From 1st to 2nd generation biofuels

PUTTING SOCIAL ASPECTS ON THE SCALE

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Shares of world oil consumption

IEA (2010)
Biofuels technology adoption

- **Engine technology and fueling structure**
  - Biofuels can be blended with gasoline or diesel

- **“Democratic” technology**
  - While not all countries have oil, many can produce biofuels
## Bioethanol

<table>
<thead>
<tr>
<th>1st generation</th>
<th>2nd generation (lignocellulosic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Starch and sugar crops</td>
<td>• Lignocellulosic feedstock</td>
</tr>
<tr>
<td>○ Maize</td>
<td>○ Agriculture and forest residues</td>
</tr>
<tr>
<td>○ Wheat</td>
<td>○ Municipal solid wastes</td>
</tr>
<tr>
<td>○ Sugarcane</td>
<td>○ Short-rotation forests and prairie grasses</td>
</tr>
<tr>
<td>○ Sugar beet</td>
<td>• Technologies in pilot or demonstration stage</td>
</tr>
<tr>
<td>• 80% of liquid biofuels</td>
<td></td>
</tr>
<tr>
<td>• U.S. + Brazil = 90% total production</td>
<td></td>
</tr>
</tbody>
</table>
Social aspects of bioethanol production

- Core social criteria

- Land use aspects
- Water security
- Food security
- Rural development
- Economic aspects
- Social acceptance
- Public participation
1. Land use aspects

1. Emergence of monocultures for large-scale production of feedstocks
2. Spatial reorganisation of land use types

Photo by Djof
1. Land use aspects

- Agribusiness objectives vs. rural communities objectives
- Social access to the land
- Displacement of rural workers to urban areas
### 1. Land use aspects

<table>
<thead>
<tr>
<th>1st-Generation</th>
<th>lignocellulosic</th>
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<tbody>
<tr>
<td>Crop expansion towards land dedicated to other activities</td>
<td>Use of agriculture and forest residues, municipal waste as feedstocks</td>
</tr>
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<td>Crop expansion towards land dedicated to other activities</td>
<td></td>
</tr>
</tbody>
</table>

- **Lignocellulosic**
  - Use of agriculture and forest residues, municipal waste as feedstocks
2. Water security

1. Water requirements for each type of feedstock
2. Local climate conditions
3. Water availability for irrigation
4. Conversion technologies
5. Effluent generation
Total population
Rural population
Water resources per capita

Data: FAO/AQUASTAT, 2008
## 2. Water security

<table>
<thead>
<tr>
<th>1st-generation</th>
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<tr>
<td>Plants need water to grow</td>
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</tr>
<tr>
<td>Maize and sugarcane are water efficient</td>
<td>Woody crops from existing forests should perform better</td>
</tr>
<tr>
<td>Crop grown on ‘marginal’ land, with low irrigation</td>
<td>Woody crops grown with degraded water irrigation on ‘marginal’ land</td>
</tr>
<tr>
<td>Feedstock grown on ‘marginal land’, without irrigation</td>
<td></td>
</tr>
</tbody>
</table>

Plants need water to grow
3. Food security

- Current 1st-generation bioethanol could not substitute half of our gasoline use even if all cropland in the world were used to feedstock cultivation.

- Although in debatable levels, increasing in the production of 1st-generation bioethanol could interfere with food prices.
3. Food security

- The ‘marginal’ land concept

  - Low potential for food production
  - No carbon sinks
  - Low levels of biodiversity
  - Not dependent on irrigation

  But, what about...

