Production and availability of agricultural residues for energy in LAC and EU

learning from the Indian experience.

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# Agricultural residues

<table>
<thead>
<tr>
<th></th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
<td>In the field during agricultural practices or during harvest</td>
<td>In a related industry during transformation of the main product</td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td>Straw, stalks, leaves</td>
<td>Bagasse, shells, fibers</td>
</tr>
</tbody>
</table>
| **Characteristics** | Heterogeneity  
Spread over large areas | Homogeneity  
Concentrated in the industry |
Agricultural residues for energy production

- Abundance and renewability
- Cheaper biomass than dedicated plantations
- Complementarity rather than competition with food production
- Local resource, available in every agricultural area

How much residues are produced? At what conditions are they available for industrial energy production?

- Low energy density
- Seasonal variations and instability
- Availability limited by competitive uses
  - Soil management (fertility, erosion)
  - Animal feed
  - Construction material
- Spread over large areas → high cost collection

Focus on EU and LAC regions

Results and discussion based on the Indian experience in the industrial energy use of agricultural residues
Assessment methodology for... Crop residue availability

Crop residue production

Agricultural production

From FAO-Stat 2007-2011

Residue-to-product ratios:
- Specific value for each residue
- Estimated from literature
- Ex: 1.3T straw produced / T wheat

GTP Gross technical potential

x rpr

Recoverability factors after agricultural or other uses
- Global value for primary and secondary residues
- Estimated from literature
- Ex: 15% and 55% of primary and secondary respectively remain available after agricultural needs

RF_{agri}

GTP Gross technical potential

x RF_{agri}

NTP Net technical potential

x RF_{other}

pp Practical potential

Agricultural uses
- Soil
- Animal feed

Other uses
- Domestic fuel
- Construction
### Crop residues selected for productions assessment in EU-28 and LAC

#### 29 crop residues from 21 crops

<table>
<thead>
<tr>
<th>PRIMARY RESIDUES</th>
<th>SECONDARY RESIDUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Straw from cereals, soybean, mustard and rapeseed</td>
<td>- Sugarcane bagasse</td>
</tr>
<tr>
<td>- Stalks from sunflower, maize and cotton</td>
<td>- Groundnut shells</td>
</tr>
<tr>
<td>- Residues from pineapple harvest</td>
<td>- Coconut shell, husks and pith</td>
</tr>
<tr>
<td>- Coconut fronds</td>
<td>- Rice husk</td>
</tr>
<tr>
<td>- Groundnut haulms</td>
<td>- Corn cob</td>
</tr>
<tr>
<td>- Sugarcane tops and leaves</td>
<td>- Oil palm empty bunches, fibers</td>
</tr>
<tr>
<td>- Coffee branches</td>
<td></td>
</tr>
<tr>
<td>- Banana rachis</td>
<td></td>
</tr>
</tbody>
</table>

*Milhau A. Fallot A.*
Crop residues generated by agricultural production in EU-28 and LAC

19% of world prod.
High secondary residues prop. 7% of world prod.
Low secondary residues prop.

<table>
<thead>
<tr>
<th></th>
<th>Production (10^6 tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>World</strong></td>
<td>5623</td>
</tr>
<tr>
<td><strong>LAC Region</strong></td>
<td>1083</td>
</tr>
<tr>
<td><strong>EU</strong></td>
<td>403</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5623</td>
</tr>
<tr>
<td>Secondary residues</td>
<td>1002</td>
</tr>
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Crop residues generated by agricultural production in EU-28 and LAC

**In EU-28**
- 7% of world crop residues production
- Only 3% secondary residues
- Straws of wheat and barley + stalks of maize and rapeseed = 85% residue production
- France, Germany, UK, Poland and Spain = 5 main producers (60% of EU production)

**In LAC**
- 19% of world crop residues production
- 72% are primary; 28% are secondary
- Sugarcane bagasse / tops and leaves + Soybean and maize stalks = 81% residue production
- Brazil = 60% of LAC crop residues production
- Brazil, Argentina, Mexico, Colombia
Availability

