Integrated assessment of policy and climate change impacts: a case study on protein crop production in Austria

Economics of integrated assessment approaches for agriculture and the food sector

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outline

• context of analysis, stakeholders, policy relevance: protein crops
• research problem: integrated assessment
• data
• models
• scenarios and results
• discussion and outlook
MACSUR / TradeM

context of the analysis: protein production and use

case study on soy beans in Austria
integrated assessment modeling framework

Source: own construction
regional production of soy 2012

Source: STAT, Agrarstrukturerhebung 2012
soy bean production in AT

Source: STAT, Erntestatistik
soy bean output in AT

Source: STAT, EAA
soy bean balance in AT

Source: STAT, Versorgungsbilanz, various years
soy bean use in AT

Source: STAT, Versorgungsbilanz, various years
soy bean & soy meal feed in AT

Source: STAT, Futterbilanz, various years
farm level: frequency of soy yields

Source: FADN, LBG, BMLFUW, own calculations; observations for 1998-2012
spatial heterogeneity
HRU Homogenous Response Units

Source: own construction
Data: Past and future climates

- period 1975-2005: observed weather data
- period 2010-2040: 5 climate change scenarios (Strauss et al. 2012, 2013): rising trend in temperature (+1.5 °C), different precipitation scenarios

Source: own construction
policy response:
goal stimulation of protein crops
greening of CAP 2013 reform
protein crops are more competitive
concern about CC
MACSUR / TradeM models
CROP ROTA

Source: Schönhart, Schmid, Schneider, 2009
\[
\text{max. TotValue} = \\
\frac{1}{2} \sum \left[p_{\hat{c}, \hat{c}} R_{\hat{c}}^1\right] + \sum \left[\frac{1}{2} p_{\hat{c}, \hat{c}} (R_{\hat{c}, \hat{c}}^2 + R_{\hat{c}, \hat{c}}^2)\right] + \sum \left[\frac{1}{3} p_{\hat{c}, \hat{c}, \hat{c}} (R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}}^3 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}}^3 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}}^3)\right] \\
+ \sum \left[\frac{1}{4} p_{\hat{c}, \hat{c}, \hat{c}, \hat{c}} (R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}}^4 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}}^4 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}}^4 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}}^4)\right] \\
+ \sum \left[\frac{1}{5} p_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}} (R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}}^5 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}}^5 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}}^5 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}}^5 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}}^5)\right] \\
+ \sum \left[\frac{1}{6} p_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}} (R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}}^6 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}}^6 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}}^6 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}}^6 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}}^6 + R_{\hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}, \hat{c}}^6)\right] \\
- \sum p_{\hat{c}} [(T_{\hat{c}} + U_{\hat{c}}) * d] \\
\]

Source: Schönhart, Schmid, Schneider, 2009
Bio-physical process model

EPIC

Source: own construction
simulated protein crop yields 1975-2000

Source: own results
BiomAT

\[ \begin{align*}
\max TGM_i &= \sum_{m} \pi_{i,m} x_{i,m} \\
\text{s. t.} \sum_{m} (A_{i,m} x_{i,m}) &\leq b_i
\end{align*} \]

\[ \forall i \]

- TGM: total gross margin
- \(\pi\): average gross margin in €/ha
- i: grid cells (I=40,244)
- m: management variants (up to 32 per i)
- x: level of crop production in t
- A: technical coefficients
- b: resource constraints

Source: Asamer, Stürmer, Strauss, Schmid, 2011
scenarios

- future CC: 1.5°C +/- 20% precipitation
- increasing prices of protein crops
- c.p.: other prices/costs (2006/2008)
- more land (previously set aside land) for protein crops
- management variants $m$:
  - considered: low/moderate/high intensity, irrigation
  - simulated: more choices on crop rotations
results: +/- management variants

Source: own construction
results: ... plus CC

Source: own construction
extreme scenario S20

Share of cropland cultivated with protein crops

- 0%
- >0 - <=15%
- >15 - <=30%
- >30%

Source: own construction
discussion

• heterogeneity has to be accounted for
• integrated model approaches contribute to our understanding
• accounting for management variants helps explain yield ranges
• in Austria: CC impact relatively minor compared to other factors (e.g. management)
outlook:
yield & revenue variance

Source: FADN, LBG, BMLFUW, own calculations