plant to a second generation biorefinery or the optimum configuration of a green field integrated biorefinery should be a strategic decision. Biorefinery options include synergistic parallel facility, byproduct utilization and holistic production process realignment. Because of site consideration, a different approach may be necessary in each plant. Energy consumption implications are critical. Furthermore, integration of the new process with the existing equipment plays a key role for a successful implementation.
Application of Process Integration techniques and Pinch technology are therefore essential for early evaluation and design of novel biorefinery process concepts. Process Integration and Pinch technology combined with simulation modeling are powerful tools for reliable and quick feasibility analysis and techno-economic evaluation of different options. The optimum integration schemes are identified and the process energy consumption is optimized, while concurrently considering the capital cost.
The main principles and methodology of Process Integration and Pinch technology will be presented. An example of feasibility analysis and identification of the best options for a second generation biorefinery integration, with the use of Process Integration and simulation modeling, will be presented.

1:40 PM Bioenergy Production through Microalgae in Brazil: An Activity Joint with Ethanol Plants of the Country

Laryssa R. Holanda, Production Engineering Department, Federal University of Pernambuco - UFPE, Recife, Brazil and Francisco S. Ramos, Economics Department, Federal University of Pernambuco - UFPE, Recife, Brazil

Abstract:
This paper proposes a process for the production of microalgae for electricity generation, regarded as a joint activity with ethanol in order to meet the expected increase in energy demand caused by economic growth in Brazil. Microalgae are efficient in generating electricity, as by burning a ton of the biomass are generated 8.12 MWh. The production of this alternative energy source in conjunction with an ethanol plant maximizes the production of both, as it reduces the costs of production of microalgae using waste from the ethanol plant and the reduction of idleness of its equipments, furthermore brings benefits the

environment, with the microalgae capturing the carbon dioxide emitted by the ethanol plant. The production process proposed sum revenue from carbon credits, selling oxygen and electricity.

2:00 PM Socioeconomic Aspects of Sugarcane Producing Municipalities in Brazil
Pedro Gerber Machado Sr., FEM, UNICAMP, campinas, Brazil

Abstract:
Government policies to support the production of ethanol from sugar cane , large availability of land and a favorable climate , ie tropical, with good rainfall and temperatures , have made Brazil a global leader in this field . In 2009, Brazil accounted for 33 % of global production of ethanol and was also the largest exporter (HERRERAS, 2013). The importance of the sector to the economy has taken large proportions, especially in the last four decades. In 2008 participation in the Brazilian GDP reached 2 %, generating more than 1,280,000 formal jobs (UNICA, 2011). The number of plants in 2010 was 413, with 103 producing only ethanol, 11 producing sugar and 297 mixed (MAPA, 2010).
The scale of production of sugarcane and ethanol, as well as the growth of consumption, which is a consequence of the introduction and success of flex vehicles in the Brazilian fleet, justifies the analysis not only of environmental aspects, but also social and economic issues, including its contribution to the development of the country and the regions in which it operates
This article aims to analyze the socio-economic aspects associated with the production of sugarcane in two major producing states: São Paulo, the largest producer in the Center-South region, and in the country, and Alagoas, the largest producer in the Northeast. To do so, regularly compiled municipal indicators were used and disclosed by official Brazilian government agencies. The cluster method was used to separate in a non-biased way two groups: with higher and lower socioeconomic indicators.

2:20 PM Analysis of the Viability of Ethanol Production in Brazil: Economical, Social & Environmental Implications
Isabel Alvarez Murillo, Rotary International, Montreal, QC, Canada

Abstract:
The global dependency on fossil fuels as energy sources has encouraged many countries to look for different renewable alternatives. Some have come to consider biofuel production as the ‘solution’ to the oil dependency. The leaders of ethanol production in the world are the United States and Brazil. This paper will focus on ethanol production in Brazil, outlining its development through Brazil’s history as well as the advantages and the negative impacts of such a market. The importance of this energy source in Brazil’s economy and the possible future outcomes of Brazil’s biofuel dependency will be discussed. Three different aspects of primary impacts will be highlighted: economic, environmental and social. The effects of the new advancements in emerging biofuels will be discussed as they pertain to the current market for first-generation biofuels. An analysis of the economic impacts of ethanol will concentrate on the influence of the American ethanol market and its policies on Brazil. The environmental impacts of land use change, with a focus on soil, water and biodiversity, will also be reviewed. Likewise, the social impacts associated with food security, sugarcane workers and indigenous peoples’ rights will be discussed. An overall view of the repercussions of biofuel production will be presented and questions regarding the viability of the biofuel market in Brazil will be addressed.

