Effects of Agricultural Biogas-Production on Land Use and Land Use Change in Lower Saxony

B. Osterburg & N. Röder
Thünen Institute of Rural Studies, Braunschweig (Germany)
Motivation of the study

- German grassland declined markedly within the last decade (-9%)
- Area cropped with silage maize expanded (+69%)
  - Despite declining cattle stocks (-14%)
  - Parallel to increasing capacity of biogas digesters (+5,900%)
- Maize most frequent crop after grassland conversion

Datasource: DeStatis (various years); FVB (2012)
Background (Biogas)

Why is it promoted?
- Climate Change (Saving GHG by replacing fossil fuels)
- Increasing self-sufficiency
  - Replacement of fossil fuels
  - High energy yields per ha compared to other biofuels
- Development of technology (new technologies for export markets)
- Promotion of agriculture (instead of intervention or other safety nets)

How is it promoted?
- Renewable Energy law
  (support per kWh of electricity produced or per m³ of gas fed into the gas grid)
Background

(Grassland loss)

Why is it of concern?

• Climate Change (Loss of soil carbon in case of conversion to arable land)
• Various environmental issues
Background

(Grassland loss)

Why is it of concern?

- Climate Change (Loss of soil carbon in case of conversion to arable land)
- Various environmental issues

Datasource: Osterburg et al. (2009); data for 4 North-West German Länder
Research Questions

Does the promotion of biogas lead to an increased grassland conversion or is it coincidence?

- Who is converting grassland to arable land?
- Up to which distance influence biogas digesters land use decisions?
- Is there an effect of site characteristics such as soil or legal designation as protected area?

![Graph showing changes in agricultural land use](image-url)

Source: Osterburg et al. (2012)
Data

Data
• Integrated Accounting and Control System (IACS) Data for 2005-2007
  • Plot specific data on land use and characteristics of the farmer (avg. plot size 2.6 ha)
• Location and capacity of biogas digesters (BNetzA)
• Soil map of Lower Saxony (1:50,000)

Study area
• 2.6 Mio ha UAA (72% arable land)
• Avg. Farm size:
  • 62 ha
  • Standard Output: 210 k€ vs. 25 k€ (EU-27))
• High intensive dairy (North) and granivore (West) production
• Increasing dairy and granivore production
• 11% of grassland converted to arable land (2005-2009)
  Net conversion
Methods

Geographical intersection of the data

**Analysis of Variance** (Kruskal-Wallis and Wilcoxon Test)
- Who is converting grassland to arable land?

**Logit analysis**
- Up to which distance influence biogas digesters land use decisions?
- Is there an effect of site characteristics such as soil or legal designation as protected area?
## Results (Grassland Conversion)

### Who is doing it?

<table>
<thead>
<tr>
<th>Without crops for biogas production</th>
<th>Grassland Loss in Lower Saxony of total (in %)</th>
<th>in the group (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farms without livestock</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td>... with non-grazing livestock</td>
<td>2.5</td>
<td>5.3</td>
</tr>
<tr>
<td>... with grazing livestock, no dairy</td>
<td>11.3</td>
<td>1.5</td>
</tr>
<tr>
<td>... with dairy (extensive)</td>
<td>19.1</td>
<td>2.5</td>
</tr>
<tr>
<td>... with dairy (intensive)</td>
<td>40.2</td>
<td>4.3</td>
</tr>
<tr>
<td>With crops for biogas production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farms without livestock</td>
<td>1.8</td>
<td>12.5</td>
</tr>
<tr>
<td>... with non-grazing livestock</td>
<td>1.6</td>
<td>12.8</td>
</tr>
<tr>
<td>... with grazing livestock, no dairy</td>
<td>4.5</td>
<td>7.7</td>
</tr>
<tr>
<td>... with dairy (extensive)</td>
<td>8.3</td>
<td>7.4</td>
</tr>
<tr>
<td>... with dairy (intensive)</td>
<td>7.9</td>
<td>7.9</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Source: Osterburg (2010).

**) Dairy extensive: < 1.8 livestock units (LU) per hectare main forage area (MFA), Dairy extensive: > 1.8 LU/ha MFA.
Results (Grassland conversion)

Influence of the biogas digester

![Graph showing the likelihood of grassland conversion compared to the regional average against distance from the next biogas digester (in km). The graph illustrates a decreasing trend with higher likelihood near the digester and lower likelihood as the distance increases. There are specific areas highlighted to indicate regions of interest.](image-url)
Results

(Grassland conversion)

Effects of designated areas

Average conversion rate

Conversion of permanent pasture in % (basis 2005)

Conversion of permanent pasture to arable land (ha) in % of permanent pasture area 2005 (right axis)

Conversion of permanent pasture in 1,000 hectares

Source: Osterburg et al. (2012)
Results (Grassland conversion)

Effects of soil characteristics

- Higher conversion rates on organic soils (histosols) and wet soils (gleysols)
- Low conversion rates on shallow and dry soils (e.g. Leptosols)
Results (Cultivation of Biogas feedstock)

Effects of nearest digester
- Strong positive effect within the next 3 km but identifiable until 9 km

Effects of designated areas
- Markedly lower increase only on protected habitats (regional legislation) (-73%) and nature protection areas (-27%)
- Slightly lower increase in Landscape and Water protection area (~-10%)
- Slightly higher increase in SPA (+10%) and SAC (+20%)

Effects of soil characteristics
- Higher conversion rates on organic soils (histosols) and wet soils (gleysols)
- Low conversion rates on shallow and dry soils (e.g. Leptosols)
Summary

Biogas production is additional driver for grassland conversion (via direct and indirect effects (mainly via raising tenure))

However, more grassland is converted by dairy farms

Biogas feedstocks are overproportionally grown on carbon rich and moist soils

→ Severely challenges the climate mitigation effect of biogas

Conversion even of grassland with high biodiversity value

Preliminary data for 2005-2009 confirm trends
Take away message

Biogas from plants is not a reasonable option to produce energy

• Compared to technical renewables
  • Too costly
  • Too area ineffective
  • Too many negative side effects (intensification, leaching,...)

• Compared to timber (short rotation coppices)
  • Too strongly linked to the location of production
    (due to the high water content of intermediates and residuals)
Thank you for your attention

contact: Norbert Röder
norbert.roeder@ti.bund.de