Influence of Indirect Land Use Change on the GHG Balance of Biofuels

A Review of Methods and Impacts

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Agenda

1. **Brief introduction to the project „Fair Fuels?“**
2. **Definition of „indirect effects“**
3. **Political regulation**
4. **Quantification of indirect land use change (iLUC)**
5. **Conclusions**

Brief introduction to IÖW and “Fair Fuels?”

- **Institute for Ecological Economy Research (non-profit)**
  - independent research and consulting institute
- **several current projects on biomass and renewable energies,**
  - further information on www.ioew.de/en/

- **a recently started 4-year research project on biofuels: “Fair Fuels?”**
  - junior research group with 4 dissertations, 2 habilitations: an interdisciplinary approach
  - 3 case studies: Brazil, Sub-Saharan Africa (Malawi, Mozambique), EU/Germany
  - further information on www.fair-fuels.de/en/

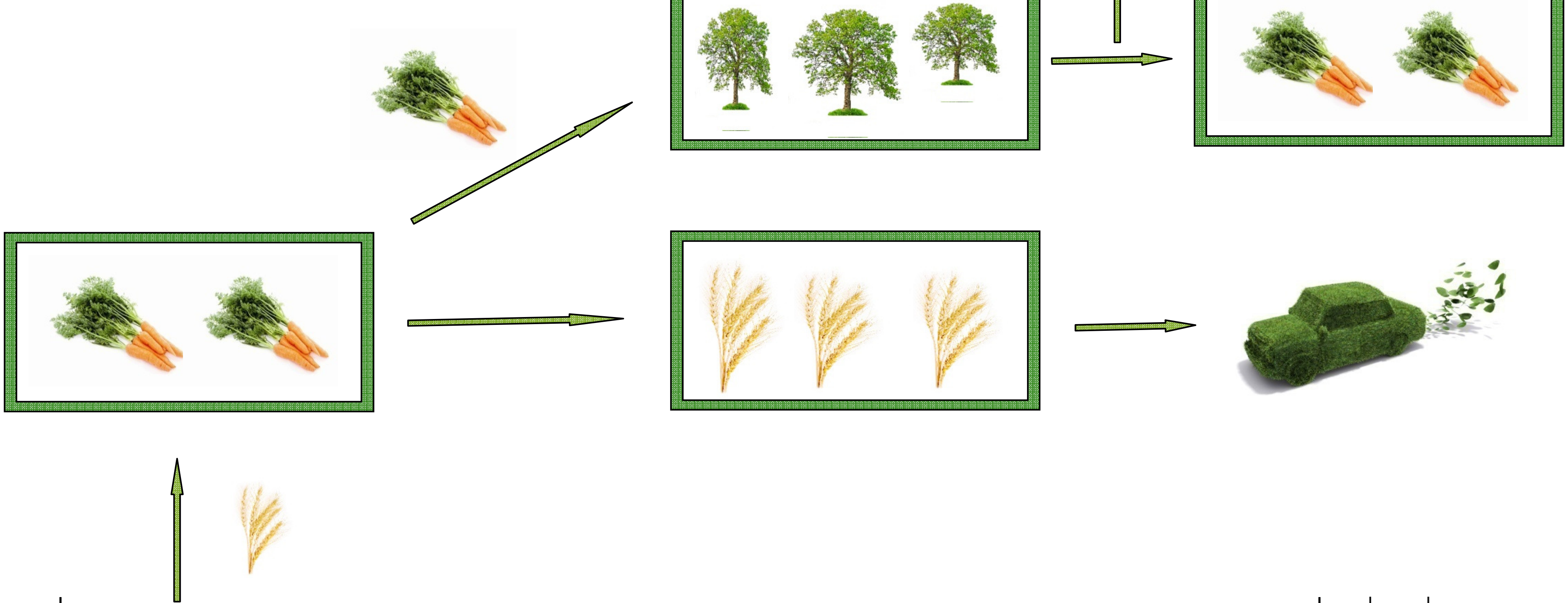
Definition of „indirect effects“

indirect effects:

