Food Security Impacts of Rural Households' Employment at a Large-scale Biofuel Project in Madagascar

Christine Bosch[1], Manfred Zeller[2], Ana Lucia Kassouf[3]

[1]University of Hohenheim (christine.bosch@uni-hohenheim.de) [2]IFPRI-HarvestPlus [3]University of São Paulo

BACKGROUND

- After hype in 2007/08 and subsequent downfall, Jatropha is still promoted and new projects are being undertaken (Wahl et al., 2012).
- Jatropha production has comparative advantage in areas with low-input farming systems, abundant land, poor infrastructure and high fossil fuel prices (De Yong and Nielsen, 2011, Achten et al., 2014)
- Besides economic, agronomic and environmental questions, doubts exist on the social dimension of sustainability.
- There is little research quantifying socio-economic impacts of large-scale Jatropha production on smallholders, mainly due to lack of baseline studies and detailed data collection. (Hodbod and Tomei, 2013, Van Eijck et al., 2014, Schut and Florin, 2014)
- Former impact analysis of the project in Madagascar shows that
  - households working for the Jatropha plantation are poorer
  - household income is increased and income inequality reduced (Grass and Zeller, 2011, Bosch and Zeller, 2013)

OBJECTIVES

- Provide insights into relationship between employment for the Jatropha project and household food security.

ACTIVITY

- Five household surveys from 2008 – 2013 in three villages in the surroundings of a large-scale Jatropha project in Madagascar
- Focus group discussions
- Food security indicators:
  - Diet diversity, past 7 days (8 food groups with weights, WFP, 2008)
  - Lack of food, past 30 days and 12 months
- Wage work for Jatropha project
  - Number of household members working
- Agricultural production
  - Seeds, yields (kg), land (m^2)
- Fixed effects models
  - Robust standard errors, year dummies included

RESULTS (Focus group discussions)

- Income derived from daily wage work for the project, in particular during off-season and droughts, helps to increase households' resilience against climate variability and poverty.
- Labor demand declined substantially after build-up phase in 2010, very few regular jobs have been created.
- Incomes are mostly used for food and other necessities and only a small percentage is invested in agriculture or business.

RESULTS (Descriptives)

Outcome and explaining variables – Variable means	2008	2009	2010	2012	2013
Diet diversity (8 Food groups, weighted, past 7 days)	9.83	9.50	8.51	13.6	10.1
Lack of food (number of days in past 30 days)	7.7	5.06	3.38	3.46	2.42
HH members working for Jatropha project (Number)	0.91	0.82	1.1	0.54	0.29
Total land per capita (in ha)	0.55	0.42	0.41	0.52	0.43
Crop diversity (Number of crops grown)	4.4	4.7	3.8	8.0	7.4
Agricultural equipment (Dummy)	0.47	0.45	0.53	0.63	0.64
Storeroom for agricultural products (Dummy)	0.26	0.29	0.34	0.37	0.38
Livestock sales (Dummy)	0.48	0.39	0.23	0.61	0.26
Public employment (Dummy)	0.04	0.03	0.04	0.06	0.06
Own Business (Dummy)	0.22	0.34	0.25	0.32	0.23
Employment as agricultural labor (Dummy)	0.37	0.30	0.18	0.56	0.31
Dependents (Number, <10 and >65)	2.0	2.1	2.1	2.0	2.3
Labor force (Number, >=10 and <=65)	3.2	3.3	3.4	4.2	4.2
Total rice yield (kg)	1331	1430	542	1632	944
Total cassava yield (kg)	2267	767	642	1666	1991
Total maize yield (kg)	316	135	45	380	158
Total pulses yield (kg)	143	127	14	260	91
Agricultural workers (Dummy)	0.24	0.42	0.34	0.31	0.38
Mutual help (Dummy)	0.28	0.83	0.85	0.86	0.82
Number of observations	735	613	473	418	390

RESULTS (Fixed effects regression)

