

Trip report for Keith L. Kline and Virginia H. Dale
June 25, 2012
“The only thing worse than the henequen industry is not having one”
or
“It takes a village”

Itinerary:

May 26: Travel to Merida, Mexico, for the Research Coordination Network (RCN) Workshop on “Pan American Biofuels and Bioenergy Sustainability”
May 27 (Sunday): orientation to Merida and workshop venues
May 28: Workshop planning - met with workshop organizers and other session leaders
May 29-31: Formal workshop sessions with participants from 8 nations involved with bioenergy in the Pan American region (details below).
May 31 Pm - Field Trip: KuoSol Jatropha biodiesel and CDM projects
June 1: Meetings with participants and informal field research on agave as a potential bioenergy feedstock crop
June 2: Return from Merida to Oak Ridge.

Summary: The Research Coordination Network (RCN) Workshop on “Pan American Biofuels and Bioenergy Sustainability” is a project designed to develop and maintain collaborations that generate and share new knowledge on sustainability in the region. The by-invitation workshop and costs for all participants were supported by a grant from the National Science Foundation to Michigan Technical University (MTU). During workshop sessions on May 29-31, Dale and Kline each made presentations on Oak Ridge National Laboratory (ORNL) activities and presented six posters. Kline provided a model for structuring presentations by participants that was adopted by the other session leaders.

Kline served as a session leader (Water-Energy Nexus), break-out group facilitator (Research Collaborations) and group reporter (see Annex with breakout group notes). Dale and Kline also made substantive contributions to a proposed graduate level course curriculum on bioenergy sustainability – one of the products to be developed by the RCN – and to ideas for developing an outline for the regional research roadmap. In addition, Kline and Dale participated in field trips and additional discussions with workshop participants on May 28, 31 and June 1.

Kline and Dale participated in a series of side discussions related to potential collaborations on applications of standard indicators for sustainability, the Roundtable for Sustainable Bioenergy (RSB) certification scheme, the International Organization for Standardization (ISO) Standard development process, sampling and measurement protocols for soil carbon in forests used as bioenergy resources, and other issues of common interest.

The workshop agenda, list of participants, notes from field trips to KUOSOL (Jatropha biodiesel) and agave research/potential, and more detailed notes from specific workshop sessions and side discussions, are attached.

Workshop goals: The goals of the RCN workshop were to

- Foster collaboration in research on bioenergy sustainability across the Americas
- Help define challenges for establishment of sustainable bioenergy systems
- Become a more coordinated network and do research even beyond the scope of this project to define sustainable bioenergy
- Plan for a large workshop in two years
- Develop a web-based graduate course
- Determine communication strategies for interactions among the members of the network

ORNL contributions and interactions: Kline chaired the session on May 29 on the “Water-Energy Nexus.” In communicating the session goals to the participants before the workshop, Keith provided a format for presentations that was adopted by other session chairs and workshop organizers. Each speaker was asked to prepare three slides:

1. Name, relevant research and expertise (high level, topic areas), An internet link to research or teaching web page, Institutional and departmental affiliations (and internet link for more information)
2. One or two examples of current research that is most relevant to RCN, (Project title, goal, sponsor(s), funding level, timeframe, website if available), Relevance to this RCN
3. A bullet statement of what the presenter hopes to contribute to RCN, Two or three bullets describing what they wish to take away from the workshop, A question or suggestion that helps spark discussion can be included as a final bullet (optional)

Dale and Kline each presented a summary of the work in which they are engaged (those presentations are posted on CBES web site: <http://www.ornl.gov/sci/ees/cbes/>).

In her talk, Dale emphasized the work that ORNL is doing in defining and quantifying bioenergy sustainability as well as developing means to communicate about it. She presented the 12 indicators categories for environmental and socioeconomic indicators as well as an overview of the work that is being done to assess effects of bioenergy systems on profit, water quality and quantify, and biodiversity in east Tennessee. She said that her contribution to RCN is thinking about a small set of sustainability indicators and developing consistent ways to test concepts in diverse settings. Her “take away” from workshop is better relations with collaborators and establishing comparable empirical tests of how bioenergy affects sustainability. A question to spark discussion was “How does RCN define bioenergy sustainability in a way that can be tested?” This presentation promoted questions from the audience on how to quantify attribution due to bioenergy.

Kline’s presentation reviewed DOE support to improve the science underpinning various initiatives to develop standards and certification schemes around the world, including the International Organization for Standardization (ISO), Global Bioenergy Partnership (GBEP), Council on Sustainable Biomass Production (CSBP), and Roundtable on Sustainable Biofuels (RSB). He noted that ORNL contributions include, (a) identifying what land is available for agricultural expansion without affecting areas of high conservation value (HCVAs), (b) assembling, analyzing and comparing empirical data to modeling results, and (c) developing better data sets and new models for improved assessments of effects of bioenergy systems, particularly related to land cover and land management. He noted that this workshop presents opportunities to expand collaborations to test indicators and conceptual frameworks for sustainability and to

jointly develop systems approaches to optimize for defined socio-economic and ecological targets. Questions to spark discussion included, how to best determine and assign attributions among multiple, complex interactions (causal analysis) and how to address trade-offs among multiple goals when addressing

The ORNL team shared six posters (available on the CBES website:

<http://www.ornl.gov/sci/ees/cbes/>):

- “Empirical measures of effects of bioenergy policy on land-use change” by Keith L. Kline, Allen C. McBride, Nagendra Singh
- “A Comparison of Empirical and Theoretical Eucalyptus Yields in Brazil” by Carolyn and Gbadebo Oladosu
- “Assessing Effects of Bioenergy Choices” by V.H. Dale, L.M. Baskaran, M. Davis, M.E. Downing, L.M. Eaton, R.A. Efroymsen, C.T. Garten Jr., N. Griffiths, M. Hilliard, K.L. Kline, H.I. Jager, M. Langholtz, A.C. McBride, R. Middleton, P.J. Mulholland, G. Oladosu, E.S. Parish, P.E. Schweizer, A. Sorokine, J.M. Storey, and N. Thomas
- “Bioenergy Sustainability” by V.H. Dale, L.M. Baskaran, M. Davis, M.E. Downing, L.M. Eaton, R.A. Efroymsen, C.T. Garten Jr., N. Griffiths, M. Hilliard, K.L. Kline, H.I. Jager, M. Langholtz, A.C. McBride, R. Middleton, P.J. Mulholland, G. Oladosu, E.S. Parish, P.E. Schweizer, A. Sorokine, J.M. Storey, and N. Thomas
- “Review and Comparison of USDA Baseline Projections for Planted Acreage versus Actual Land Use 1996 to 2011” by A. Lawson, A. McBride, K. Kline, L. Eaton and MJ Emanuel
- “US Billion Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry”

The workshop provided an excellent opportunity for scientists from diverse disciplines from all the Americas to share their ideas on developing a sustainable bioenergy industry. The presentations and discussions focused on the scientific principles and their practical applications of bioenergy. The discussions showed the increasing importance of planning and a systems approach to resource management. The benefits of ORNL participation by two researches include:

- Participation in parallel work sessions and break out groups.
- More comprehensive representation of ORNL research and institutional capabilities
- More groups are interested in adopting the indicators being proposed by ORNL (McBride et al. 2011; Dale et al. in review) and tested by DOE
- There will be opportunity to test the role and tradeoffs of diverse measures of sustainability in different types of bioenergy systems in a variety of locations
- ORNL scientists had an opportunity to explain their concerns about indirect land use change (iLUC) and how it is represented in the Roundtable Table on Sustainable Bioenergy (RSB) to those directly involved in the RSB process.
- Watershed experiments being conducted in several locations may adopt more common methodologies.