  - Indigenous communities or poor minorities
  - Cultural value of those land to some groups
# 3. Food security

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<thead>
<tr>
<th>1st-generation</th>
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<tbody>
<tr>
<td><strong>Energy crops can compete with food</strong></td>
<td><strong>Crops could compete with food if expansion is towards land dedicated to other activities</strong></td>
</tr>
<tr>
<td><strong>Maize and sugarcane are water efficient</strong></td>
<td><strong>Perennial grasses as potential option if grown in marginal lands</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Woody crops grown with degraded water irrigation on ‘marginal’ land</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Municipal solid waste as feedstock</strong></td>
</tr>
</tbody>
</table>
4. Rural development

- Changes in rural labour force patterns
- Changes in communities density
- Economic risks to small farmers
- Negative impacts mostly concentrated on poorer countries from Asia, Africa and Latin-America (essentially rural)
### 4. Rural development

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<tr>
<td>Biofuel power plants cause changes in labour patterns</td>
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</tr>
<tr>
<td>Feedstock plantations cause changes in community density</td>
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</tr>
<tr>
<td>Energy crops involve financial risks to small farmers</td>
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</tr>
<tr>
<td>Poor countries suffer from major social impacts</td>
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</tr>
<tr>
<td>Residues and waste used as feedstock could generate new jobs and attract investments??</td>
<td></td>
</tr>
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5. Economic aspects

- Feedstock market price depend on crop-yield fluctuations
- Bioethanol should be able to compete with gasoline prices
- The whole supply-chain interferes with bioethanol prices
5. Economic aspects

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<tr>
<td>Technology is fully deployed</td>
<td>Technology is in R&amp;D stage + pilot facilities</td>
</tr>
<tr>
<td>Its production is often subsidized</td>
<td>Conversion process is very expensive</td>
</tr>
<tr>
<td>Compete with fossil fuel prices</td>
<td>Conversion of lignocellulose by-products into value added chemicals</td>
</tr>
<tr>
<td>Bioengineering to increase crop productivity</td>
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</tr>
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</table>
6. Social acceptance of bioethanol

- Very few studies
- Little attention to differences between 1st-generation and lignocellulosic bioethanol
- Lack of depth with respect to the arguments behind the opinion
6. Social acceptance of bioethanol

- **Savvanidou et al. (2010)**
  - North-Eastern Greece
  - Potential area for feedstock cultivation
  - No distinction between bioethanol and biodiesel

- **Delshad et al. (2010)**
  - Mid-Western U.S.
  - Important bioethanol producer region
  - Distinguished between 1st-generation and lignocellulosic

- **Skipper et al. (2009)**
  - U.S. and Belgium, simultaneously
  - Food versus fuel controversy
  - 1st-generation bioethanol and biodiesel
6. Social acceptance of bioethanol

The group that was most supportive of biofuels was the one that showed less knowledge about biofuels.

People think that energy saving is preferable over new energy sources adoption.

Lignocellulosic bioethanol is preferred cause it’s made from non-edible crops.

Social impacts are not discussed.
7. Public participation

- A lot of literature available surrounding overall energy aspects
  - Renewable energy sources
  - Energy policy (USDOE, Performance and Innovation Unit of UK, Danish parliament...)

- Consensus conferences, citizens panels, participatory workshops, public hearings, mediation
Why participatory assessments

- Foster democratic exercise
- Social learning (knowledge input)
- Social acceptability of the technology in the future
Conclusions

- Social impacts of bioethanol production are closely related to environmental consequences.

- Lignocellulosic bioethanol production from residues or waste could present minimised negative social consequences compared with 1st-generation bioethanol.

- The use of marginal lands can entail less negative social impacts than the use of other cropland or those dedicated to livestock activities.
Conclusions

A more socially sustainable option...

- Low-contaminant and efficient conversion process
- Low costs throughout the supply-chain
- High availability
- Residues and waste only
- Affordable technology available to poorer regions
Priority issues to be addressed

- More empirical data is needed, especially from rural regions of poorer countries
- Scientific and public consensus surrounding the ‘marginal’ land concept should precede evaluation of potential areas
- Consequences of climate change over agriculture should be considered and best investigated through modelling
- Priority should be given to integrated assessments that include participatory methods
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