2:40 PM Socioenvironmental Aspects of the Palm Oil for Biodiesel Production in the Center of Endemism Belém – Brazil

Gustavo Simas Pereira[1], **Rodrigo Medeiros**[2], **Bruno Henrique Coutinho**[3] and **Tatiana Martins**[4], (1)IFRJ/RJ and UFRRJ/IF/DCA, IFRJ and UFRRJ, Rio de Janeiro, Brazil, (2)Conservation International, RIO DE JANEIRO, Brazil, (3)UFRJ, Rio de Janeiro, Brazil, (4)UFRJ and CI, Rio de Janeiro, Brazil

Abstract:
In Brazil the use of biofuels to replace the fossil fuels is not new. According Gazzoni (2013), the country search for oil sources for power generation (biodiesel) since 1920. Recently, the National Program for Production and Use of Biodiesel (NPPB), created in 2004 by the Brazilian government, has the objective to increase the production of biodiesel from oilseed crops, including palm oil (*Elaeis guineensis*), in the North and Northeast regions, against the Brazilian biodiesel production focused on soybean in the central west region (ANP, 2012). The program is an attempt to associate the production of renewable sources with socioeconomic development and environmental protection.

In order to include the small farmer (out of soy) (NPPB) set different taxes depending on the origin of the raw material, with the biggest discount to that produced by small farmers in the North and Northeast regions of Brazil. The biodiesel producer to receive the tax benefits in the selling price in the auction, must possess the Social Fuel Seal (established by Decree No. 5,297 of December 6, 2004). The seal is a guarantee that the producer buys its raw materials from family farmers - framed in the National Program for Strengthening Family Agriculture (PRONAF) - with the purchase and sale contracts, with fair price, in percentage established by the Brazilian government and offering technical assistance and training to this population.

The NPPB, has the legal apparatus the Law No 11.097 of 2005 (BRAZIL, 2005), which introduced the biodiesel into the Brazilian energy matrix and established the mandatory use of 2% biodiesel blended with petroleum diesel, with increases gradual coming to current levels (2014) of 7% of the total volume. Thus, the Brazilian government created a demand for this biofuel, causing between 2005 and 2011 biodiesel production jumped from 736 m3 to 2.6 million m3. During this period the acreage of soybeans increased by 29.4% bringing the total to 24 million hectares, producing over 75 million tons of grain.

However, soy failure to meet inclusion of family agriculture, one of the goals of PNPB, due your characteristic of a culture whose production is highly mechanized. In this sense, a culture that has great potential to include smallholders in the supply chain is the palm oil.

One of the possibilities to increase biodiesel production is the use of already degraded areas in the Amazon, where they could be used for growing perennial oilseed species such as palm oil. This possibility is indicated in the study conducted by Embrapa, the Agro-Ecological Zoning Palm oil / AZP (EMBRAPA, 2010), which identified more than 700.000 km² with a good possibility for biodiesel generation in order to ensure its sustainable expansion. This area is equivalent to about 14% of the Legal Amazon. It is noteworthy that these areas indicated by AZP are within the same regions identified in the National Agro-Energy Plan (PNA, 2011), who identified the regions in Brazil that have characteristics suitable agricultural production focused on power generation.

In the Brazil we can identify that the production of biodiesel (with the palm oil) is concentrated in the states of Pará and Bahia, that the area under cultivation increased by 39% and 18% respectively since 2011. During 2001, the crop intended the palm oil occupied a total of 85,240 hectares, mainly in the North and Northeast regions. In 2011, the area under cultivation reached 109,080 hectares, equivalent to about 30% increase when compared to 2001. Pará state has the largest city in Brazil with dedicated to the cultivation of Elaeis guineensis, Tailândia area with 20,893 hectares, that between the years 2001 and 2011 increased your area of palm oil by 34% (following the state average). Another highlight (among the 21 municipalities) is the city of Moju who increased by 270% to your area, reaching a total of 7,093 hectares.

The Amazon Rainforest is a mega-diverse environment that has a large territory with about 6,5 million km², housing almost 20% of existing species on the planet. Many of the species found in the Amazon do not exist elsewhere on the planet. These are called endemic species and are located in certain geographical regions with their own characteristics. Given these unique characteristics and using the great water courses, different authors (CRACRAFT, 1994; HAFFER & PRANCE 2001; SILVA et al, 2005) classified the Amazon biome in eight centers of endemism: Napo; Imeri; Guiana; Inanbari; Rondônia; Tapajós; Xingu and Belém. Among the centers of endemism, the Belém (CEB) has the highest deforestation rate, with almost 70% of its impacted area, a situation which is explained by higher occupancy and urban density in this region (ALMEIDA & VIEIRA, 2010).

The present work aims to identify areas for expansion of palm oil (*Elaeis guineensis*), in the Amazon, in particular Center of Endemism Belem and present an socioenvironmental characterization of the micro-region Tomé-Açú, focused on the expansion of palm oil region. The growth areas were identified based on the results published by other authors through literature to scientific articles, theses, legal documents and other publications relevant to the topic search. The socioenvironmental characterization was carried out from the base of the Brazilian Institute of Geography and Statistics (IBGE) and the National Institute for Space Research (INPE) where forest cover data were analyzed; degraded areas; farms; protected areas; agricultural settlements; deforestation; among others. ArcGis10.1 using the program, data were compared with the Agro-Ecological Zoning of Palm oil in order to verify the impact generated by palm oil cultivation in the region.

