Agricultural adaptation to climate change under different policy environments

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Contents

- Background and aim of the ‘Agri-Test Case’/interaction with stakeholders: DG-Agri
- Modelling approach
- Results and discussion
Climate change impacts on agriculture in EU

2003: heat wave in Europe
Projections: mainly positive effects in Northern Europe, negative in South

lower crop yields

Olesen and Bindi, 2002, Olesen et al., 2011
## Climate change and other drivers of change in EU

<table>
<thead>
<tr>
<th>Policy</th>
<th>Socioeconomics and Environment</th>
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<tbody>
<tr>
<td></td>
<td><strong>Demand</strong></td>
</tr>
<tr>
<td>CAP pillar I</td>
<td>Population, GDP growth (consumption)</td>
</tr>
<tr>
<td>(single farm payment, safety net, cross compliance, greening ..)</td>
<td></td>
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<tr>
<td>CAP pillar II</td>
<td>Consumer preferences (meat, organic)</td>
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<td>(LFA, agri-env. zones)</td>
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<tr>
<td>Environmental policy</td>
<td>Bio-based economy</td>
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<tr>
<td>(NVZs, ESAs)</td>
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<td></td>
<td>Multi- and bi-lateral trade liberalization EU enlargement</td>
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</tbody>
</table>
Farmers are faced with changes in (i) CAP and markets and (ii) climate change, such as more frequent extreme weather events, that may result in lower yields and/or yield quality.

Agri-test case: use an Integrated Assessment Model (IAM) approach to gain more insight in consequences of changes in climate, in interaction with changes in CAP and global markets, on agricultural income and environmental impacts.
Discussion aspects with Stakeholders: DG-Agri

- Key policy questions and aims test case
- Time scale and geographic extent of the assessment
- Indicators for economic and environmental impacts
Aim test case in view of policy questions: Assess

- the impacts of climate change and changing technology on crop yields, crop patterns and *farm net income*.
- the resulting consequences for the *environment (emissions of N, P and GHG to air and water)*.
- which adaptations at *farm level* to changed climate conditions are most effective.
- which are the most (CAP) effective *(inter)national* policy instruments to support adaptation.

for the year 2050, depending on farming structure, bio-physical conditions and region within EU27
Integrated assessment of adaptation strategies

Scale dependent responses

Drivers
- Climate
- Market
- ...

Impact
- Performance, Risk, Resilience
- Adaptation

Policy
- Subsidies
- Protection
- ...

Agriculture
- Food production
- Land use
- Income
- Environment
- Productivity

Global
- China
- EU
- Country
- Region
- Farm
- Field

Global (WTO, ..)
- EU (CAP, ..)
- National
- Region
- Farm management
- Crop management

Agri-adapt scheme used in the test case
Approach

- Multi-scale assessment of climate change impacts, policy changes and adaptation strategies by linkage of a:
  - Crop growth model (SIMPLACE): effects on crop yield, N-Demand, Water-Demand.
  - Socio-economic model CAPRI: impacts of agricultural policies and CC on markets, farm management and income.
  - Environmental quality model (INTEGRATOR): effects on the environment.
  - Farm model (FSSIM): effects on farm income and labour demand (incorporates farm management; specific regions).
Scenarios

B1 is baseline scenario; A1-b1 is strong economic growth and B2 is weak economic growth: no policy changes are investigated, other than through different global scenarios.

<table>
<thead>
<tr>
<th>Scenarios IPCC</th>
<th>Variations</th>
<th>Climate change (change in CO₂ and climatic parameters)</th>
<th>Technological change (e.g. improved cultivars)</th>
<th>Price changes for both inputs and products</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1, A1-b1, B2</td>
<td>CLIM</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>B1, A1-b1, B2</td>
<td>CLIMT</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>B1, A1-b1, B2</td>
<td>CLIMP</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>B1, A1-b1, B2</td>
<td>CLIMTP</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Linkages between drivers and results

- Scenarios
  - Climate + CO$_2$ change
  - Technology
  - Prices
  - Food demands

- Crop Yield ↑
  - Farm income

- $\Delta$Cropping pattern
  - Labour demand

- N emissions air
  - N uptake/ N input
  - N losses water
Results

Ratio of selected model outcomes (farm income, labour demand, N inputs and N$_2$O emissions) in 2050 and in base year (2003-2005)

- for two regions in Europe, i.e. Flevoland/The Netherlands and Midi Pyrenées/France.
- for three IPCC scenarios (Base line B1, A1-b1 and B2)
- four variations (CLIM, CLIMT, CLIMP and CLIMTP)
Example of current and future cropping patterns

**Flevoland Base year**
- Onion
- Potato seed
- Spring barley
- Spring wheat
- Sugar beet
- Winter wheat

**Midi Pyrénées Base year**
- Maize grain
- Soya bean
- Sunflower
- Winter durum wheat
- Winter soft wheat
- Other (crops&fallow)

**Flevoland B1 scenario - Effect of Climate change**
- Onion
- Potato seed
- Spring barley
- Spring wheat
- Sugar beet
- Winter wheat
- Other (crops&fallow)

**Flevoland A1-b1 scenario - Effect of Climate change**
- Onion
- Potato seed
- Spring barley
- Spring wheat
- Sugar beet
- Winter wheat
- Other (crops&fallow)
Relative changes in farm net income averaged across all farm types in Flevoland and Midi Pyrenées for the Base line (i.e. B1), A1-b1 and B2 scenarios for 2050 compared to the Base year (i.e. 2003-2005), for the variations CLIM, CLIMT, CLIMP and CLIMTP.
Relative changes in farm labour demand averaged across all farm types in Flevoland, Midi Pyrenées and Denmark for respectively the Base line (i.e. B1), A1-b1 and B2 scenarios for 2050 compared to the Base year (i.e. 2003-2005), considering the variations CLIM, CLIMT, CLIMP and CLIMTP.
Relative changes in nitrous oxide emissions in Flevoland, Midi Pyrenées and Denmark for respectively the Base line (i.e. B1), A1-b1 and B2 scenarios for 2050 compared to the Base year (i.e. 2003-2005), considering the variations CLIM, CLIMT, CLIMP and CLIMTP.
Relative changes in the sum of N leaching and runoff to ground water and surface water in Flevoland, Midi Pyrenées and Denmark for respectively the Base line (i.e. B1), A1-b1 and B2 scenarios for 2050 compared to the Base year (i.e. 2003-2005), considering the variations CLIM, CLIMT, CLIMP and CLIMTP.
Discussion and conclusions

- Farm income mostly increases in B1 and A1 scenario but may decrease in B2 scenario in response to changes in crop yields, cropping pattern and prices for inputs and outputs.

- Changes in farm labour demand depend on region and are mainly caused by changes in cropping patterns.

- Changes in N emissions and N leaching are mainly caused by changes in total N inputs, which are determined by changes in crop yields (mostly increase) and cropping patterns.
Discussion and conclusions

- The differences in farm net income between scenarios are mainly caused by differences in *prices* and less by changes in climate/technology.

- Changes in labour demand are mainly due to the differences between the four variations and less between the three scenarios.

- Considering the different influencing variables, it is clear that the results are highly variable between scenarios, variations and regions.
Thank you for the attention