Next steps include further development of the curriculum for graduate level course on sustainability and a follow-up workshop next year (location to be determined).

This workshop and its next steps contributed to addresses the following Technical Barriers identified in the DOE Multiyear Program Plan of the Biomass Program:

- FT-B Sustainable production
- FT-D Sustainable harvesting
- IM-B Agriculture sector wide paradigm shift
- IM-C Lack of understanding of environmental/energy tradeoffs
- IM-E Lack of industry standards and regulations
- PM-B Need for consistent policy drivers and regulations
- PT-B Need for understanding of environmental tradeoffs
- PT-C Lack of experience and understanding of impacts of using biomass and engineered biomass as fuels
- ST-A Scientific consensus on bioenergy sustainability
- ST-B Consistence, defensible message on bioenergy sustainability
- ST-C Sustainability data across the supply chain
- ST-E Best practices for sustainability bioenergy production
- ST-F Systems approach to bioenergy sustainability
- AT-A Lack of comparable, transparent and reproducible analysis

In discussions following the workshop, Kline and Dale discussed with other workshop participants opportunities to collaborate further on setting standards via the International organization for Standards; on modelling land use, sustainability and land-use change in Brazil, Columbia and other countries; and applying sustainability indicators in different contexts.

Key contacts (in addition to MTU team):

- Brian Titus, Environment Canada, interested in several collaborations on testing standard approaches for measuring sustainability indicators including standard sampling protocols for forest management and residue collection projects.
- Adam Branson (USDA Ag Attache for Mexico) and Adriana Otero Arnaiz (USDA Ag specialist) both with the Foreign Agricultural Service in D.F. Mexico.
- Maria Elena Zaccagnini and Jorge Hilbert (INTA – Argentina), interested in potential collaborations on ILUC, measuring sustainability, publications and standards.
- Damiana Serefina, Argentina, Chamber Member of RSB and Manger of large project to develop bio-jet fuel for international markets.
- Jose Luis Perez Fernandez, General Director, and Carlos Ochoa F., General Manager, KuoSol Mexico.
- Rodrigo Medeiros (UDFR, Brazil), on land-use change modeling, carbon cycle, residues and biodiversity issues
- H.T. Gollany of USDA (Oregon) on collaborations regarding soil indicators and residue removal rates.

Attachments

1. Thank you letter from MTU for participation
 - A. To VH Dale
 - B. To KL Kline
2. Workshop agenda
3. Workshop participants
4. RCN Education Plan and Assignments
5. Workshop and side meeting notes [including meeting notes of Dale and Kline; notes from breakout group chaired by Kline, KUASOL field trip notes and photos, and agave potential notes and map of sisal (henequen) production area and export statistics for Yucatan, Mexico]



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May 31, 2012

Virginia H. Dale
Oak Ridge National Lab

Dear Virginia,

I would like to thank you for your participation and acknowledge your contributions to our program in collaboration with scientists from throughout the Pan American region in the Research Coordination Network on Pan American Biofuels and Bioenergy Sustainability Workshop 2012. The workshop, held in Merida, Yucatan MX from May 29-May 31 on the campus of UNAM-CEPHCIS, was a success in every aspect of the program.

It was invaluable to have both you and Keith Kline from ORNL contribute to the workshop. Keith did an excellent job of chairing the session on the water/energy nexus, suggesting the format for oral presentations, leading break-out group work and contributing to the discussion about international collaboration opportunities and research priorities. Your contributions to framing discussions about indicators for sustainable bioenergy and how they might be tested as part of the empirical studies that occur across the research network were very valuable. Your efforts to assist in the development of a research roadmap report on sustainability of biofuels and bioenergy in the Pan American region and to assist in designing a graduate course in sustainability of biofuels/bioenergy to be disseminated to the network partners is also very much appreciated.

If you have any questions, please feel free to contact me at (906) 487-3468 or Richard Donovan at (906) 487-3612. You may also send correspondence to:

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Sincerely,

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May 31, 2012

Keith Kline
Oak Ridge National Lab

Dear Keith,

I would like to thank you for your participation and acknowledge your contributions to our program in collaboration with scientists from throughout the Pan American region in the Research Coordination Network on Pan American Biofuels and Bioenergy Sustainability Workshop 2012. The workshop, held in Merida, Yucatan MX from May 29-May 31 on the campus of UNAM-CEPHCIS, was a success in every aspect of the program.

It was invaluable to have both you and Virginia Dale from ORNL contribute to the workshop. You did an excellent job of chairing the session on the water/energy nexus, suggesting the format for oral presentations, leading break-out group work and contributing to the discussion about international collaboration opportunities and research priorities. Virginia's contributions to framing discussions about indicators for sustainable bioenergy and how they might be tested as part of the empirical studies that occur across the research network were very valuable. Your efforts to assist in the development of a research roadmap report on sustainability of biofuels and bioenergy in the Pan American region and to assist in designing a graduate course in sustainability of biofuels/bioenergy to be disseminated to the network partners is also very much appreciated.

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Sincerely,

David R Shonnard

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Page 1

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**Research Coordination Network (RCN):
Pan American Biofuels and Bioenergy Sustainability
1st Workshop Agenda
May 29-31 2012, Merida, Mexico**

Tuesday May 29, 2012

Time	Activities	Location
Morning		
8 am – 8:15 am	Opening welcome and remarks (Mario Ruz UNAM-CEPHCIS, David Shonnard, MTU, USA)	
8:15 am – 10:00 am	Oral Presentations: Community Impacts (Chair: Connor Bailey, AU, USA) Conner Bailey (AU, USA), Carmen Bain (ISU, USA), Theresa Selfa (SUNY-ESF, USA), Samuel Sweitz (MTU, USA), Enrique Rodriguez (UNAM-CEPHCIS, Mexico), Mario Ruz (UNAM-CEPHCIS, Mexico), Angel Lendechy (UADY, Mexico), Ricardo Isaac (UACAM, Mexico); Barry Solomon (MTU, USA)	
10:00 – 10:15 am	Break	
10:15 am – noon	Oral Presentations: Water-Energy Nexus (Chair: Keith Kline, ORNL, USA) Keith Kline (ORNL, USA), Jorge Hilbert (INTA, Argentina), David Watkins (MTU, USA), Alberto Acevedo (INTA, Argentina), David R. Shonnard (MTU, USA), Julio Sacramento (UADY, Mexico), Javier Becerril (UADY, Mexico), Kathleen Halvorsen (MTU, USA), Marcia Moraes (UFDP, Brazil), Dr. Mascha Smit (CICY, Merida)	
Lunch noon – 1:15 pm		
Afternoon		
1:15 pm – 3pm	Oral Presentations: Biodiversity – Ecosystems (Chair: Heidi Asbjornsen, UNH, USA) Heidi Asbjornsen (UNH, USA), Rod Chimner (MTU, USA), Virginia Dale (ORNL, Tennessee, USA), Rodrigo Medeiros (UDFR, Brazil), Maria Elena Zaccagnini (INTA, Argentina), Victor M Loyola Vargas (CICY, Mexico), Audrey Mayer (MTU, USA)	
3 pm – 3:15 pm	Break	
3:15 pm – 5 pm	Oral Presentations; Biogeochemical Cycles and Community Stakeholders (Chair: Hero Gollany, USDA-ARS, USA) Hero Gollany, (USDA-ARS, USA), Sigrid Resh (MTU,	