According to Sakamoto (2013), within the CEB, in the state of Pará, are found some of the main units of production of biodiesel from vegetable oil using the Palm oil as feedstock. This production is being held in an area of approximately 140,000 hectares, reaching almost 470,000 hectares in the coming years, after the consolidation of expansion projects by 2020. Besides the large and medium-sized companies, palm oil production has the participation of local community in nuclei of family farmers in area a nearby 20 thousand hectares (to year 2010). Between 2010 and 2012 over 581 families (in 5,810 ha) were added to the partnership programs of Amazônia Bank (BASA) for the production of palm oil.

It is estimated that for the 2012/2013 crop the Amazônia Bank have the partnership with over 1,610 contracts in an area of 15,300 ha to the palm oil. This expansion of palm oil enabled the inclusion of 2,191 new families (in 21,110 hectares) in the last three years. On average each family occupies 10 hectares and can get an average of R $ 2,000 monthly between the fifth and eighteenth year of life of the palm oil when it reaches the height of its productivity, totaling R$ 24,000 per year (SAKAMOTO, 2013).

With indications that the state of Pará has a prominent role in the production of palm oil and also has a set of degraded with potential for cultivation of palm oil (identified by AZP), was determined the regions with the greatest potential for socioenvironmental development of palm oil plantations. Thus, was highlighted the micro-region of Tomé-Açú (five municipalities: Acará; Concórdia do Pará; Moju; Tailândia and Tomé-Açú) with great aptitude expansion of palm oil plantations.

Thursday, July 24, 2014: 01:00 PM - 04:00 PM, Piedade Room
Industry-Government Perspectives on Biofuel and Bioenergy
Chair: Abraham Sicsu, General Office of Science and Technology, Recife Brazil

Session Overview:
This session seeks abstracts on industry and government initiatives and project on biofuel and bioenergy sustainability.

1:00 PM	Bioenergy and Biofuels: Presentation . **A. Sicsú**
1:20 PM	Commercial Experience of Rapid Thermal Processing (RTP) of Sustainable Biofuels . **M. J. Cleveland** and D. Szeezil
1:40 PM	The Sustainability of Biofuels in Brazil . **S. T. Coelho** and J. Goldemberg
2:00 PM	Bioethanol Industry Perspectives in Brazil . **J. G. Eugenio de França**
2:20 PM	Bioenergy in Northeastern Brazil: Opportunities and Challenges . **R. S. Cezar Menezes** and C. de Lima Júnior
2:40 PM	Forest Biomass Harvesting and Site Productivity: Is Policy Ahead of Science? . **E. D. Vance**, W. M. Aust, B. D. Strahm, R. E. Froese, R. B. Harrison, and L. A. Morris
3:00 PM	Roundtable Discussion of Key Research Issues and Challenges

1:00 PM Bioenergy and Biofuels: Presentation
Abraham Sicsú, UFPE, Recife, Brazil

Abstract:
The proposal of this specific table of discussion on Government and Industry interface for Bioenergy and Biofuels on the view that the action of the state in regulating and supporting the sector in Brazil has always been strategic and essential to the definition of a pattern of sectorial development. In this direction, as political issues for the feasibility of public and private investment; impacts in relation to the environment; labor relations; government regulation for the production and trading of electricity; promotion of research; agricultural zoning are the key points. The table was structured with the following proposal: a brief opening presentation. Eric will make a presentation of the important international experience in the commercial exploitation of energy forests and debate on ethanol and biodiesel. Suani also doing a presentation on biofuel sustainability in various aspects. As the topic of debate is vast it seems that will focus on the possibilities of introduction of raw materials and innovations that increase productivity and reduce the differences in agricultural productivity in certain regions. The need for public policies to support the development of supply chains is another important point. It seems very unlikely that the operation of the market alone would reach these guidelines. Geraldo Eugenio will put in context the perspective of the Ethanol Industry in Brazil, including the outputs of the current crisis and Marcelo Guerra, with a practical view of those who follow the daily lives of the sector, will present the view of the productive sector about the current situation and Brazilian prospect. Romulo Meneses will report on recent studies on the potential for energy recovery from biomass sources in the Northeast region with emphasis on biodiesel. He will present the reality of this specific sector and its prospects, including the technological stand point. In this debate four strands emerge as guiding practices. Agronomic Technology and agro-climatic conditions defined for the type of crop or raw material being used; agro industrial and industrial technology established and developed for production in small, medium and large scale; logistics and infrastructure for the production and circulation of goods in the economic production chain; the minimum scale of production, complementarity in production processes and simultaneity of production shares. All this items will be discussed for the development of an institutional arrangement that is being built between the State and Industry as effective partnerships.

