Biomass for bioenergy: Outline

- What?
- > Why?
- > Which crops are preferable?
- Current sources
- > Future sources
- > Examples
- Discussion
- Resources for more information



DOE Bioenergy Technology Office's Sustainability Activities

ENERGY | Energy Efficiency & Renewable Energy

Identifying and addressing the challenges for sustainable bioenergy production through field trials, applied research, capacity building, modeling, and analysis.



eere.energy.gov



McBride et al. (2011) *Ecological Indicators* 11:1277-1289 Dale et al. (2013) Ecological Indicators 26:87-102.

Recognize that measures and interpretations are <u>context</u> specific Efroymson et al. (2013) *Environmental Management* 51:291-306.

Looking at the biofuel supply chain in terms of sustainability indicators





Efroymson et al. (2013) Environmental Management 52:291-306. Dale et al. (2013) Ecological Indicators 26:87-102.

Water

- Greenhouse gases
- Biodiversity
- Air quality -----
- Productivity

- Social well being
- External trade
- Energy security
- Resource conservation
- Social acceptability

Categories without major effects

Which biomass crops are preferable?

Preferred biomass production systems -

- Promote improved land management
- Provide other services to society
- Increase efficiency and help minimize or eliminate:
 - fossil fuels
 - "wastes"
- Reduce "climate forcing" (different from GHG emissions and worthy of a separate talk)
- Can compete in the local market
- Support adaptive management
- Promote continual improvement toward "sustainability"

What biomass sources are recommended?

- Those that most effectively achieve society goals



Biofuels need to be sustainably managed

THE STATUS QUO

BIOFUELS

INHERENTLY UNSUSTAINABLE **POORLY** MANAGED SUSTAINABLY MANAGED Production of Non-Conventional Petroleum Use of Unsustainable Land Management **Development of Biofuels Based on** with Loss of and Harm to Natural Ecosystems Practices and/or Conversion of Perennial Sustainable Land Management Practices **Ecosystems to Intensive Agriculture** and Perennial Feedstocks INCREASING GREENHOUSE GAS EMISSIONS **REDUCED GREENHOUSE** INCREASED GREENHOUSE GAS EMISSIONS GAS EMISSIONS INCREASED SHALE OIL BIODIVERSITY AND LOSS OF BIODIVERSITY WILDLIFE HABITAT OIL SANDS AND WILDLIFE HABITAT MINING LOSS OF BIODIVERSITY ALTERED NATURAL AND WILDLIFE HABITAT HYDROLOGY INCREASED FOOD SECURITY DECREASED INCREASED SOIL SOIL ORGANIC INCREASING DECREASED SOIL ORGANIC CARBON CARBON TRANSPORTATION ORGANIC CARBON HAZARDS INCREASED SUSTAINABLE RURAL DEVELOPMENT NCREASING **REDUCED SOIL EROSION** INCREASED SOIL EROSION COSTS TO FIND AND ACCESS REDUCED FERTILIZER USE INCREASED FERTILIZER USE AND LEACHING/EMISSIONS AND LEACHING/EMISSIONS OFFSHORE DAMAGED WATER QUALITY DAMAGED WATER QUALITY IMPROVED WATER QUALITY DRILLING

Dale B et al. (2014) Take a Closer Look: Biofuels Can Support Environmental, Economic and Social Goals.

OAK RIDGE

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Pop Quiz

Photo credit: Ron Savage http://sierravistaimages.zenfolio.com/ Q: What percent of global population depends on bioenergy as their primary household fuel (e.g. for cooking and heating)?

Pop Quiz

What percent of global population depends on bioenergy as their primary household fuel (e.g. for cooking and heating)?

	2004	2015	2030
Sub-Saharan Africa	575	627	720
North Africa	4	5	5
India	740	777	782
China	480	453	394
Indonesia	156	171	180
Rest of Asia	489	521	561
Brazil	23	26	27
Rest of Latin America	60	60	58
Total	2 528	2 640	2 7 27

Table 15.2: People Relying on Traditional Biomass (million)

Chapter 15 - Energy for Cooking in Developing Countries

431

A: 38% (2.5 billion out of 6.5 billion total pop. in 2006; considerable uncertainty with these data)

EA World Energy Outlook Special Report (2006)

Traditional biomass (cooking) represents about 9% of primary global energy use. Q: What percent of primary global energy comes from liquid biofuels?

Pop Quiz

A: While traditional biomass represents about 9% of primary global energy use, less than 1% currently comes from liquid biofuels,

A: 0.8% (2012)

What are current sources of biomass? Global consumption: traditional, heat

Estimated Renewable Energy Share of Global Final Energy Consumption, 2012



REN21. 2014. Renewables 2014 Global Status Report (Paris: REN21 Secretariat).



Current biomass sources: biofuels

Ethanol, Biodiesel, and HVO Global Production, 2000–2013



REN21. 2014. Renewables 2014 Global Status Report (Paris: REN21 Secretariat).



Current biomass sources: wood pellets

Figure 7. Wood Pellet Global Production, by Country or Region, 2000-2013



www.ren21.net

Current biomass sources: Large losses = opportunities for future improvement

Purpose-Forest Agriculture Food and Municipal Fuel wood. and forest grown fibre wastes* crop residues, crops residues processing dung from harvesting residues and scavenging Food Global annual Animal Chemical Materials | Energy feeds feedstock primary biomass demand 55.6 EJ Modern Traditional biomass bioenergy Heat Losses Losses Industry used **Biofuels** Electricity Buildings Heat for cooking and heating * Organic solid and liquid wastes Policy Network REN REN21. 2014. Renewables 2014 Global Status Report (Paris: REN21 Secretariat).

Biomass Resources and Energy Pathways

1 Kg of LPG (liquid petroleum gas) is approx. equivalent to 6.5 to 30 kg of traditional biomass:



Source: Sepp 2014 (giz)