The environmental role of protein crops in the new common agricultural policy

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Protein crops

Aspects of the protein deficit

Resource effects

Environmental effects

Competitiveness

Policy implications and options
Forage legumes
Cereal production is remarkably stable in Europe

Source: FAOstat 2013
Europe is one of the world’s largest users of soy

Source: FAOstat 2013
Growth in poultry and pig meat consumption is the major driver behind increased plant protein imports.

Source: FAOstat 2013.
Growth in poultry and pig meat consumption is the major driver behind increased plant protein imports.
European livestock production depends on imported protein - and crop land outside Europe

Carbohydrate

Protein
The proportion of EU cropland used for protein crops is low since 1961. The area has declined from 4.6 to 1.8% of arable land in Europe. 

Source: EuroSTAT 2013

Since 1961 the area has declined from 4.6 to 1.8% of arable land in Europe
This means that the EU is foregoing any resource and environmental effects of legume crops.
Resource protection

Protein crops require no nitrogen fertiliser and the need for fertiliser in the following crop is lower

Photo: RAUCH Landmaschinenfabrik GmbH
Resource effects

Break crop effect:
Reduced crop diseases
Improved soil conditions
Improved soil fertility

15 - 25% yield increase in following crop yield
These are all ‘internal’ benefits

Break crop effect:
Reduced crop diseases
Improved soil conditions
Improved soil fertility

15 – 25% yield increase in following crop yield
‘External’ environmental benefits - nitrogen cycle

Lower greenhouse gas emissions (particularly nitrous oxide)
Reduced fossil energy CO₂ emissions
‘External’ environmental benefits - biodiversity

Mass flowering
Crop diversity
Soil organisms
‘External’ environmental benefits - land use change

Source: Paula Fridman/Carbis, Business Week May 22, 2008
### ‘External’ environmental benefits - life cycle

<table>
<thead>
<tr>
<th>Study</th>
<th>% change in environmental impact</th>
<th>Energy demand</th>
<th>GHG emission</th>
<th>Ozone</th>
<th>Eutrophication</th>
<th>Acidi-fication</th>
<th>Eco-toxicity</th>
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<tr>
<td><strong>Comparison of soya-based and domestic legume-based feed</strong></td>
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<tr>
<td>Sweden, pork¹</td>
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<td>-31</td>
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<td>-10</td>
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<tr>
<td>Germany, pork³</td>
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<td>17</td>
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<td>32</td>
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<tr>
<td>France, chicken meat³</td>
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<tr>
<td>France, eggs³</td>
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<td>-10</td>
<td>-5</td>
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</table>

### Comparison of soya-based and farm-produced feed

<table>
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<th>Acidi-fication</th>
<th>Eco-toxicity</th>
<th>Land-use</th>
</tr>
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<tbody>
<tr>
<td>Germany, pork³</td>
<td></td>
<td>-19</td>
<td>-16</td>
<td>-25</td>
<td>-11</td>
<td>-10</td>
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</tr>
</tbody>
</table>

1 Cederberg and Flysiö 2004; 2 Eriksson et al. 2005; 3 Van der Werf et al. 2005
The public benefits of protein crops justify public policy intervention, and farmers respond.
If we want more legume crops, what do they cost society?
## Crop-level gross margins

<table>
<thead>
<tr>
<th>Case study, year</th>
<th>Annual gross margin (€/ha)</th>
<th>Gross margin deficit of legume compared to other crop (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Wheat</td>
</tr>
<tr>
<td><strong>Netherlands, 2008</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pea</td>
<td>631</td>
<td>-571</td>
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<tr>
<td>Faba bean</td>
<td>796</td>
<td>-406</td>
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<tr>
<td>Lupin</td>
<td>616</td>
<td>-586</td>
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<tr>
<td><strong>France Midi Pyrénées, 1999-2003</strong></td>
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<tr>
<td>Rainfed loam</td>
<td>Soya bean 245</td>
<td>206</td>
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<tr>
<td>Pea</td>
<td>-48</td>
<td>-87</td>
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<tr>
<td>Rainfed clay</td>
<td>Soya bean 253</td>
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</tr>
<tr>
<td>Pea</td>
<td>-52</td>
<td></td>
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<tr>
<td>Irrigated loam</td>
<td>Soya bean 83</td>
<td></td>
</tr>
<tr>
<td>Pea</td>
<td>153</td>
<td></td>
</tr>
<tr>
<td>Irrigated clay</td>
<td>Soya bean 189</td>
<td></td>
</tr>
<tr>
<td>Pea</td>
<td>190</td>
<td></td>
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<tr>
<td><strong>France Ariège, 2009</strong></td>
<td></td>
<td></td>
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<tr>
<td>Pea</td>
<td>-181</td>
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</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td><strong>240</strong></td>
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</table>

**Sources:** Calculations based on data from:  
1Kamp et al. (2010),  
2Mahmood (2011),  
## Cropping sequence gross margins