1:20 PM Commercial Experience of Rapid Thermal Processing (RTP) of Sustainable Biofuels
Michael J. Cleveland, UOP LLC, A Honeywell Company, Honeywell do Brasil, Rio de Janeiro, Brazil and Dan Szeezil, Envergent Technologies LLC

Abstract:
Envergent Technologies is a biofuels technology licensor and equipment producer for RTP™ Rapid Thermal Processing, a proven route to convert low-value biomass residues into a high-value liquid biofuel. RTP Green Fuel production is cost-effective, virtually carbon-neutral and sustainable and can be used for renewable heat, power and, ultimately, transportation fuels.

Backed by Honeywell-UOP, a leader in the refining and petrochemical industries for nearly 100 years, and Ensyn, developer of the RTP technology with 20 years of commercial experience, Envergent offers a low-risk, high-reward solution for renewable fuels production.
The proposed presentation will cover the RTP technology highlighting the following:
Benefits of RTP Green Fuel

- RTP technology can utilize a wide range of biomass from eucalyptus and other trees to residues that are readily available such as bagasse and agricultural remains.

- RTP Green Fuel is a light, pourable clean-burning liquid that contains little sulfur and reduces greenhouse gas emissions by 70-90% compared to fossil fuels, depending on application
- RTP Green Fuel can be co-processed in a petroleum refinery FCC unit to produce a blended renewable fuel for transportation use
- RTP technology is virtually self-sustaining, using the co-products to generate much of the heat and power required to run the unit
- RTP technology provides biomass conversion into a liquid fuel that can be transported & stored for future use, fully decoupling the feedstock source from energy usage.
- Low risk, modular construction allows efficient site selection and accelerated commissioning

1:40 PM The Sustainability of Biofuels in Brazil
Suani Teixeira Coelho, University of Sao Paulo, Sao Paulo, Brazil and José Goldemberg, University of Sao paulo

Abstract:
The concept of sustainability has evolved considerably in the 20th century. Initially it was focused on the conservation of the landscape and biodiversity mainly in the advanced industrialized countries. The rapid growth of the world population and greater access to material goods in former undeveloped countries put strong pressures on mineral resources, leading to scarcity and increased environmental problems, such as urban air pollution and global warming. Sustainability concerns focused then on using such resources in a more rational fashion, ranging from increased efficiency to shifting the resources used, and privileging the use of renewable resources, particularly in the case of energy. The emphasis in this case is to find substitutes for the use of fossil fuels. One of them corresponds to the liquid biofuels, in which Brazil in the United States are the main producers. However, liquid biofuels sustainability is still seen as a controversial issue considering environmental and social aspects. Several studies have already discussed these issues with different points of view but today is a consensus that "bioenergy is not bad or good" but it depends on how it is produced. Contributing to this discussion, The Global Bioenergy Partnership (co-chaired by Brazil and Italy) has developed together with FAO (Food and Agriculture Organization) and UNEP (United Nations Environmental Program) a set of 24 bioenergy sustainability indicators (environmental, social and economic), accepted by all its member countries. Several if these countries are already implementing this methodology in Europe, Africa and Latin America for different types of bioenergy. Brazil had not yet applied it but now a new study is starting to be developed for sugarcane ethanol mills in São Paulo State by the University of São Paulo, funded by the Government of Italy/Forum of the Americas with the support of the Brazilian Federal Government and the Secretariat for Environment of São Paulo. In this presentation a general overview of sustainability issues for sugarcane ethanol in Brazil will be presented, as well as the general context and background of the GBEP indicators to be applied in Brazil. Despite the fact that there are several certifications schemes already in place, it appears that this GBEP indicators methodology is a consensus among the governments members of GBEP and could be a good experience for comparing bioenergy among the countries.

2:00 PM Bioethanol Industry Perspectives in Brazil
José Geraldo Eugenio de França, The Technological Institute of Pernambuco, Recife, Brazil

Abstract:
Brazil has a long history of biofuel production and use, and is the country that first developed a large scale program aiming the use of ethanol as an automotive fuel. The main feedstock for the Brazilian

