SUSTAINABILITY OF WOODY BIOMASS PRODUCTION

Potential Environmental Benefits and Concerns

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<th><strong>WEYERHAEUSER: FOREST PRODUCTS LEADERSHIP</strong></th>
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<td><strong>FOUNDED:</strong></td>
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<td><strong>2011 REVENUES:</strong></td>
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<td><strong>FORTUNE 500 RANK:</strong></td>
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<tr>
<td><strong>NUMBER OF EMPLOYEES:</strong></td>
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<td><strong>TECHNOLOGY STAFF:</strong></td>
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<td><strong>FORESTLAND OWNED OR MANAGED:</strong></td>
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SUCCESSFUL MANAGEMENT DEPENDS ON SUSTAINABLE PRACTICES
SIGNIFICANCE OF SUSTAINABLE MANAGEMENT

• Responsible environmental performance critical to:
  – Meeting regulatory obligations
  – Obtaining third-party certification
  – Retaining customers
  – Maintaining “public license to operate”
WOODY FEEDSTOCK FOR BIOFUELS

- Major impetus for the development of biofuels is environmental concerns related to climate change.
- Positive impact on GHG emissions relative to fossil fuels but also environmental concerns relative to the production of feedstock.
SUSTAINABILITY ISSUES

- Carbon – GHG
  - Life Cycle Analysis (LCA) What is the carbon balance of biomass production and transportation?
  - What are the GHG consequences of biofuels relative to fossil-based alternatives?

- Productivity and Soil Nutrients
  - What are the effects of various biomass production strategies on soil properties and long-term tree productivity?
SUSTAINABILITY ISSUES

- **Water**
  - What effect does biomass production have on water yield, timing of flow and water quality?

- **Biodiversity**
  - How does flora and fauna respond to biomass production?
GBEP ENVIRONMENTAL

THE GLOBAL BIOENERGY PARTNERSHIP SUSTAINABILITY INDICATORS FOR BIOENERGY
FIRST EDITION

GBEP ENVIRONMENTAL

PILLARS
GBEP’s work on sustainability indicators was developed under the following three pillars, noting interlinkages between them:

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<th>Environmental</th>
<th>Social</th>
<th>Economic</th>
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| THEMES
GBEP considers the following themes relevant, and these guided the development of indicators under these pillars:

- Greenhouse gas emissions
- Productive capacity of the land and ecosystems
- Air quality
- Water availability, use efficiency and quality
- Biological diversity
- Land-use change, including indirect effects
- Price and supply of a national food basket
- Access to land, water and other natural resources
- Labour conditions
- Rural and social development
- Access to energy
- Human health and safety
- Resources availability and use efficiencies in bioenergy production, conversion, distribution and end-use
- Economic development
- Economic viability and competitiveness of bioenergy
- Access to technology and technological capabilities
- Energy security/Diversification of sources and supply
- Energy security/Infrastructure and logistics for distribution and use

INDICATORS

1. Lifecycle GHG emissions
2. Soil quality
3. Harvest levels of wood resources
4. Emissions of non-GHGs air pollutants, including air toxics
5. Water use and efficiency
6. Water quality
7. Biological diversity in the landscape
8. Land use and land-use change related to bioenergy feedstock production
9. Allocation and tenure of land for new bioenergy production
10. Price and supply of a national food basket
11. Change in income
12. Jobs in the bioenergy sector
13. Change in unpaid time spent by women and children collecting biomass
14. Bioenergy used to expand access to modern energy services
15. Change in mortality and burden of disease attributable to indoor smoke
16. Incidence of occupational injury, illness and fatalities
17. Productivity
18. Net energy balance
19. Gross value added
20. Change in consumption of fossil fuels and traditional use of biomass
21. Training and re-qualification of the workforce
22. Energy diversity
23. Infrastructure and logistics for distribution of bioenergy
24. Capacity and flexibility of use of bioenergy
CREATING A RESEARCH PLATFORM

- Establish a system of study sites where a complete set of basic environmental data is being collected
- The availability of the sites and support for collection of base data will attract collaborators
  - Additional expertise
  - Access to new sources of support – grants
  - Credibility
- Studies established in NC, AL, MS, WA, OR, UY
AFFORESTATION IN URUGUAY

• Forestry program initiated in 1990s to diversify the rural economy of Uruguay
• Areas with soils unsuited to agriculture designated for forestry
• 23% of land designated for forestry (4 million ha); 1 million ha planted by 2010
• Raised questions about ecological response:
• Research site in northern Uruguay and initiated studies on afforestation effects on hydrology, plant biodiversity, soils and carbon, bird communities
• Collaborators: Weyerhaeuser, Universidad de la Republica, Instituto Nacional de Investigación Agropecuaria (INIA), North Carolina State University, University of Washington, Mississippi State University, National Council for Air and Stream Improvement (NCASI)
WY-UW: EUCALYPTUS ROTATION

1. Grassland
- trees, + grazing

2. Young Forest
+ trees, - grazing

3. Mid-stage Forest
+ trees, + grazing

4. Old Forest
+ trees, + grazing

5. Post-Harvest
- trees, + grazing
Objective: Evaluate the effect of afforestation on water yield and quality

- Collaboration with North Carolina State U., INIA and U. d.l. Republica
- Four watersheds included in study; 80 ha to 114 ha
- Three treatments and a control watershed
  - Pine afforestation
  - Eucalyptus afforestation
  - Pasture/grassland (control)
  - Undecided
- Pine and control watersheds established in 2000 – planted 2003
- Eucalyptus and biomass watersheds established in 2009 – planted 2013
Study initiated in 2009

- Effect of afforestation on understory plant diversity
- Invasive potential of loblolly pine (*P. taeda*)
- Conducted in conjunction with U. of Washington and INIA
Site-level Total Species Richness

Species richness (per 40m$^2$)

$p = 0.0056$

Year since planting

Specie richness
- 11 year-old pine plantations
- Seedling density highest in forests, low in grasslands
- Seedlings in grasslands only near forest edge
Objective: Examine the effects of afforestation on soil carbon, nutrients and physical properties
Collaboration with NCASI, INIA, U. of WA and U. de la Republica
Objective: Examine the effect of afforestation on bird diversity, abundance and nest productivity

Collaborative effort with U. de la Republica and Mississippi St. U.

Examining species present and nest productivity through the forest management cycle
RESTORATION AND WOODY

• Site level responses need to be extended to broader spatial and temporal scales to be at socially and economically relevant.

• Forest biomass management effects will vary across the landscape in time and intensity
  – Cannot be applied to all acres
  – Effects will vary through the tree rotation

• Developed methods of scaling-up results from the plot- and watershed-scale studies to regional scale estimates of environmental response – models and remotely-sensed data
CAMPOS GRASSLANDS

Figure reproduced from Azpiroz et al. (2012)
CONCLUSIONS

• Any approach to biofuels production will require a thorough evaluation of all sustainability concerns and the development of management techniques that address impacts.

• An integrated, collaborative research program is a very effective method for generating the information necessary to develop sustainable biomass production methods.