<table>
<thead>
<tr>
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<th>Secondary residues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraction dedicated to soil</td>
<td>85%</td>
<td>45%</td>
</tr>
<tr>
<td>and animal feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fraction dedicated to other</td>
<td>20%</td>
<td>60%</td>
</tr>
<tr>
<td>uses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Availability = small part of residues generated

(PP = 12-15% of GTP)

GTP
403 Mt

NTP
65 Mt

PP
49 Mt

GTP
1083 Mt

NTP
283 Mt

PP
160 Mt

6% secondary

41% secondary

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EXAMPLE WITH RICE

Straw: 5 ton/ha generated (GTP)
0.7 ton/ha potentially available (PP)

In a region where rice use 30% of land

→ 476,000 ha are needed to feed a 10MW plant

Primary residues availability limited by costs and transportation
Learning from the Indian experience

- Assessment of crop residues production and their availability
- Compare with how they are used for energy production through the CDM experience
- Understand conditions in which crop residues can be mobilized for energy production
Learning from the Indian experience

**The Indian Context**

- 2010, India generated 0.6 billion tons crop residues = 10% world production
- 2004-2010: 136 CDM using crop residues for energy generation → data
  - Installed capacity of 1300MW (0.8% total installed cap.) (9.8MW/project on average)
  - Mainly consume secondary residues: rice husk and bagasse
  - Primary residues poorly exploited: 1-3% PP, mainly cotton stalks
  - Technology: Direct combustion, energy for captive use or sold to the grid
  - Average efficiency: 0.6 kWh/kg residues

**Observed Consequences:**

- Exhaustion of a few residues vs. potentials of other remain largely untapped
- Agricultural residues price increases by 30% between 2004 and 2010
- Technology limited for full exploitation of the energy potential
Conditions for the exploitation of residues

- **Financial analysis**, based on IRR, gives information concerning important parameters to maintain viability of projects:
  - Electricity purchase tariff and crop residues cost: most determinant factors.
  - Carbon credits: impulse projects implementation but cannot compensate for fuel cost increase.

![Diagram showing required variation to compensate a 10% increase in fuel cost](image)
Conditions for mobilizing residues for energy production

**AVAILABILITY**
Crop residue generated ≠ available for energy production
Think first: SOIL, ANIMAL FEED AND OTHER USES previously
Global asses.: 15% residues generated are available for energy, must be adjust at local level

**Projects feasibility**

- QUALITY
- PRICE
- QUANTITY
- DISTANCE

Secondary residues are more attractive: food industries can transform crop residues into energy for captive use → economic incentive.
More risky to implement profitable energy plant that have to collect and transport residues to make energy and sell it to the grid.

**Projects viability**

- CONSTANCY OF RESIDUE PRODUCTION (Depends on climate, markets, agricultural policies...)

- PRICE OF THE BIOMASS (including transportation cost)
  - New market for residues, without regulation → prices rise up
  - Risk: residues can be sold for energy with negative impact on soil and agric. production

- ELECTRICITY PURCHASE TARIFF
  - Determinant factor for feasibility and viability of projects
  - Needs for politics decision to state on the electricity produced from residues

- CARBON PRICE: « good to take but not determinant incentive »,
  - cannot absorb residue price increase
Perspectives for energy production from residues in LAC and EU

In LAC, situation similar to India
- Important quantity of residues generated (++) secondary residues) but projects didn’t boomed in LAC as in India
- **Obstacle**: Electricity purchasing conditions limit adoption of projects (Mexico & Colombia, pioneers in small scale)
- Industrial **opportunity** for economic and environmental competitiveness (Bagasse valorization largely adopted...)
- **Alternative**: residues can be transform into biomaterial
- **Challenge**: improve technology efficiency and provide market for the energy
- **Caution**: projects should be go with measures to prevent take off residues from soils, animals or other uses

In EU-28
- Scarcity of secondary residues limits projects feasibility
- Experiences of large-scale energy production from straw in Denmark, UK...
- **Obstacle**: availability and constancy of resource → residues mixed with other fuels such as wood or coal
- European countries can invest in residue projects in developing countries through CDM
Thank you for your attention

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Questions?
Discussion