ethanol industry is sugarcane, a traditional crop in the country since the XVI century. In the last ten years the country witnessed a boom in ethanol use, especially due to the development and marketing of the flexfuel (gasoline and ethanol) vehicles in 2003. By 2009, 90% of the new automobiles in Brazil were flexfuel what illustrates the effectiveness of this technology adoption. It is common sense that the economics effective ratio of the ethanol vs gasoline prices is 10 to 7. However in the last 4 years particularly due the high sugar prices in the international market the ethanol has shown a higher ratio and the consumers have dropped remarkably the use of pure ethanol preferring the use of gasoline that in Brazil is a mixture with 25% of ethanol. There has been a lot of discussion in the last few months on how the government can work with the sugarcane industry in order to reconquer the Brazilian market. It looks something interesting since in 2013/2014 the Brazilian industry has used 65% of its 9,3 million hectares of cultivated sugarcane for producing ethanol instead of sugar. After few years with the ethanol production stalled around 23 to 24 billion liters a year, the last year have witnessed a surge in the ethanol production reaching 28 billion liters. The country has also observed that a reasonable portion of this production has been sold abroad, what makes the local market extremely vulnerable and open for the outside competitors, particularly the corn ethanol industry of the USA. For a long term perspective it is clear that the ethanol industry has to use the bagasse for producing second generation ethanol even though this feedstock has become very valuable for energy production through cogeneration or as row material for sugar high valuable derivatives. The country still has an edge in ethanol production comparable with most competitors however it will be extremely indispensable to invest in research, development and innovation in its sugarcane industry as well as to update the research agenda on the production of biofuels from agricultural, industry and urban residuals since although the sugarcane acreage has increased it will not be enough to fulfill the local and international demand for sugar, ethanol and energy.

2:20 PM Bioenergy in Northeastern Brazil: Opportunities and Challenges

Rômulo Simões Cezar Menezes, Nuclear Energy Department, Universidade Federal de Pernambuco, Recife, Brazil and Claudemiro de Lima Júnior, Universidade de Pernambuco

Abstract:
The use of biomass sources for energy purposes is very relevant in Brazil. The same importance is observed in the NE region of Brazil, but there are regional sources that are still underutilized. Therefore, this subject deserves more attention from researchers and government officials to point the potential opportunities for the industry and other sectors. We have recently completed the "Atlas of Bioenergy in NE Brazil", in which we quantified the annual production of the main biomass sources with potential for energy recovery, for each municipality of the region. We also calculated the primary energy content of each biomass source. Similarly to the rest of Brazil, sugarcane bagasse, ethanol, firewood and charcoal were the sources with highest primary energy production. Several other sources with potential energy contribution are underutilized or are not used for energy purposes, such as the organic fraction of municipal solid waste, sugarcane vinasse, coconut shells and animal manure. Biomass conversion through anaerobic biodigestion, particularly in decentralized micro generation systems, could improve the energy recovery of several of these regional biomass sources. However, the region lacks the human resources and infrastructure to develop and support this route on a large scale. Information on the spatial distribution of these potential sources available, routes for energy recovery and suggestions of public policies to stimulate the use of these sources will be discussed.

2:40 PM Forest Biomass Harvesting and Site Productivity: Is Policy Ahead of Science?

Eric D. Vance, National Council for Air and Stream Improvement, Inc. (NCASI), Research Triangle Park, NC, W. Michael Aust, Department of Forest Resources and Environmental Conservation, Virginia Tech, Blacksburg, VA, Brian D. Strahm, Department of Forest Resources and Enviornmental Conservation, Virginia Tech, Blacksburg, VA, Robert E. Froese, School of Forest Resources and Environmental Science, Michigan Technological University, Houghton, MI, Robert B. Harrison, School of Environmental and Forest Sciences, University of Washington, Seattle, WA and Larry A. Morris, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA

Abstract:
Emerging bioproduct and energy markets provide incentives for harvesting greater quantities of biomass at shorter intervals and have raised environmental concerns, including effects on the productive capacity of forested sites. In response to these concerns, governments and non-governmental organizations have developed biomass harvesting guidelines (BHGs) with provisions for retaining specific proportions or quantities of biomass on site and restricting harvests on sites deemed sensitive. These guidelines are largely voluntary but may be incorporated in some form into forest practice mandates and certification systems. BHGs are well intentioned and based on a reasoned, conceptual understanding of the role of harvest residues in sustaining soil organic matter, nutrient availability, and future site productivity. Management restrictions come with economic and environmental costs, however, and the science supporting them deserves greater scrutiny. Field experiments show that forest responses to biomass harvesting vary widely and are often counterintuitive. With site-specific data lacking, BHGs tend to rely on default assumptions supported by best professional judgment. These include (i) the natural or unmanaged state is an ideal frame of reference, (ii) conventional harvesting retains and distributes most residues across the site, (iii) biomass harvesting removes virtually all residues, (iv) decomposing residues always enhance soil C and site productivity, (v) biomass harvesting is conducted without operational practices that alleviate site deficiencies and sustain productivity, and (vi) changes in forest state are equivalent to changes in forest function. While harvesting-induced nutrient deficiencies can be prevented or corrected with fertilizers or other soil amendments, soil disturbance and exposure may warrant greater attention. Effective BHGs are science-based, operationally feasible, and protect values of interest while allowing managers the flexibility to prevent or mitigate potential impacts within constraints imposed by existing forest practice rules, best management practices, and forest certification provisions.