– *“Indirect effects are the effects that are caused by the introduction of a bio-energy product, but cannot be directly linked to the production chain.”* (Ros et al. 2010)

Definition of „indirect effects“

iLUC – indirect land use change
The cultivation of agricultural products on arable and pasture land can induce a replacement of the previous crops in other regions and areas.
(e.g. Fritsche et al. 2011)



Definition of „indirect effects“ Examples

indirect effects:

- biofuel production -> higher prices of food or fodder crops (e.g. Searchinger et al. 2008)

  -> creation of new agricultural land (iLUC) (e.g. Searchinger et al. 2008)

  -> decreased food consumption -> “free” agricultural areas (iLUC) (e.g. Plevin et al. 2010)

  -> increased use of fertilizer/irrigation (e.g. Fritsche et al. 2010)
  -> GHG effect not clear

- biofuel production -> supply of animal feed as by-products -> “free” agricultural areas (iLUC) (e.g. Lywood et al. 2009)

- subsidies, tariffs etc. (biofuel, agricultural, land use and trade policy) -> change in fuel demand (iFUC) (Rajagopal et al. 2011)

Political regulation

EU Directive 2009/28

– 35% GHG emission reduction compared to fossil fuels, until 2017 50%

Tasks until summer 2011:

– development a method to minimize GHG emissions due to iLUC

– Investigation of the inclusion of an iLUC factor in the GHG emission balance

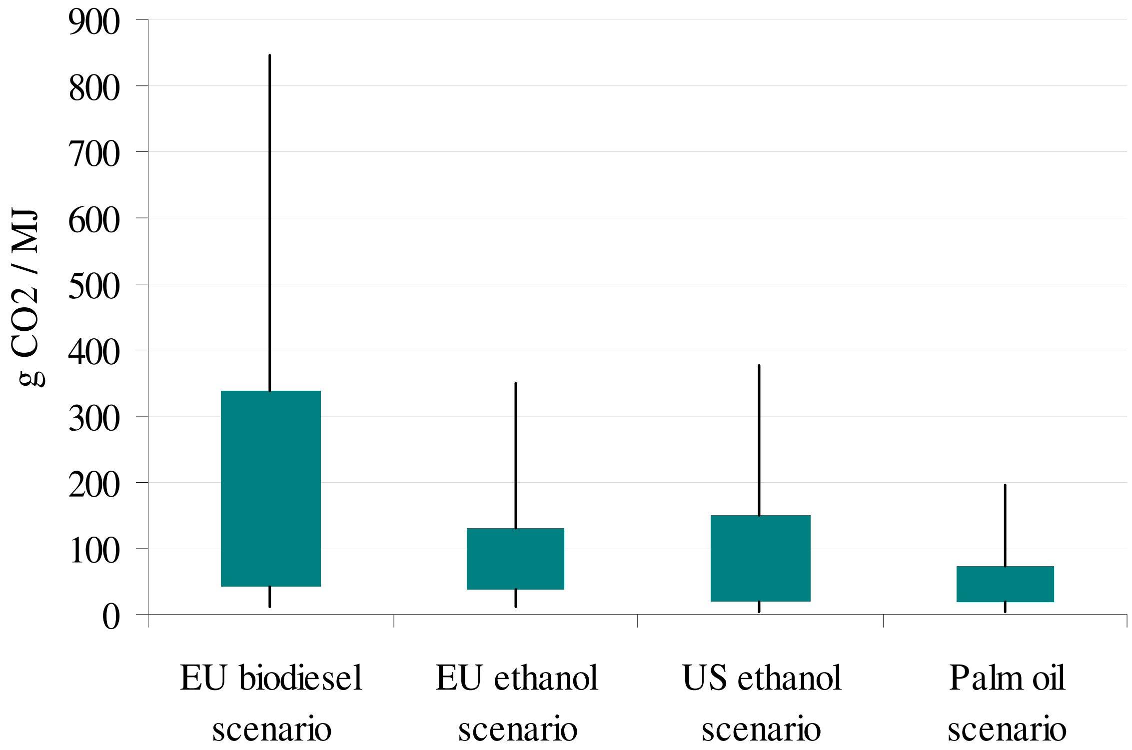
Quantification of iLUC

- **around 2007: first publications about this topic**
  before: rather separated perspectives on different sectors (e.g. Eickhout et al. 2007)
- **three different approaches to quantify iLUC**
  - Economic modeling:
    changes in supply, demand and prices
    (e.g. Searchinger et al. 2008, Melillo et al. 2009, Lapola et al. 2010)
  - Deterministic modeling:
    based on simplified assumptions
    (e.g. Fritsche et al. 2010, Plevin et al. 2010)
  - Regional modeling:
    based on local effects (regional data and observations)
    (e.g. Lahl 2010)

Quantification of iLUC: Economic modeling

- **existing models to forecast market changes induced by agricultural policy measures are developed further and used to estimate iLUC:**
  - general economic models
    - GTAP, LEITAP, MIRAGE, DART
  - and partial economic models
    - FASOM, FAPRI
- **linking these models with biophysical models allows the calculation of GHG emissions due to iLUC**

Quantification of iLUC: Economic modeling



Range of CO_2 emissions due to LUC calculated on basis of results of various economic models using different C emission factors 40 tC ha-1 [error bars: 10 tC ha-1, 95 tC ha-1] – based on Edwards et al. (2010).

- **relevant amounts of GHG emissions due to iLUC in all models**
- **wide range of crop area changes and GHG emissions**

(Edwards et al. 2010)