	USA), Datu Buyung Agusdinata (PU, USA), Juan Pablo Sesmero (PU, USA), Brian Titus (CFS, Canada), Damiana Serafini (BSA, Argentina), Jose Luis Perez (KUOSOL, Mexico), Nancy Walker (Parque Aak, Mexico), Renata Moreno (PhD Student in Environmental Natural Resources Policy Program at ESF)	
8 pm – 10 pm	Dinner	Piedre de Agua Hotel

Wednesday May 30, 2012

Time	Activities	Location
Morning		
8 am – 8:30 am	Presentations: Alex Mayer (MTU, USA), Others	
8:30 - 9:30 am	Presentation on RCN goals and objectives, milestones and deliverables (David Shonnard, MTU, USA)	
9:30 am – 10 am	Assessment Plan (Jackie Huntoon, MTU, USA)	
10 am – 10:15 am	Break	
10:15 am – 11:30 am	Small group discussions (Topics: increasing network participation, expanding RCN sustainability topics, broadening diversity, identification of collaborative research opportunities and preparation for conference).	
11:30 am – noon	Report back to Workshop	
Lunch 12:00 pm – 1:00 pm		
Afternoon		
1:00 pm – 2:00 pm	Curriculum Theme (Presentations by David Shonnard, Rodrigo Medeiros, Jorge Hilbert and others on sustainability education initiatives in the network)	
2:00 pm – 3:00 pm	Proposed Graduate Course (David Shonnard, Michigan Technological University, Houghton, MI, USA)	
3:00 pm – 3:15 pm	Break	
3:15 pm – 5:00 pm	Small group discussion – course preparation assignments and work	
8:00-10:00 pm	Dinner: Hacienda Teya	Hacienda Teya

Thursday May 31, 2012

Time	Activities	Location
Morning		
8:00 am – 9:00 am	Cyberinfrastructure Training (Richard Donovan, MTU, USA)	
9:00 am – 10:00 am	Conference Preparation (David Shonnard, MTU, USA)	
10:00 am – 10:15 am	Break	
10:15 am – 11:30 am	Small group discussion – conference themes and structure	
11:30 am – 12:00 pm	Report back and discussion	
Lunch 12:00 pm – 1:00 pm		
Afternoon		
1:00 pm – 2:00 pm	Evaluation and Assessment (Jackie Huntoon, MTU, USA)	
2:00 pm – 5:00 pm	Field Trip : KUOSOL – Integrated Bioenergy Production in the Yucatan	
8:00-10:00 PM	Dinner at Panchos in Downtown Merida	

Attendees at May 29-31, 2012 Workshop of the Research Coordination Network (RCN): Pan American Biofuel and Bioenergy Sustainability

Name	Institution	email	Topic
Heidi Asbjornsen	University of New Hampshire	Heidi.Asbjornsen@unh.edu	Biodiversity-Ecosystems
Conner Bailey	Auburn University	bailelc@auburn.edu	Community Impacts
Carmen Bain	Sociology, Iowa State University	cbain@iastate.edu	Community Impacts
Rod Chimner	Michigan Technological University Center for Bioenergy Sustainability,	rchimner@mtu.edu	Biodiversity-Ecosystems
Virginia H. Dale	Oak Ridge National Laboratory	dalevh@ornl.gov	Biodiversity-Ecosystems
Richard Donovan	Michigan Technological University	rpdonova@mtu.edu	Cyber-Infrastructure
H.T. Gollany	USDA-ARS, Pendleton, Oregon	hero.gollany@oregonstate.edu	Biogeochemical Cycles and Community Stakeholders
Kathleen Halvorsen	MTU, Social Sciences	kehalvor@mtu.edu	Water/Energy Nexus
Jorge Hilbert	INTA, Argentina	jorgeantoniohilbert@gmail.com	Water/Energy Nexus
Jackie Huntoon	MTU	jeh@mtu.edu	Evaluation
Keith Kline	Oak Ridge National Laboratory	klinekl@ornl.gov	Water/Energy Nexus
Alex Mayer	Michigan Technological University	asmayer@mtu.edu	Water/Energy Nexus
Audrey L. Mayer	Michigan Technological University	almayer@mtu.edu	Biodiversity – Ecosystems
Rodrigo Medeiros	Universidade Federal Rural do Rio de Janeiro	rmedirosnadc@yahoo.com.br	Biodiversity-Ecosystems
Sigrid Resh	Michigan Technological University	scresh@mtu.edu	Biogeochemical Cycles and Community Stakeholders
Mayra Sanchez	Michigan Technological University	mosanche@mtu.edu	
Theresa Selfa,	SUNY-ESF	tselfa@esf.edu	Community Impacts
Damiana Serafini	Biocombustibles Sustentables Argentina, Buenos Aires, Argentina	damiana.serafini@biojetcorp.com	Biogeochemical Cycles and Community Stakeholders
David R. Shonnard (PI)	Michigan Technological University	drshonna@mtu.edu	Water/Energy Nexus
Barry Solomon	Michigan Technological University	bdsolomo@mtu.edu	Community Impacts
Datu Buyung Agusdinata	Purdue University	bagusdin@purdue.edu	Biogeochemical Cycles and Community Stakeholders
Samuel Sweitz	Michigan Technological University	srsweitz@mtu	Community Impacts
Jaun Pablo Sesmero	Purdue University	jsesmero@purdue.edu	Biogeochemical Cycles and Community Stakeholders

Brian Titus	Canadian Forest Service, Victoria BC	Brian.Titus@NRCan-RNCan.gc.ca	Biogeochemical Cycles and Community Stakeholders
Maria Elena Zaccagnini	INTA, Argentina	mzaccagnini@cnia.inta.gov.ar	Biodiversity-Ecosystems
Alberto Acevedo	INTA, Argentina	aaavedo@cnia.inta.gov.ar	Water/Energy Nexus
David Watkins	MTU	d Watkins@mtu.edu	Water/Energy Nexus
Marcia Moraes	Universidade Federal de Pernambuco	marciagamoraes@yahoo.com.br	Water/Energy Nexus
Julio Sacramento	Universidad Autonoma de Yucatan	julio.sacramento@uady.mx	Water/Energy Nexus
Mario Ruz	UNAM-CEPHCIS	mhruzs@gmail.com	Community Impacts
Enrique Rodriguez	UNAM-CEPHCIS	enrique.rodbal@gmail.com	Community Impacts
Mascha Smit	Centro de Investigación Científica de Yucatán (CICY)	mascha@cicy.mx	Water/Energy Nexus
Jose Luis Perez	KUOSOL	jose.perez@kuosol.com.mx	Biogeochemical Cycles and Community
Angel Lendechey	Universidad Autonoma de Yucatan	lendechy@uady.mx	Community Impacts
Ricardo Isaac	Universidad Autónoma de Campeche	ricisaac@hotmail.com, ricisaac@uacam.	Community Impacts
Nancy Walker			Biogeochemical Cycles and Community
Javier Becerril	Universidad Autonoma de Yucatan	javier.becerril@uady.mx	Water/Energy Nexus
	Unidad de Bioquímica y Biología Molecular de Plantas - Centro de Investigación Científica de Yucatán		
Victor M Loyola Vargas		vmloyola@cicy.mx	Biodiversity-Ecosystems