Thursday, July 24, 2014: 01:00 PM - 04:00 PM, Imperial Room
Industry-Academic Perspectives on Biofuel and Bioenergy Sustainability
Chair: M. Regis L.V. Leal, Brazil Bioethanol Science and Technology Lab, Campinas Brazil
Co-Chair: Hayri Önal, Department of Agricultural and Consumer Economics, University of Illinois, IL, USA

Session Overview:
Industry and Academia are forming partnerships to address challenges and opportunities in biofuel production and sustainability. This session welcomes abstracts from research, demonstration, and commercialization projects from the Pan American region.

1:00 PM	Sustainability in Biofuel and Bioenergy Sectors: The Role of Public Policy . **H. Önal**
1:18 PM	Biofuels and Bioenergy Sustainability Assessment Methods . **D. Schuster** and L. Alexander
1:36 PM	Biogas Generation from Sanitary Landfill Leachate . **V. Mello**, V. Lima, S. Holanda, J. Ferreira, J. F. Jucá, and M. Motta Sobrinho Sr.
1:54 PM	The Potential Use of Waste Stabilization Ponds for Biofuel Production By the Microalgae Biomass . **M. Paiva**
2:12 PM	The Sustainability of Brazilian Sugarcane Ethanol: The Contribution of the Brazilian Bioethanol Science and Technology Laboratory (CTBE) . **M. R. L. V. Leal**
2:30 PM	Comparison of Acid and Enzymatic Hydrolysis of Jerusalem Artichoke Tubers for Fermentative Butanol Production . **T. Sarchami**
2:48 PM	Understanding Concentration and Pressure Changes during Ultrasonication-Enhanced Blending of Petrol-Ethanol Blended Fuel . **D. Nkazi**, M. O. Daramola, and S. E. Iyuke
3:06 PM	Roundtable Discussion of Key Research Issues and Challenges

1:00 PM Sustainability in Biofuel and Bioenergy Sectors: The Role of Public Policy
Hayri Önal, Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, IL

Abstract:
I will give an overview of the existing policies and the development of the biofuel and bioenergy sectors in the US and summarize the empirical findings of a large-scale economic simulation model we developed for the US agriculture and biofuel/bioenergy sectors. The talk will focus on the role of alternative policy designs, in particular the RFS blending mandates, subsidies, and trade policies. The model includes a Brazil component similar to the US component and we have conducted some analyses for the Brazil ethanol industry as well (impacts of ethanol pipelines, changes in gasoline pricing and blending mandates, etc.).

1:18 PM Biofuels and Bioenergy Sustainability Assessment Methods
Darlene Schuster, Institute for Sustainability, An AIChE Technological Community, New York, NY and Lucy Alexander, Institute for Sustainability, AIChE, New York, NY

Abstract:
This presentation from AIChE's Institute for Sustainability will explore biofuels and bioenergy sustainability assessment methods, focusing on supply chain and value chain, and safety, economic, social, and environmental concerns. Various popular methods will be compared on the basis of cost- and time-effectiveness, ease of use, flexibility, clarity of results, and other strengths and weaknesses. Also discussed will be the needs for and benefits of such assessments for bioenergy producers and users. The presentation will identify areas where more research is needed and what challenges exist for implementing assessment methods across the supply chain. Applicability will be compared for different types of energy producers, and specific recommendations will be made based on size, feedstock, location, process, products, and resource availability. The ways in which these factors are likely to affect attitudes, operations, impacts from a sustainability standpoint will be explored.

This paper will come from educational materials offered as part of the AIChE Credential for Sustainability Professionals.

1:36 PM Biogas Generation from Sanitary Landfill Leachate
Victor Mello[1], Valmir Lima[2], Sávio Holanda[3], Joelma Ferreira[3], José Fernando Jucá[4] and Mauricio Motta Sobrinho Sr.[5], (1)Engenharia Civil, Universidade federal de Pernambuco, Recife, Brazil, (2)Universidade Federal de Pernambuco, Recife, Brazil, (3)Universidade federal de pernambuco, Recife, Brazil, (4)Universidade federal de pernambuco, recife, Brazil, (5)Universidade federal de Pernambuco, recife, Brazil

Abstract:
The use of alternative sources of energy not only contributes to environmental sustainability and for diversifying the energy matrix, which in the case of Brazil , has a high renewable portion (45%). The possibility of obtaining energy when treating an effluent has been a current focus of fundamental and applied research, and the last developed by companies or partnerships with research institutions. The anaerobic degradation process generates a blend rich in methane (70 to 50%) to degrade solid or liquid contaminants. The generation of biogas from landfills is already a reality, with several installations in

