GOALS

Develop sustainable, renewable energy systems for Hawaii and the tropics through:

• Biomass feedstocks that grow year-round.
• Feedstock characteristics that impact conversion processes.
• Renewable energy projects that reduce dependence on fossil fuels.
• Impact of renewable energy projects on rural communities.

This project addresses the BEPO goal to “Develop sustainable technologies to proved a secure, reliable, and sustainable biomass feedstock supply for the U.S. bioenergy industry, in partnership with USDA and other key stakeholders.”
**QUAD CHART OVERVIEW**

**Timeline**
- Start: 7/30/2008
- End: 9/30/2013, Completed: 80%
- End: 6/30/2014, ONR
- End: 5/31/2016, BRDI

**BEPO Barriers Addressed**
- Feedstocks availability and cost.
- Sustainable feedstock production.
- Feedstock quality and monitoring.
- Material properties.

**Budget**

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<tr>
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<td>$492K</td>
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<td>FY2009</td>
<td>$1.4M</td>
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<td>FY2010</td>
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<td>$8.1M</td>
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<td><strong>TOTAL</strong></td>
<td><strong>$7.9M</strong></td>
<td><strong>$10.5M</strong></td>
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<table>
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<tr>
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<tr>
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<td>$991K</td>
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<td><strong>TOTAL</strong></td>
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**Partners**
- Hamakua Springs Water
- Hawaiian Commercial & Sugar
- Office of Naval Research
  - USDA/ARS
  - USDA/NIFA/BRDI
- Oregon State University
- Washington State University
- ZeaChem
PROJECT OVERVIEW

HISTORY:
• Started in 2008 as a Congressionally Directed project to assist the Hawaii Clean Energy Initiative.

CONTEXT:
• Strategic location re: “Asia-Pacific Pivot”
• >90% of Hawaii’s energy needs depend upon fossil fuels.
• Ideal platform for renewable energy projects.

OBJECTIVES:
• Develop high (net) yield of tropical feedstocks
• Optimize biomass conversion of feedstocks
• Develop and assess integrated, sustainable renewable and bioenergy systems for Hawaii and the tropics
APPROACH

- Feedstocks for biofuels:
  - 4 energy crops @ 3 elevations, 3 irrigation levels
  - Develop feedstock yield models
  - Feedstock-conversion interactions
  - Economic and Carbon cycle assessments

- Renewable energy options:
  - Micro-hydro impact on community economic development
  - Cane trash for biopower
  - Landfill gas utilization
  - Wood chips for coal
  - Solar powered irrigation
ACCOMPLISHMENTS

• Simple sequence repeat markers for Napier grass developed.
• Napier grass-by-pearl millet hybrids developed and being evaluated.
• Determined chemical composition of target crops.

• Methodologies to measure carbon dioxide flux and sequestration have been developed.
• Preliminary results indicate sugar cane a atmospheric C source, while Napier grass a C sink.
• Strong environmental effect on genotype performance.
• Water affects some crops more than others.
• Harvesting frequency is a consideration.
Green processing of feedstock has pros and cons:

+ Nutrients, min. storage, continuous processing, co-products.
- High moisture, nutrients.

Feedstock pre-processing required.

Techno-economic analyses needed.

Life cycle analyses needed.
Relevance to Biomass Program Multi-Year Program Plan:

• Develop feedstocks, sustainable agronomic practices, and feedstocks production processes and systems.
• Develop, test and demonstrate sustainable feedstocks logistics systems.

Applications of Expected Project Outputs:

• Results applicable to a vertically integrated 35,000 acre agribusiness.
• Hawaiian Electric Company and other utilities currently seeking local biofuel.
• Results applicable to regional allies in the Asia-Pacific region.
  • Australia (biofuels)
  • Papua New Guinea (biopower)
• Department of the Navy’s Great Green Fleet Initiative
CRITICAL SUCCESS FACTORS

Success Factors
- Comprehensive study
- Integrated analyses
- Focus on feedstocks relevant to the tropics
- Partners with expertise, resources, and production readiness

Challenges
- Coordinating project tasks and deliverables.
- Research vs Development.