Attachment 4. RCN Education Plan and Assignments

The proposed 3-semester credit graduate course on Pan American Biofuels and Bioenergy Sustainability will be developed and identified by participants in the RCN and delivered by video conference between the collaborating universities and institutions. Recording of lectures should take place for archiving and also for posting on the RCN web site for students to take online if there are scheduling conflicts with the course period. Student-led teams will lead a presentation and in-class discussion of more advanced concepts, readings, and case studies. There will be interdisciplinary teams working on term projects where applications of concepts, methods, and analysis tools from the course will be targeted to bioenergy case studies in different Pan American regions. It is planned for a January 2013 start for this course. The following table lists the final course theme titles and assignments for participants. Deadlines have yet to be set for these deliverables, but a logical target date for completion of the lectures and identifying a list of required readings for each theme is end of August, 2012.

Title: “Pan American Biofuel and Bioenergy Sustainability”

1. Introductory Concepts and Theories
 - a) Concepts and Theories of Sustainability (David Shonnard, Keith Kline)
 - b) Fossil Energy Dependence Dilemma (Keith Kline, Conner Bailey)
 - c) Energy Trade Offs (conservation and other renewables) (Conner Bailey)
2. Bioenergy Supply Chains and Technologies (David Shonnard, Julio Sacramento)
 - a) Feedstocks for Bioenergy (Conner Bailey, Alberto Acevedo, Jorge Hilbert)
 - b) Integrated Biorefineries (Julio Sacramento, David Shonnard)
3. Energy, Agricultural and Climate Policies (Barry Solomon, Javier Becerril)
4. Life Cycle Assessment and Other Analysis Tools (Jorge Hilbert, David Shonnard)
5. Environmental Dimensions , Ecosystem Services (Virginia Dale, Heidi Asbjornsen, Marie Zaccagnini)
 - a) Biogeochemical Cycles (Brian Titus, Hero Gollany, Sigrid Resh)
 - b) Water Issues (Alex Mayer, David Watkins, Marcia Moraes)
 - c) Biodiversity (Marie Zaccagnini, Adriana Otero, Rodrigo Medeiros)
6. Socioeconomic Dimensions (V. Dale, Carmen Bain, Theresa Selfa, J. Becerril, Sam Sweitz)
 - a) Economic Viability and Other Socioeconomic Effects (Juan Sesmero)
 - b) Land Rights and Food Security (Adriana Otero, Keith Kline)
7. Integrated Analysis within Agroecological Systems (Jorge Hilbert, Daniel S., Juan Sesmero, Datu Agusdinata)
8. Implementation and Best Management of Bioenergy in Pan American Contexts

Attachment 5. Workshop and side meeting notes:

A. Meeting notes of Dale and Kline

MAY 29 NOTES

David Shonnard –

- Goals of RCN:
 - Collaboration
 - Help define challenges
 - Become more coordinated network and do research even beyond the scope of this project to define sustainable bioenergy
 - Workshop year 3
 - Graduate course
 - Determining communication strategies amongst network
- Rationale: production ramping up in region but insufficient understanding of sustainability issues.
- RCN will basically fund four events:
 - This workshop (in Merida),
 - Workshop 2 in Argentina,
 - A large conference that has more intense and longer interactions including more participants from industry and NGOs. It will be a capstone activity to develop the research roadmap report (RRR) and perhaps peer-reviewed publications based on the RRR.
 - Workshop 3 in Houghton, Michigan, will serve as a wrap up of activities.
- Deliverables to cover specific research themes ref biofuels: community impacts, water/energy nexus, biodiversity, energy policy, LCA, food and related systems, biogeochemical cycles, biomass supply, transport and logistics. Two deliverables: Roadmap and Education (graduate course on bioenergy sustainability). Latter – hope to deliver course by MTU “2013 Spring Term” (Jan 2013) including lectures by RCN experts using video conference or taped presentations. Web-based node for sharing information.
- Develop and maintain collaborations to generate and share new knowledge on sustainability in region.
- RCN includes eight Sustainability Themes:
 - a. Community: land, water, labor rights. Involve stakeholders, understand history and current cultural-political systems. Socio-econ effects.
 - b. Water-Energy Nexus: Water quantity and quality issues; identify water management tools/practices.
 - c. Biodiversity - Two strategies: protected areas and management for enhanced biodiversity.
 - d. Biogeochemical: how do harvesting and management affect nutrient cycling, SOC, microbial communities, CH₄, N₂O, CO₂ and soil amendments issues.
 - e. Energy Policy issues: Review laws and policies in region and compare to P&C in RSB.
 - f. LCA tools.
 - g. Food-fuel competition issues.

h. Transport and logistics.

- Workshop 1 outputs: planning for major conference in year 3, research proposals, and initial thinking about curriculum and who else should be involved.
- Desired outcomes: diversity of participants (different disciplines, different levels of experience, etc). Hence there needs to be evidence of collaboration and shared goals for future. Are there documented mutual benefits? Is there Increased understanding of the issues?
- **KuoSol Project:** medium term goal is to produce 40,000 ton oil per year (with long term target of 4 Mtpy). No production yet. Establishing feedstock plantations at present on private land. An LCA-style study was done with external funding support and involving MTU (Packard Foundation grant?) based on RSB draft guidance. This study estimated 73% reduction in G C02eq/MJ compared to fossil diesel. Also, David and Richard with MTU did a study showing 80% GHG reduction for this product if used for aviation fuels (bio-turbismo). The company is already in the agricultural production business (edible oils and pork). Using residues from *Jatropha* for animal feed would require “detox” treatment or specific genetic selection of new varieties for lower toxicity. Now looking at potential use of residues for fabrication of fuel “pellets.”
- Jackie Huntoon (MTU) is serving as the evaluator of workshop and distributed questionnaires to all participants before and after the workshop.

Socioeconomic issues

Connor Baily: Auburn University – Democratization of energy and power

- Energy is core issue of many problems and dependence on fossil fuel (war, environment, sea level rise, enhanced storms, etc.)
- Bioenergy offers options
- Forest options in the SE US

Carmen Bain: Iowa State University

- Rise of private sector governance – e.g. certification systems
- Teaches rural sociology
- Case study under US DOE – six rural communities in Kansas and Iowa (corn ethanol)
- Framing of risks and benefits at local level in Iowa (economics benefits)

Theresa Selfa (State University of New York - SUNY)

- PhD was in Rondonia, Brazil on participatory development in grassroots campaigns
- Current project on rural impacts of corn ethanol plants in Kansas and Iowa (funded by DOE)
- Questions of interest –
 - What are the soil measures of sustainability (lit review of certification schemes)
 - What are social impacts?

