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/

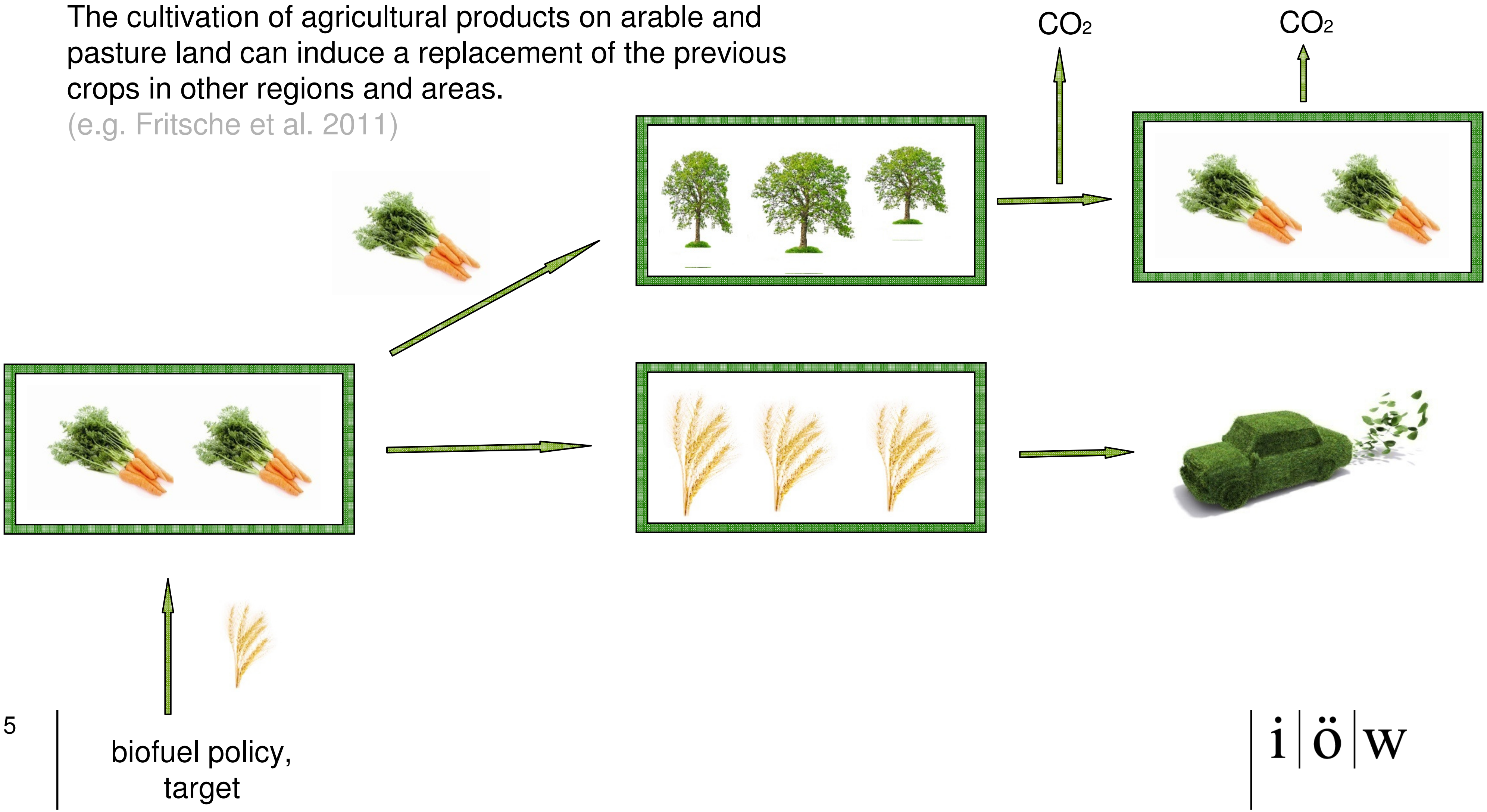
Definition of „indirect effects“

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

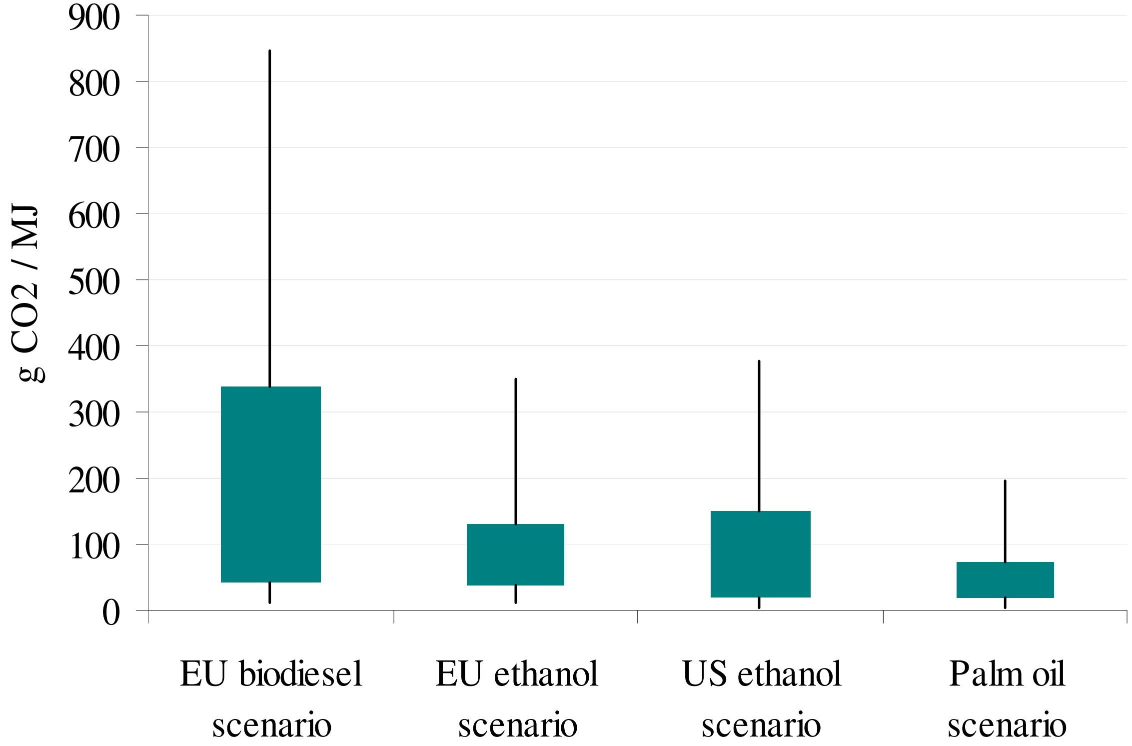
Quantification of iLUC

- **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

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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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