operation in the country. However the treatment of leachate (liquid derived from the anaerobic degradation diluted in water from the landfill itself) is one of the main barriers to the installation of this type of disposal for waste, for its complexity , toxicity and recalcitrance. To estimate the potential for generation of biogas from waste is generally used the BMP test (Biochemical Methane Potential), which assesses the biodegradability of waste from the total production of biogas (containing mainly CH_4 and CO_2) under controlled conditions, knowing the initial composition of the waste and the conditions they are subjected to biodegradation (ALVES, 2008). However, the increase of pressure inside the bottle can shift the equilibrium of the reaction, underestimating the generation of biogas. It is noteworthy that the ratio F:M. (organic load/microorganism), the head-space of the bottle and the pH (which should be close to neutrality) may influence the production of biogas. Consequently, this study aimed to evaluate the influence of parameters mentioned in the production of biogas through a 2^3 full factorial design in BMP trials. All experiments were performed in triplicate. The leachate used was collected from the landfill leachate treatment unit of Muribeca and presented a COD of 3,066 $mgO_2.l^{-1}$, and pH of 8.3, which was adjusted according to the planning (6.0, 7.5, 8.5). The anaerobic sludge was provided by Brazil Kirin brewery (Guabiraba - PE). In parallel, a blank experiment, with only a white sludge, was realized to evaluate the biogas production with the organic matter of the sludge itself. In order to minimize the pressure effect, every time that it reached 0.8 bar, there was release of the bottle. Under the condition of 50 ml of sludge (VSS = 152.27$g.L^{-1}$) leached in 50 ml of pH 7.5, the production rate was 9.7 $ml.d^{-1}$and the total volume of biogas generated was 277 ml. The methane concentration in the biogas from leachate was 67% and in the bottle with only anaerobic sludge was 55%.

1:54 PM The Potential Use of Waste Stabilization Ponds for Biofuel Production By the Microalgae Biomass
Marcella Paiva, Civil engineering, UFPE, Olinda, Brazil

Abstract:
In the work the performance of a real scale polishing pond treating domestic wastewater in Rio Formoso city Southern coast of Pernambuco State, Brazil was evaluated. The principal objective was investigate the the potential use of waste stabilization ponds for biofuel production by the microalgae biomass Samples were taken monthly at two different times (2h and 14h) comprising a period of six months (from Janury till June of 2011) covering the rainy and dry seasons. It was observed that the phytoplankton community was represented by 40 taxa belonging to divisions Cyanophyta, Chlorophyta and Euglenophyta, being the Cyanophyta the most representatives comprising (45% from total). We found that the higher and lower biomass density was observed during January and June in both periods (diurnal and nocturne) These months represents respectively the dry and rainy periods in the region, showing that a higher sunlight penetration promote a higher algae growth on the water column. By the diagnosis of the potential use of algae growing in the polishment pond from Rio Formoso WWTP, it was possible to observe the biomass concentration, and to propose ways to optimize the biomass growth for an efficient and sustainable biodiesel production.

2:12 PM The Sustainability of Brazilian Sugarcane Ethanol: The Contribution of the Brazilian Bioethanol Science and Technology Laboratory (CTBE)
M. Regis L.V. Leal, Brazil Bioethanol Science and Technology Lab, Campinas, Brazil

Abstract:

The Brazilian Bioethanol Science and Technology Laboratory (CTBE) was created in 2010 by the Ministry of Science, Technology and Innovation (MCTI) as a research institution to fill the gaps in science and technology that had been identified in the production chain of sugarcane ethanol. As a national laboratory it is open to receive outside researchers, from universities, research centers and private companies, to use its facilities and staff expertise. The handling of the key technology gaps had been distributed in five divisions working in close association and focusing on improving the sustainability of our main biofuel:

- Biomass Production: designing a new concept of agricultural mechanization for sugarcane to reduce the production costs, negative impacts on the soil, greenhouse gas emissions and use of fertilizers and chemicals.
- Biomass Processing: develop the complete processing chain of sugarcane residues to second generation ethanol (2G), counting on a very flexible pilot plant and several supporting laboratories; the 2G ethanol is expected to decrease the production costs and land demand.
- Functional Biology, Biotechnology, and Biophysics: understanding the sugarcane plant physiology, cell wall structure and deconstruction and enzyme production.
- Integrated Evaluation of Biorefineries: process simulation for 1G/2G ethanol and other products from sugarcane.
- Sustainability of the Production of Biomass and Bioenergy: GHG emissions Lifecycle Analysis, land use change dynamics, soil carbon stock and emissions, impacts on water availability and quality, biodiversity and socioeconomic issues.

As a young institution CTBE has already been able to demonstrate that it is possible to bring the private sector and academia together in the search for more sustainable alternatives of bioenergy production from sugarcane. The mains projects in development will be briefly presented as well as the main partnerships with universities and private companies.