Renata Morena Q. (student at SUNY)

- Environmental policy and governance in Columbia

- Beginning work on social impacts of ethanol production in Valle del Cauca, Columbia
 - Columbia has action plan to become a major biofuel producers
 - Problems of ownership rights of land and water quantity
 - Plan to conduct interviews

Samuel (Sam) Sweitz (MTU) – Department of Anthropology

- Effects of industry on people and house hold communities - works in Yucatan and Puerto Rico
- Local stakeholder perspectives
- Concerns about sustainability and local perspectives
 - Historical circumstances of historical considerations
 - Current social and political systems
 - Working in partnership with local expertise -- participatory research
 - Equitable production
 - Local initiatives
- Yucatan – rise of hacienda system and its effects in Yucatan (e.g., social acceptance)
- How can we create frameworks that both account for and incorporate local stakeholders into the design, implementation, analysis and solution toward sustainable bioenergy production?

Enrique Rodriguez (UNAM) - anthropologist

- Mayan issues in Yucatan
 - Cultural diversity
 - Biodiversity
 - Coastal changes
- Relation between social and environmental issues and role of local knowledge

Richardo Issac Marquez(UACAM)

- Land use and land cover change
- Rural development strategies
- Effects of public policies on community development

Barry Solomon (MTU) Ecological Economics

- Sustainability of biofuels development in North and Latin America
- Us and Brazil are still leaders but other countries are growing fast
- Comparison of certification schemes
- Case studies of 8 countries – US, Canada, Brazil, Argentina, Columbia, Paraguay, Guatemala, and Mexico
- Developing e-book for Springer

Summary of panel by Connor Bailey: Issues of ecological sustainability, history, and social justice

Questions:

- How does the question of resilience fit into sustainability?

Water-Energy Nexus – Chair: Keith Kline (ORNL)

Jorge Hilbert (INTA – Argentina)

- Approach to develop sustainable bioenergy growth from different resources

- Involved with European Union, Indonesia, and Africa
- Cooperation and research opportunities
 - LCA analysis
 - NO₂ emissions on real agricultural systems
 - Organic matter and nutrient cycles
 - Special focus on new species and their risks
 - iLUC

David Watkins (MTU – Civil and Environmental Engineering)

- Current Projects:
 - Feedstock supply chain model for a new facilities on Upper Peninsula of Michigan, and it evolved into decision support system (asking questions about transportation and costs)
 - Modeling water use efficiency value and governance (impacts of withdrawals).
- Contributions to workshop goals
 - To help develop hypothesis that may be addressed thru integrative approaches
 - Understand information that is needed
 - Define data gaps and feedbacks for water resource impacts
 - Gain understanding of diverse settings in which people are working

Alberto Acevedo (INTA – Argentina) – genetics and molecular biology of plants

- Developing tools for sustainable growth of bioenergy production from different sources – which crops are suitable for different reasons based on energetic
 - Looking for enzymes in natural forests
 - Strategic development of resources (e.g., genetic material)
- Contribution: Adding the genetic perspective to workshop (may be a way to achieve objectives with minimal water consumptions)

David Shonnard (MTU)

- Engineering and LCA approaches
- Developing classes and outreach on sustainability

Julio Sacramento Rivero (UADY – Mexico) – Engineer

- Interested in process side of engineering and sustainability
- Developing a tool to aid the design of sustainability biorefineries (e.g., a framework with 14 indicators)
- Optimization of biodiesel production from microalgae

Javier Becerril (UADY – Mexico)

- Current research
 - Cost-benefit analysis of genetics crops in Mexico
 - Economic impacts
 - Effects of globalization on biodiversity
- Contributions
 - Research in Mayan rural areas
 - Economic impact assessment of bioenergy

Kathleen Halverson (MTU)

- Work on climate change, biodiversity, and social dimensions

- Theory of planned behavior (rules that people think others are following that can be used to predict behavior) – interested in how this affects environment

Marcia Moraes (UFPE -Brazil)

- Economics in decision support for integrated water resources management
- Report on NE Brazil released by UNEP recently
- Now working on technical assistance related to all options (not just bioenergy) for NE - where sugarcane production is a major crop)
- Designing water-use policies that promote economic development

Mascha Smit speaking for Ruby Valdez of Yucatan Center for Scientific Research (CITY - Mexico)

- Focused on biodiesel from *Jatropha curcas*
- Microalgae for biodiesel and synthetic fuels (genetics)
- Microbial fuel cells / microbial electrolysis cell

Keith Kline

- What are the tradeoffs and how are they addressed?

Biodiversity

Heidi Asbjornsen (UNH)

- Must consider tradeoffs
- Effects on ecosystem services
- Relationship between function and diversity

Rod Chimner (MTU)

- No bioenergy experience
- Carbon cycling
- Grazing intensity effects

Virginia Dale (ORNL)

- Defining environmental and socioeconomic costs and benefits of bioenergy systems
- Quantifying opportunities and risks associated with sustainable bioenergy in specific contexts
- Communicating the challenges and paths forward for sustainable bioenergy to a range of stakeholders

Rodrigo Medeiros (UDFR, Brazil)

- Current research
 - Contribution of Brazilian protected areas to the national economy – considers carbon sequestration, tourism value, water, etc.
 - Global MDP network
 - Biodiversity, environmental services, land use patterns and bioenergy development
- Contributions:
 - Integrate MDP network

Maria E. Zaccagnini (INTA, Argentina)

- Biodiversity monitoring
- Land use and effects of spatial patterns
- Assessing conservation and sustainable use; developed IUCN framework

- Managing conflicts between biodiversity and agriculture
- Teaches landscape ecology
- Agroindex: ask eviglez@cpenet.com (ask Dr. Ernesto Viglez)

Victor M Loyola Vargas (CICY, Mexico)

- Jatropha biofuel research:
 - Improvements in the production and oil quality
 - Resistance to disease and other stresses

Audrey Mayer (MTU)

- Biodiversity patterns estimated for large areas using remote sensing data
- Environmental policy
- Sustainability science (information theory)
- Green infrastructure
- Agent based models of information flow across forested landscapes (Upper Peninsula)
- Workshop take aways
 - A vision for spatially explicit data base
 - Opportunities for transdisciplinary work

Heidi Asbjornsen (University of New Hampshire)

- No bioenergy experience
- Ecophysiology effects of land use change in a tropical montane cloud forest in Veracruz, Mexico
- Mixed perennial and annual agroecosystems for enhancing ecosystem services in the midwestern US
 - How does strategic planting affect water quality and biodiversity (plants, birds, and insects). Are adding a socioeconomic component (willingness to adopt new planting). (Ask John Tyndall economics at Iowa State University)
 - Scale – watersheds of 3 to 8 acres in size

Questions:

- How is attribution to biofuel of a change in indicator value determined and calculated?