Advancing Technology
- Identification and baseline of new feedstocks
- Predicting tropical biomass production that is of strategic importance
- Baseline for environmental sustainability in tropical environments
FUTURE WORK

• Continue multi-year energy crop trials
• Complete feedstock characterization for biochemical and thermochemical conversion to biofuel
• Terrestrial carbon stock and dynamics
• Net energy productivity of tropical bioenergy crops
• Economic impact of low-cost electricity to increase food production and employment opportunities in a rural community
• Develop and validated crop simulation models
• Techno-economic and life cycle assessments.
• Strategic importance for the Nation and the tropics.
• Comprehensive in scope.
• Developing high-yield biomass feedstocks that are grown sustainably.
• Strong collaborative team involving academe, government, and large and small commercial entities.
• Information sharing with other state and regional bioenergy entities.
ADDITIONAL SLIDES
This is a lot of money to be spending in a state/area that has limited ability to meet its own renewable liquid fuel needs, let alone the country’s needs.

It is clear that Hawaii cannot meet all its energy needs through bioenergy; however, any replacement of imported fossil fuels will benefit the Hawaiian economy and reduce the carbon footprint of this remote island community. Before any commercial-scale bioconversion facilities are planned, we must determine whether feedstock can be grown sustainably (economically, environmentally and community friendly), and that the feedstock characteristics are compatible with the planned conversion processes. Very little research has been conducted on tropical feedstocks, and the results from this research will be useful for growers in Hawaii and many tropical areas of the world. Many large and small land owners are very interested in the results of this project, but the reality is that if biomass feedstocks cannot be grown economically on 35,000 contiguous acres, it will be hard pressed to be economically viable on smaller acreage.
The focus of this research is on growing biomass feedstocks sustainably and understanding how the feedstock may affect biochemical and thermochemical conversion processes. If the feedstocks can be grown sustainably at competitive costs, viable conversion processes will be evaluated (this is being evaluated in the current BRDI project). This project addresses the fuel versus food issue by developing models to produce feedstocks in areas where food crops are not being grown (this is the reason for the wide ranges in elevation and irrigation for the energy crop evaluations to obtain growth coefficients under this growing conditions). The models developed from this project will estimate the biomass yields, input requirements, economics, life cycle analyses and environmental impacts. As an example of the possible environmental impacts, we will be assessing the impacts of perennial grasses on carbon sequestration in organic-matter depleted soils. Maintaining adequate levels of soils organic carbon in the tropics is always a challenge because of year-round microbial activity in the soil which converts organic carbon into carbon dioxide. If these perennial crops add to the soil carbon balance in tropical soils, this will be a positive factor in the long-term sustainability of growing these crops.
Publications:


Publications (continued):


Presentations:


Presentations (continued):


Illukpitiya, P. Economic competitiveness of biofuel feedstock production in Hawaii. Presented at the Dalian Nationalities University, Jinzhou, Dalian, Liaoning, People's Republic of China (October 25 - 26, 2010).


Reeves, Mataia * and Susan Crow. 2010. "Assessing the Potential Carbon Sequestration of Hawai'i's Soils Used for Bioenergy Feedstock Production: An Investigation of Soil Fractionation Methods”. CTAHR Student Research Symposium, University of Hawaii, Honolulu, HI.

Smith, Leanna * and Scott Turn. 2010. "Net energy analysis of bioenergy feedstock production of Eucalyptus" CTAHR Student Research Symposium, University of Hawaii, Honolulu, HI.


Presentations (continued):

Takara, Devin* and Samir Khanal. 2010. "Wet processing of adolescent Pennisetum purpureum for enhanced sugar release and co-product generation," CTAHR Student Research Symposium, University of Hawaii, Honolulu, HI.