Quantification of iLUC: Economic modeling

- **reasons for the deviations** (e.g. Edwards et al. 2010)**:**
  - differences in the methods of calculation: by-products
  - differences in the assumptions about increasing use of fertilizer, irrigation
- **general criticism:**
  - not enough consideration of market distortions (e.g. custom duties)
  - lack of tracebility due to high complexity
  - lack of complexity to consider all relevant factors

Quantification of iLUC: Deterministic modeling

for example: iLUC-factor of Öko-Institut (Fritsche et al. 2010)

– **explicit, simplified assumptions**
  – iLUC can be estimated on the basis of exported products
  – and by considering only the most relevant countries
– **approach:**
  – the total area needed to produce these products is calculated -> each country's proportionate share is derived (world mix)
  – share of displaced land corresponds with that in the world mix
  – assumptions about country specific land use changes
  – a theoretical emission potential of 13 t CO_2/(ha*a) based on IPCC conversion factors was calculated

Quantification of iLUC: Deterministic modeling

  - due to yield increases and unused areas -> realistic factors lie between 25 and 75% of the theoretical emission potential
  - with the help of yields and conversion factors biofuel specific iLUC factors were calculated
- **results:**
  - 25%-iLUC-factor: many biofuels miss the GHG emission reduction target of 35% compared to fossil fuels
  - 50%-iLUC-factor: some biofuels have even higher carbon footprints than fossil fuels
- **criticisms:**
  - lack of consideration of internal trade

Quantification of iLUC: Regional modeling

- **approach according to Lahl (2010)**
  - all LUC in a specific country and for a specific period must be acertained
  - GHG emission due to these LUC (ERLUC) are calculated
  - the share of biofuels production is calculated (Δ biofuels production divided by Δ total agricultural production multiplied with ERLUC)
  - dLUC due to biofuels production is subtracted
  - the remaining emissions are allocated to the „originator“ (farms, regions)
- **criticism: iLUC are non-local**

Conclusion

- **observations:**
  - time pressure because of need for political regulation
  - problematic results for first-generation biofuels
  - wide range of results
- **research questions:**
  - What can we learn from regional case-studies for modelling?
  - What relevance do country-specific factors have?
  - Which other indirect effects should be included in GHG balances?
  - How should one allocate the iLUC induced GHG emissions between the biofuel and the previous crop?

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Thank you for your attention.

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