Biogeochemical Cycles and Community Stakeholders

Sigrid Rush (MTU)

- Belowground carbon allocation
- Eucalyptus in Puerto Rico – nitrogen fixer comparisons

Datu Buyung Agustinata (Purdue University)

Juan Pablo Sesmero (Purdue) – Economist from Argentina

- Harvesting corn residues for energy – optimal harvest rate and economic viability (but was role of no-till ag included in estimated of effects of stover removal on irrigation)
- Economic comparison of switchgrass and corn residue for energy (combined heat and power= CHP) – CHP is only economically viable at \$120 per barrel of oil

Brian Titus (Canadian Forest Service)

- Meta analysis – impacts of intensive forest harvesting

- Legacy trials operationally driven monitoring plots (using randomized and replicated sampling design)
- Link soil productivity and biodiversity

Damiana Serafini (Biocombustibles Sustentables Argentina SA (BSA SA))

- Biojet International –will make biofuels available around to world for jet transportation using diversity of feedstocks (but focused on sustainability) and feedstock pathways
- Trying to apply RSB approach to industry (and Damiana has worked on RSB Industry Chamber for several years)
- Bioenergy International: linking biojet fuels in N.America, S Am., ASIAPAC... Agnostic to feedstock choice but looking for sustainability. BSA SA: 150,000 ha plantation of camelina planned for 28 Mgy of renewable jet fuel. Hoping to improve seed and technology to double yield. Camelina requires fewer inputs per ton oil than other options. The company wants to promote sustainability, but requires minimum profit to sustain production. Jorge-INTA: most Argentines have no idea what biofuels are; no awareness.
- Contribution – close the gap between what is perceived versus what is real for industry, on the ground
- Take away – How to close the gap between what is perceived versus what is real

Delfinia Perez (KUOSOL, Mexico)

- Jatropha for energy and animal feed in Mexico
- Applying RSB standards for sustainability (done by a German company)
- Product is a design for implementation in Yucatan
- LCA
- Focused on crops that not have food options

Hera Gollany (USDA ARS, Corvallis)- Soil Scientist

- Organic carbon management for sustainable agroecosystems
- National database of greenhouse gas (GHG) fluxes and storage: GRACEnet (GHG Reduction through Ag Carbon Enhancement) = National database on GHG flux and C storage; guidelines for practices that increase sequestration (for producers, agencies, C brokers); development and testing of models such as CQUESTER Ver2.0, and DAYCENT (Global Research Alliance efforts).
- USDA team doing summary papers for policy makers based on state of science. Guidelines for sustainable residue removal: Gollany et al. 2011 Agronomy Journal 103(1) 234-246 (REAP paper). IPCC numbers tend to overestimate for some areas; underestimate in others. It depends on site context etc. Need to have same protocol for measurements, etc. or you get totally different results. Many variables interact to affect SOM.

MAY 30 NOTES

Alex Mayer (MTU – Civil and Environmental Engineering)

- Has collaborations with a range of biophysical and socioeconomic scientists
- Impacts of water use, land use and climate change at watershed and regional scales

- Works in Sonoran state in Mexico
 - Risk perception
 - Willing to pay for ecological flows and rural water supply improvements. The issue is water rights take all the water and there is no water left to flow. Contingent valuation study focused on residential section.
- North American dimension of rural sustainability (US, Mexico and Canada) – developed internet course

David Shonnard - Overview of RCN

- Workshops (location tentative) and target the following themes from the eight sustainability themes listed below
 1. Merida (topics a, b, c, g)
 2. Buenos Aires (topics d, e, f, h)
 3. Brazil (more comprehensive conference and greater outreach)
 4. Houghton, MI final workshop and wrap up
- Themes to be covered
 - a. Community impacts
 - b. Water/energy nexus
 - c. Biodiversity/ecosystems
 - d. Energy policy
 - e. LCA
 - f. Food and other systems
 - g. Biogeochemical cycles
 - h. Biomass supply transportation logistics
- Anticipated products
 - Graduate course on biofuels and bioenergy sustainable development
 - Framework for US government funding agencies – Research Roadmap Report (RRR) – covering all sustainability themes and providing a plan for future research
- Conference in year 3
 - Research Roadmap Report (RRR) – covering all sustainability themes
 - Peer reviewed papers on RRR that identify high priority research areas and multidisciplinary areas
 - Expansion to others (industry, NGOs, community leaders, etc.)
- Virginia raised need to
 - Consider ways to gather and store data
 - Design experiments using similar format and data collection processes so that the results are comparable
- Keith raised issue of starting to develop papers now

Jackie Huntoon - Evaluation of project required by NSF

- Desired outcomes – diverse participants (in terms of age, countries, etc.)
- Increase collaborations (are there mutual benefits)
- Increased understanding of the issues in different countries, economic settings, etc.
- Identify funding sources and funding opportunities

- Influence policy – do the results of the effort change how government and industry think about biofuels

Datu Buyung Agustudinata (Purdue University – systems engineer)

- Multi-actor system life cycle model for aviation biofuels
 - What are the key factors that influence viability of bioenergy production
 - To what extent can bioenergy achieve policy goals?
- Integrated biofuel sustainability assessment tool (submitted)

Jorge Hilbert – energy sustainability education in Argentina

Rodrigo Medeiros (UDFR, Brazil) – Brazilian energy sustainability education

MAY 31 NOTES

Conference in 2014 – David Shonnard

- All research themes (parallel sessions)
- Broader participation
- Need “hook” for conference to get people to come, and it could be the “research roadmap” (Kline)
 - 80% of it will be done by meeting
 - Get feedback at workshop
- Presentation format:
 - What is current knowledge and where are the gaps
 - Build from OBP’s strategic barriers
- Can we endorse a particular approach to collecting information on bioenergy systems including what is measured and how they are measured.

Lead coordinator established developing review papers for target areas and integration

- Manuscript due July 2013
- Conference date July 2014

Breakout group reports:

A. Break-Out Group 1 (Kline et al.).

1.1 Research Collaborations – How to further develop effective collaborations on sustainable bioenergy across institutions in the Pan American Region.

- We now have 8 broad themes. Need to focus to identify specific opportunities (e.g. build from the larger network in a manner that benefits specific research projects)
 - Student/faculty exchange programs
 - Define specific types of information to be shared
 - Define and share protocols to harmonize methodologies (for example):
 - for measurement of sustainability indicators (set of indicators and units)

- to have standard approach to measure baseline trends and current context (dimensions, classes, issues to consider)
 - proposed protocols for sampling and data collection
 - standard processes/approaches for analysis (this can be done for each thematic group)
 - Thematic webinars: Meet every 45 days on specific RCN theme. Prior to webinar, each country needs rep to prepare a “country report” presentation on current activities addressing the theme in that nation/region. The presentations need to be used in next workshop to identify opportunities to build inter-thematic relationships/opportunities.
 - Webinars are relatively low cost
 - Still need to have funding to organize and document results
 - The effort to establish inventory of current projects addressing each theme in each country or region might include
 - Are there government programs?
 - What data are being used
 - What data and research is needed (local priorities)
- Can we prioritize and define major topics effecting biofuels today (food security, LUC – both rely on questionable economic modeling of biofuel effects). Focus research collaborations on priority needs. Example: the effect of biofuels versus other policies on food security?
- Cross-cutting issues may represent collaboration opportunities that merit attention (Land-use change research (LUC), economics and modeling that affect most or all thematic areas)
- Cost issues. Bring private industry into network as partner to help cover costs of some research collaborations
- Structure time at this workshop that allows individual researchers to discuss potential collaborations
 - By sub-group or special topic (e.g. on Food Security, LUC?)
 - Use Donovan web tools to facilitate this and next steps
- Main challenge: finding opportunities for mutual benefits based on current research activities (everyone is already busy working on their current projects; how to effectively integrate with network)?
- Need to have more focused and mutually shared goals for effective collaboration

1.2 How to increase Network Participation:

- How do we define “participation”? What are the rules for two-way exchanges?
 - Who decides whether someone is invited to participate?
 - Who decides or how is it determined whether someone is participating?
- Language is a barrier to expanding participation; this should be easy to remedy.