<table>
<thead>
<tr>
<th>Case study, year</th>
<th>Annual gross margin incl. precrop effect (€/ha/yr)</th>
<th>Legume rotation</th>
<th>Rotation without legume</th>
<th>Deficit of legume rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regional data, averaged 2000-2004</strong> ¹</td>
<td></td>
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<tr>
<td>Germany Saxony-Anhalt</td>
<td>278</td>
<td>281</td>
<td>-3</td>
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<tr>
<td>Germany lower Bavaria</td>
<td>142</td>
<td>167</td>
<td>-25</td>
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<tr>
<td>Denmark Fyn</td>
<td>193</td>
<td>213</td>
<td>-20</td>
<td></td>
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<tr>
<td>Switzerland Vaud</td>
<td>926</td>
<td>1107</td>
<td>-181</td>
<td></td>
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<tr>
<td>Spain Castilla y Leon</td>
<td>55</td>
<td>53</td>
<td>2</td>
<td></td>
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<tr>
<td>Spain Navarra light soil</td>
<td>331</td>
<td>330</td>
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<tr>
<td>Spain Navarra deep soil</td>
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<td>France Barrois</td>
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<td>243</td>
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<td>France Picardie</td>
<td>425</td>
<td>428</td>
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<td><strong>Regional data averaged 2001-2007</strong> ²</td>
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<tr>
<td>France Eure et Loir</td>
<td>737</td>
<td>738</td>
<td>-1</td>
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<tr>
<td>France Seine Maritime</td>
<td>833</td>
<td>839</td>
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<td>Germany Niedersachsen</td>
<td>745</td>
<td>792</td>
<td>-47</td>
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<tr>
<td>Spain Castilla-La Mancha</td>
<td>136</td>
<td>137</td>
<td>-1</td>
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<tr>
<td>UK East Anglia</td>
<td>813</td>
<td>852</td>
<td>-39</td>
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<tr>
<td><strong>Average</strong></td>
<td><strong>477</strong></td>
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<td><strong>-24</strong></td>
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<tr>
<td><strong>Range</strong></td>
<td><strong>53 to 1107</strong></td>
<td></td>
<td><strong>-181 to 7</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Sources:** Calculations based on data from:

¹ von Richthofen et al. (2006b) (Considered precrop effects: yield effect on 1st subsequent crop, fertiliser saving, pesticide saving, reduced tillage).
² LMC International (2009) (Considered precrop effects: Yield effect on 1st subsequent crop, N fertiliser saving)
European protein crops are high yielding

Source: FAOstat 2013.
Soy yields in the USA and France

Source: FAOstat 2013.
European protein crops are high yielding, but Europe is a world champion in growing wheat.

- European wheat has a three-fold yield advantage.
- European and US soya bean and US wheat have similar yields.

Graph showing yield (t/ha) from 1960 to 2010 for USA and France wheat and soya bean.
CAP reform: some principles offered
• Multiple and complex public effects point to integrated policy development using complementary policy measures.

• Avoid obligation.

• Work within a comprehensive protein strategy.

Photo: J. Logan
Policy options within the CAP

- More stringent crop diversification requirements (greening in Pillar 1)
- Inclusion of legume crops in ecological focus areas (greening in Pillar 1)
- Voluntary coupled support schemes (direct support under Pillar 1)
Policy options within the CAP (continued)

- Legumes via agri-environment schemes (Pillar 2)
- Organic farming
- Investment into research, breeding, and technical progress
Policy options outside the CAP

• Climate protection policies

• Nutrient policies

• Support producer initiatives

• Support for technical progress
Nitrogen flows in agricultural sector in EU27, reference 2005

Billion kg

- **N₂**: 6.7
- **N₂O**: 0.37
- **NO₃**: 0.08
- **NH₃**: 2.8

Emissions to air

**European agricultural sector**

- **N in feed import**: 2.5
- **N fertiliser**: 11.3
- **N fixation**: 0.7

**Crops**

- N feed EU: 10.9
- N manure: 8.0

**Livestock**

- N in livestock products: 2.2

**Processing**

- N in livestock: 1.4
- N in food crops: 2.0

**Food system**

- Human consumption: 0.9

Emissions to groundwater and surface waters

- N leaching and run-off: 3.3
- Other uses and losses: 0.5

Nitrogen on the Table
TFRN Website
Nitrogen flows in agricultural sector in EU27, reference 2005

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Food system

- N in livestock products 2.2
- N in food crops 2.0

Processing

Human consumption

- 1.4
- 0.9
- 0.7
- 1.3

- Other uses and losses 0.5
- Export cereals 1.5
- Bioenergy crops 0.6

Emissions to groundwater and surface waters

N leaching and run-off 3.3

Nitrogen flows in agricultural sector in EU27, -50% meat, eggs and dairy products

Billion kg

- \( \text{N}_2 \): 3.9
- \( \text{N}_2\text{O} \): 0.25
- \( \text{NO}_x \): 0.05
- \( \text{NH}_3 \): 1.6

Emissions to air

European agricultural sector

- N in feed import 0.9
- N fertiliser 8.0
- N fixation 0.6
- N deposition 2.4

Crops

- N in feed EU 5.9
- N manure 4.7

Livestock

Food system

- N in livestock products 1.1
- N in food crops 2.5

Processing

Human consumption

- 0.7
- 1.3
- 0.7
- 0.7

- Other uses and losses 0.5
- Export cereals 1.5
- Bioenergy crops 0.6

Emissions to groundwater and surface waters

N leaching and run-off 2.0
Conclusions

- The plant protein deficit is due to comparative advantage in cereal production combined with self-sufficiency in cereals and livestock for high levels of livestock consumption.

- Increased protein crop production will contribute to the development of more sustainable and balanced agriculture.

- Public intervention is justified.

- Developing better protein crops for farmers enhances their resource conservation and environmental benefits.

- Higher fertiliser and soya prices encourage protein crop production.
Acknowledgements