Boosting Bioenergy: Sustainable Paths to Greater Energy Security

IEA Bioenergy Workshop: Mobilizing Sustainable Bioenergy Supply Chains: Opportunities for Agriculture
Rome, 17 May 2016

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International Renewable Energy Agency (IRENA)
Modern Biomass May More than Triple

26 EJ in 2010

- Buildings: 8 EJ
- Industry: 8 EJ
- Power: 5 EJ
- Transport: 3 EJ

27 EJ in total

94 EJ in 2030

- Buildings: 28 EJ
- Industry: 24 EJ
- Power: 19 EJ
- Transport: 23 EJ

94 EJ in total
Pockets of Sustainable Bioenergy

• Agriculture
  ▪ Residues associated with growing food production
  ▪ Higher yields on cropland (sustainable intensification)
  ▪ Efficient livestock husbandry: freeing up pastureland
  ▪ Reduced food losses and waste: freeing up farmland

• Forestry
  ▪ Residues (complementary fellings on timberland)
  ▪ Higher yields in planted forests (better management)
  ▪ Afforestation of degraded forest and marginal lands

• Algae
Two main types of agricultural residues
- Harvest residues (sustainably collect 25% - 50%)
- Processing residues (practically collect 90% or more)

Potential for biofuels from the residues
- 79 to 128 EJ of agricultural residues collectable by 2050
- 33 EJ of residue projected to be needed for animal feed
- 46 to 95 EJ remaining available for conversion to biofuel
- 40% efficient process for converting lignocellulose
- 18 to 38 EJ of advanced biofuel could be produced
- (22 EJ used for marine shipping and aviation in 2012)
Yield Gap: Illustrated by Maize

Ratio of Actual to Potential Yield for Maize (Year 2000)

Source: Global Agro-Ecological Zones
Pastureland Available Globally for Biofuel Crops

- Pastureland: 3.4 billion ha
- Cropland: 1.5 billion ha

- 1.5 billion ha marginal & very
  - Could possibly grow some energy crops adapted to saline or desert conditions

- 1.4 billion ha prime & good
  - Could be more suitable for energy crops than food crops

- 70 million ha more for food by 2050 (FAO)

Agricultural Land (Billion Hectares)

% Dietary protein

% Harvested Crops
## Best Practice Losses by Food Chain Stage

<table>
<thead>
<tr>
<th>Food Type</th>
<th>Agricultural Production</th>
<th>Postharvest Handling &amp; Storage</th>
<th>Processing and Packaging</th>
<th>Distribution: Supermarket Retail</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>2%</td>
<td>2%</td>
<td>3.5%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Roots &amp; Tubers</td>
<td>6%</td>
<td>7%</td>
<td>10%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>Oilseeds &amp; Pulses</td>
<td>6%</td>
<td>0%</td>
<td>5%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Fruits &amp; Vegetables</td>
<td>10%</td>
<td>4%</td>
<td>2%</td>
<td>8%</td>
<td>5%</td>
</tr>
<tr>
<td>Meat</td>
<td>2.9%</td>
<td>0.2%</td>
<td>5%</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>Milk</td>
<td>3.5%</td>
<td>0.5%</td>
<td>0.1%</td>
<td>0.5%</td>
<td>0.1%</td>
</tr>
</tbody>
</table>
Potential Land for Solid Biomass

• Closing the Yield Gap: 550 M ha
• Better Use of Pasture Land: 950 M ha
• Reduced Food Chain Losses: 270 M ha
• Reafforestation: 350 M ha
• TOTAL: OVER 2 BILLION HECTARES, 300 EJ
# How Large Is the Biofuel Potential?

<table>
<thead>
<tr>
<th>Category</th>
<th>Primary Biomass Energy Content</th>
<th>End Use Bioenergy with 1st/3rd Generation Biofuel or Combined Heat and Power (80% Efficiency)</th>
<th>End Use Bioenergy with 2d Generation Biofuel Conversion (40% Efficiency)</th>
<th>REMAP 2030 Assumptions for Primary Biomass Energy (Reference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Residues</td>
<td>46 - 95 EJ</td>
<td>36 - 76 EJ</td>
<td>18 - 38 EJ</td>
<td>19 - 48 EJ</td>
</tr>
<tr>
<td>Higher Crop Yields</td>
<td>47 - 88 EJ</td>
<td>37 - 70 EJ</td>
<td>19 - 35 EJ</td>
<td>0 EJ</td>
</tr>
<tr>
<td>Pasture Land</td>
<td>71-142 EJ</td>
<td>57-114 EJ</td>
<td>28 - 57 EJ</td>
<td>33 - 39 EJ</td>
</tr>
<tr>
<td>Reduced Food Waste</td>
<td>40 - 83 EJ</td>
<td>32 - 66 EJ</td>
<td>16 - 33 EJ</td>
<td>18 EJ</td>
</tr>
<tr>
<td>Cultivating Forests</td>
<td>83-141 EJ</td>
<td>42-112 EJ</td>
<td>21 - 56 EJ</td>
<td>41 - 58 EJ</td>
</tr>
<tr>
<td>Total</td>
<td>287-549 EJ</td>
<td>204-438 EJ</td>
<td>102-219 EJ</td>
<td>112-162 EJ</td>
</tr>
</tbody>
</table>
Policies to Boost Solid Biomass

• **Accelerate improvement of crop yields** by expanding extension services to spread modern farming techniques.

• Improve understanding of **logistical approaches** for cost-effective harvesting of farm and forest residues.

• Collect **comprehensive data** on land that could be used for sustainable **wood and grass crops**, including likely yields.

• Conduct in-depth research on **practices for cultivating rapidly growing trees and grasses** on pastureland that could sequester carbon and enhance biodiversity.

• Institute **more secure land tenure** and **better governance** to provide incentives for more intensive land management.

• Provide Incentives to plant **trees on degraded lands**.
BOOSTING BIOFUELS
Sustainable Paths to Greater Energy Security