- Need funding to cover time/participation if we are going to participate effectively.
- Need to identify which groups are most important for which specific collaboration topics/projects. Until we have more focused goals (e.g. forestry sampling example for legacy data sets in Canada) we cannot define best targets to expand participation.
- Group is perhaps too large already to really get tasks done effectively – more likely to achieve results in more focused subgroups.
- Challenge is how to keep current group focused and actually collaborating between now and next workshop. Everyone has other work to do.
 - National networks can be developed by representatives now in the CRN – e.g. within current budget, ‘advocates’ share information and have others join according to needs.
 - National networks could provide input for thematic webinars discussed above
 - Need to examine who is doing work on each theme in each country/region represented
- Network could be seen as umbrella that supports communication among many smaller projects and proposals – Do we need definitions of who is in or not?
- Spin-offs of RCN could involve others, as each spin-off research proposal is defined.
- By time of next workshop, there should be more specific collaborations defined around themes or across themes.
- For future workshops, invite local industry partners and contacts who have mutual interests.
- Have one day of each RCN workshop designated, designed and advertised and open to the public.

1.3. Comments on Expanding RCN Themes and topics?

- Public policy programs need scientific support – figure out where greatest research needs lie and link research to address public policy needs

B. Breakout Group 4 – Broadening diversity

- Key countries are US and Brazil. At small scale, some smaller countries that are still developing biofuels are not included.
- Stakeholders – we have universities representation but not industry or research labs in other countries (EMBRAPA, CTBE, USDA CAP projects)
- Racial diversity – Historical black colleges and universities (HCBU) in US and such groups in other countries, extension agents, NGOs
- Certification efforts: CSBP, EU approved certification groups

MAY 31-JUNE 2 additional side conversations:

Adam Branson (USDA Ag Attache for Mexico) and Adriana Otero Arnaiz (USDA representatives from US Embassy and USDA offices

- Are already working with NREL for LEDS and expect to have over US\$1.2 million for FY13 (State Dept/USAID climate change earmark funds).
- Interface with USAID and State Regional Environmental Hub (REH) for planning use of funds
- Information from workshop will go into June FAS bioenergy report on Mexico
- Looking for opportunities for more joint collaborations between US and Mexico
- Coordinate research including expanded cooperation with Mexican Government – have funding from State and USAID looking at climate change and land use (NREL – LEDS).

They are also doing reports for USDA on biofuels. USDA supports linkages between US and Mexican researchers (and ORNL made it clear that we are happy to help if possible as goal is to facilitate increased scientific cooperation that benefits agricultural producers). Adriana (FSN at FAS) has a background in GMO research.

Additional KUOSOL notes from field trip (see photos and hand-written notes): Initial area of about 1400 hectares has been planted (several areas within this total had to be replanted in past two years due to initial trial and error with plant material and planting techniques). They are now planting 1660 plants per hectare. Seedlings should be planted in fields after 2-3 months. Trial and error of best varieties and of potting soils and containers that worked best. Labor for planting is about Mex Peso 5000 (USD\$460) per ha – but that is only labor for planting. Majority of cost has been in site preparation (clearing former vegetation), controlling weed competition, irrigation (in some places, for short periods) and especially, the preparation and transport of proper seedling stock from seeds. They are also experimenting and testing other potential biofeedstocks and products: Neem and Moringa trees, Achiote (herb/coloring), and different varieties and management approaches for Jatropha and Moringa.

JUNE 1: Visit to former henequen plantations

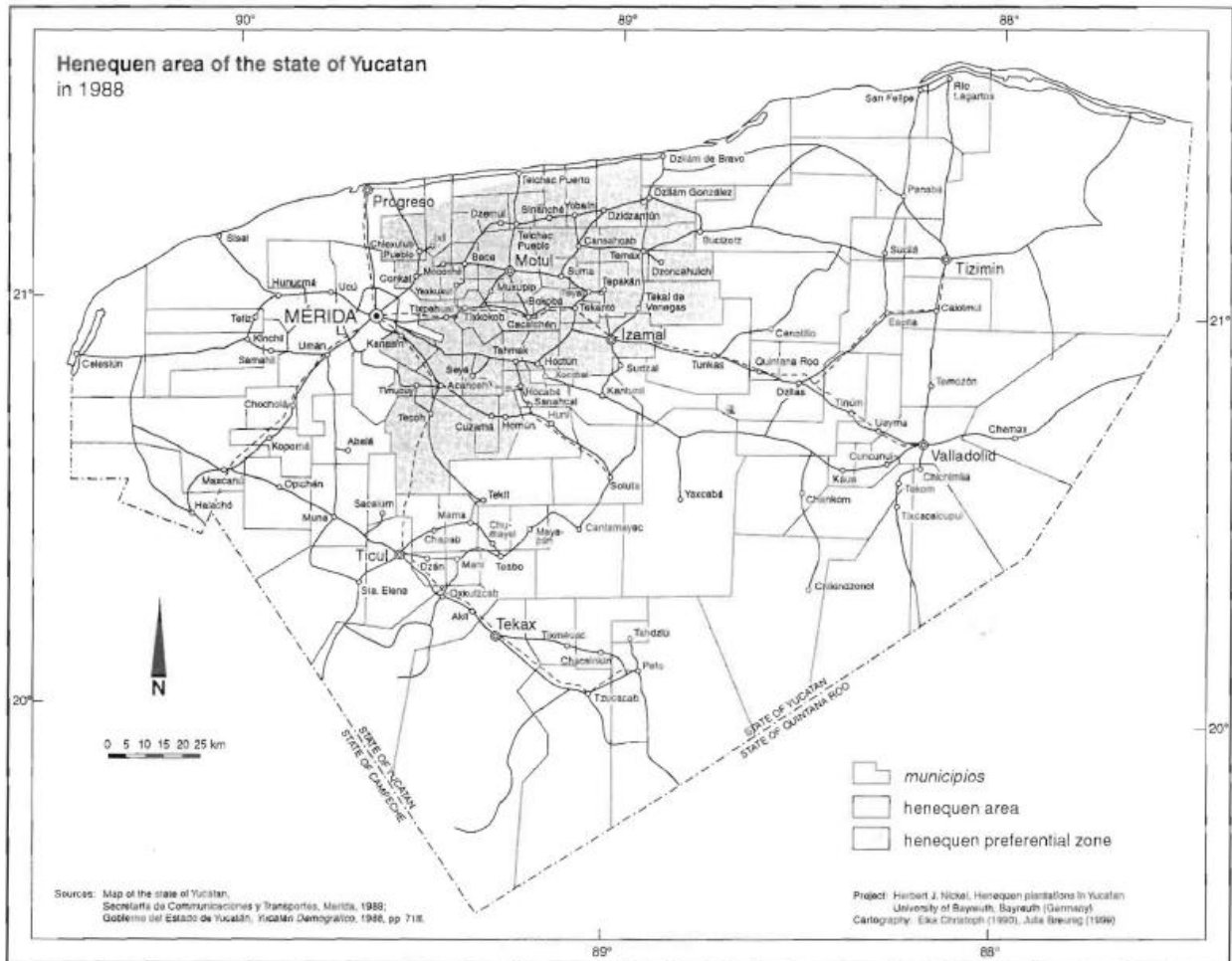
The area formerly planted in henequen in the Yucatan was reported to be 178,000 hectares, or over 430,000 acres, per discussions with staff at the Henequen Museum in Izamal. They also reported that much of the former henequen plantation land has been abandoned or is in low-intensity use (scattered small plots of maize, fruit trees, small animals, extensive pasture). The abandoned lands are susceptible to dry-season fires. Some of the land has returned to a low scrubby forest mixed with agave.