2:30 PM Comparison of Acid and Enzymatic Hydrolysis of Jerusalem Artichoke Tubers for Fermentative Butanol Production

Tahereh Sarchami, Chemical and biochemical engineering, University of Western Ontario, London, ON, Canada

Abstract:
In this study, a central composite design and response surface methodology were used to study the effect of various hydrolysis variables on both acid and enzymatic hydrolysis of Jerusalem artichoke-derived inulin. It was found that quadratic model was able to predict inulin conversion as a function of all investigated factors in both types of hydrolysis. The models were confirmed by additional experiments and via analysis of variance (ANOVA). Subsequently, numerical optimization was used to maximize the inulin conversion (94.5% in enzymatic hydrolysis and 96% in acid hydrolysis) of Jerusalem artichoke powder within the experimental range. The optimum conditions for enzymatic inulin conversion were a temperature of 48°C, pH of 4.8, substrate concentration of 60 $g.l^{-1}$, and enzyme loading of 10 unit. $g^{-1}_{substrate}$ in 24 hours. For acid hydrolysis using Sulphuric acid as catalyst, the optimum conditions were achieved at a temperature of 97°C, pH of 2.0, and in 35 minutes.

The hydrolysates of Jerusalem artichoke were fermented via solventogenic clostridia to acetone-butanol- ethanol (ABE). ABE yields of 0.33 $g.g^{-1}$ and 0.31 $g.g^{-1}$ were obtained using enzymatic and acid hydrolysates of Jerusalem artichoke, respectively. Acid hydrolysis produced HMF as fermentation inhibiting byproduct resulting in a lower yield compared to enzymatic hydrolysis. Therefore, enzymatic

hydrolysis of Jerusalem artichoke was found to be a more effective method of hydrolysis for butanol production.

2:48 PM Understanding Concentration and Pressure Changes during Ultrasonication-Enhanced Blending of Petrol-Ethanol Blended Fuel

Diakanua Nkazi, Michael O Daramola and Sunny E Iyuke, School of Chemical and Metallurgical Engineering, University of the Witwatersrand, Johannesburg, South Africa

Abstract:
Increasing global energy demand as well as air quality concerns have in recent years led to the search for alternative clean fuels to replace fossil fuels. One such alternative is the blending of petrol (gasoline) with ethanol, which has numerous advantages such ethanol's ability to act as oxygenate thus reducing the carbon monoxide emissions from the exhaust of internal combustion engines of vehicles. However, the hygroscopic nature of ethanol could cause phase separation of the blended fuel and this is a major concern in obtaining a perfectly homogenized petrol-ethanol fuel. Phase separated petrol-ethanol fuel could cause irreversible damages to internal combustion engines. Formation of perfectly homogenized petrol-ethanol blend is the key to solving the problem [1] and this depends on molecular diffusion and eddy diffusion in the vertical and horizontal direction during the process. Several mixing methods such as impinging-jet micro-mixing, high-pressure homogenization techniques have been proposed as a measure to overcome the problem [2], but ultrasonication is the most promising of all.

Ultrasonic cavitation generated during ultrasonication is an effective type of dynamic agitation due to the growth and implosive collapse of bubbles in liquid as a result of ultrasonic vibration [3]. Also designing a blender to achieve perfectly homogenized petrol-ethanol fuels via ultrasonication-enhanced blending depends on the in-depth understanding of concentration and pressure changes during the mixing. Therefore in this study, investigation was conducted to investigate effect of the position of ultrasonicator's horn on the concentration and pressure changes during ultrasonication-enhanced blending of petrol-ethanol fuels. Understanding the concentration and pressure changes during the process could pave a way for the design of a blender to achieve a perfectly homogenized petrol-ethanol blend.

Petrol-ethanol mixtures were prepared and the ethanol concentrations in the mixtures were 10%, 20% and 30% v/v. A 2.5 l-beaker of diameter 1400 mm was using the blending. During the blending, the position of ultrasonicator's horn was fixed in the beaker and the concentration and pressure were measured at distance ranging from 10 mm to 40 mm away from the position of the horn to understand effect on the homogenization of the mixture. The measurement was conducted at both horizontal and vertical distance away from the horn. The pressure during the ultrasonication-enhanced blending was measured with an oscilloscope and the ethanol and petrol concentrations in the samples withdrawn at time intervals during the mixing were analysed with a pre-calibrated high performance liquid chromatography (HPLC).

Concentration gradient, energy gradient (indicated by pressure) and diffusion rates were higher in the vertical direction when compared to the behaviour in the horizontal direction, therefore making the diffusion in the horizontal direction a rate-limiting step. This suggests that the dimensions of the blender that will ensure perfectly homogenized mixture should have larger height-to-diameter ratio. In addition, the results reveal variation of pressure with time due to the changes in the ultrasound energy at different vertical and horizontal distances away from the fixed position of the horn. Between 120 and

360 seconds of the ultrasonication-enhanced blending, the pressure gradient became zero (a plateau), indicating a constant distribution of ultrasound energy, hence perfectly homogenization of the petrol-ethanol blend. The concentration profile with distance during the blending follows a wave function but the concentration of ethanol as a function of time in the mixture remained constant in the both horizontal and vertical distance away from the fixed position of the horn of the ultrasonicator. The observed behaviour could be exploited towards designing a blender with high efficiency for ultrasonication-enhanced blending of petrol-ethanol fuels.