Interviews with the U.S. Counsel in Progreso, Yucatan and others in Merida by reporters for R.G. Dun (Dun 1908), generated an interesting perspective on the industry at that time. The report estimated that about 100,000 acres of henequen lands were in production in the Yucatan plus smaller levels of production in Campeche. The Yucatan produced 101,000 metric tons of dry fiber for export in 1907 (Nickel reports that annual exports peaked around 1915 at 200,000 metric tons. The Dun report discusses several wild and cultivated varieties of henequen found in the area, but explains that most production was from an *Agave sisalensis sacchi* (white fiber) variety. Dun also asserted

that the henequen “thrives on soils where other crops would be impossible ...<on> thin, rocky limestone soil widely found in Yucatan.” The henequen fields were reported to require four or five years after planting before the selective harvesting of only the lower leaves would begin. But from then on, a field could provide two harvests per year for over ten years while maintaining good yields (unless affected by fires). This report also indicates that henequen likes heat but that too much moisture in the wet season could reduce productivity by 25%. The primary maintenance required after planting was to clean undergrowth between rows to reduce risk of fire, as high temperature fire could destroy the field.

Today, there is interest in researching the potential for an agave-type CAM plant to serve as a bioenergy feedstock while perhaps offering additional co-products that could provide some alternative sources of income for what has become an impoverished rural area. In the Yucatan today, there are significant social and land tenure issues that present potential obstacles to large scale resurrection of plantation scale production. These are relics of the historic hacienda-peonage systems, subsequent land reforms and unsuccessful state-sponsored efforts to maintain henequen production. Most of the land in the former plantations was granted to local communities as “ejidos” in land-reform programs after the Mexican Revolution. Over time, this land is again reverting to private holdings and in some cases (see KUOSOL report) it is being consolidated by those with the means to purchase and invest.

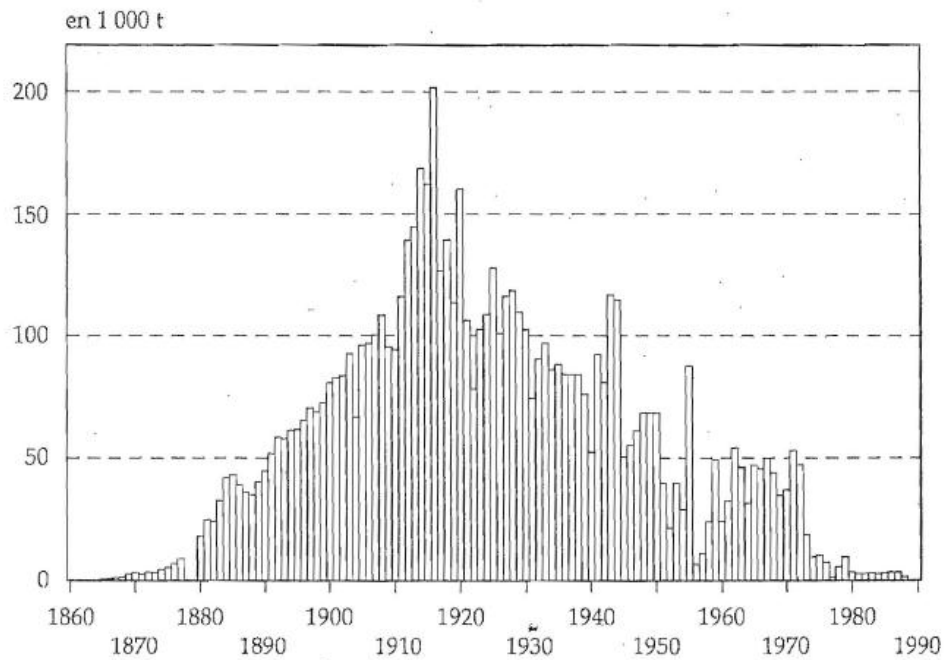
Given the many arid regions of the world with few productive options, the development of an improved variety of agave offering high yields and multiple co-product options, could be of interest.



Reports indicate that the henequen plantation area was bean-shaped, running roughly parallel to the coastline and extending beyond the boundaries of Yucatan into Campeche to the west/southwest and slightly into Quintana Roo to the east. The size of the Yucatan state (illustrated above) is 38,400 km² (3.8 million hectares) meaning that henequen plantations at one time covered about 5% of the state's area.



Henequen export from Yucatan/Mexico (1880-1990)



Sources: 1860-1935 (S. Askínasy, 1936, *El problema agrario de Yucatán*, México, pp. 100-103), 1936-1990 (*FAO Trade Yearbooks*), 1939 (E. Aznár Mendoza, 1977, «Historia de la industria henequenera desde 1919 hasta nuestros días», in *Enciclopedia yucatanense*, vol. III, p. 779), 1940-1947, 1951, 1955 (E. Iglesias, 1983, «La nueva coyuntura en la industrialización henequenera de Yucatán y el comercio con Estados Unidos», in *Yucatán: Historia y Economía*, VI, 36, p. 67)

Sources:

- Dun's Review, International Edition. Vol. XII, No 2, pgs 18-21; October 1908 (digitized by Google Books).
- Nickel, Herbert J. 2006 (first English edition of book). Henequen-Plantagen in Yucatan (first published in German in 1995) Arnold Bergstraesser Institute (ABI), Freiburg i.Br., Germany. ISBN 3-928597-11-6 abifr@abi.uni-freiburg.de
- Wikipedia
- <http://www.mexicomike.com/stories/henequen.htm>
- Coercion, Culture and Debt Contracts: The Henequen Industry in Yucatan, Mexico, 1870-1915. Lee Alston, Shannan Mattiace, Tomas Nonnenmacher
- NBER Working Paper No. 13852; Issued in March 2008
- Dr Jeff Brannon of UT El Paso has a comprehensive book called, *Agrarian Reform and Public Enterprise in Mexico*.
- John McClelland: website Henequen (2007)
<http://www.mexconnect.com/articles/521-henequen-and-its-role-in-the-yucatan-s-shifting-fortunes>
- <http://www.yucatanliving.com/culture/none-dare-call-it-tequila.htm> describes the history and attributes the rise of importance of the rope to the invention of the mechanical reaper.