	Diet diversity		Lack of food	
	Coefficent	S.E.	Coefficent	S.E.
HH members working for Jatropha project (Nbr)	0.22**	0.10	-0.03	0.29
Total land per capita (ha)	0.32*	0.17	-0.74**	0.36
Crop diversity (Nbr)	0.08**	0.03	-0.18**	0.08
Storeroom for agricultural products (Dummy)	0.50**	0.20	-1.25*	0.67
Livestock sales (Dummy)	1.2***	0.21	-0.28	0.51
Own Business (Dummy)	0.26	0.21	-2.39***	0.52
Labor force (Nbr, >=10 and <=65)	0.19**	0.09	-0.10	0.19
Cassava yield (kg)	-0.0002	0.00	-0.0001**	0.00
Pulses yield (kg)	0.0004	0.00	-0.0003**	0.00
Agricultural workers (Dummy)	0.20	0.20	-1.34**	0.56
Mutual help (Dummy)	0.46*	0.24	-0.82***	0.67
R-sq within	0.39		0.09	
R-sq between	0.20		0.06	
R-sq overall	0.33		0.09	
Number of observations	1633		1979	

LESSONS LEARNED & RECOMMENDATIONS

- Positive impacts on diet diversity, but not on long-term and more subjective food security (Households working for Jatropha plantation use less land, inputs, less yield than others over time, less other activities)
- Recommendations:
  - Rural development: promotion of investments in storage, crop diversification, livestock and savings, off-farm employment
  - For Jatropha plantation: better monitoring of employment, meet local energy needs, provide energy services, sponsor agricultural support programs and activities, set aside land for food growing

REFERENCES & ACKNOWLEDGEMENTS

Achten, WMJ, N. Sharma, B. Muys et al. 2014. Opportunities and Constraints of Promoting New Tree Crops—Lessons Learned from Jatropha, *Sustainability*, vol. 6/no. 6.

Bosch, C., and M. Zeller. 2013.The Impacts of Wage Employment on a Jatropha Plantation on Income and Food Security of Rural Households in Madagascar - A Panel Data Analysis, *Quarterly Journal of International Agriculture* vol. 52/no. 2.

De Jongh, J., and F. Nielsen. 2011. Lessons Learned: Jatropha for Local Development, *FACT Foundation, Wageningen, Netherlands*.

Grass, M., and M. Zeller. 2011. Rural Employment and Income Effects of a Jatropha Plantation in Madagascar, *Quarterly Journal of International Agriculture*, vol. 50/no. 4.

Hodbod, J. and J. Tomei. 2013. Demystifying the Social Impacts of Biofuels at Local Levels: Where is the Evidence?, *Ecological Economics*, vol. 70/no. 2.

Roundtable on Sustainable Biomaterials. 2011. RSB Principles & Criteria for Sustainable Biofuel Production

Schut, M., and MJ. Florin. 2014. The Policy and Practice of Sustainable Biofuels: Between Global Frameworks and Local Heterogeneity. the Case of Food Security in Mozambique, *Biomass and Bioenergy*, vol. 72/no. 0.

Van Eijck, J., H. Romijn, A. Balkema, et al. 2014. Global Experience with Jatropha Cultivation for Bioenergy: An Assessment of Socio-Economic and Environmental Aspects, *Renewable and Sustainable Energy Reviews*, vol. 32.

Wahl, N., T. Hildebrandt, C. Moser, et al. 2013. Insights into Jatropha Projects Worldwide-Key Facts & Figures from a Global Survey, Centre for Sustainability Management (CSM), Leuphana Universität Lüneburg.

World Food Program. 2008. Construction of the Food Consumption Score. WFP – FAO, Rome.

The authors are grateful for the financial support from the Stiftung Energieforschung and the Strategic Network Bio-based Economy (BECY).

GLOBAL LAND USE

Assessing GHG impacts of alternative EU bioenergy policy scenarios

Authors

Hannes Böttcher[1], Klaus Hennenberg[1], Nicklas Forsell[2]

1 – Öko-Institut e.V., Schicklerstraße 5-7, 10179 Berlin, Germany

2 – International Institute for Applied Systems Analysis, Schloßplatz 1, 2361 Laxenburg, Austria

Background

The world is facing increasing demand for biomass. All existing studies on projections of the future demand of biomass as energy carrier or material for EU countries but also the rest of the world show increasing trends.

The increased use of biomass in the EU will impact the environment in the EU but also abroad because more and more biomass is imported.

Global trade of biomass goods, indirect effects caused by a high degree of substitutability of feedstocks, branched process chains and the competition for land make an estimation of net impacts a challenge.

Objective and Activity

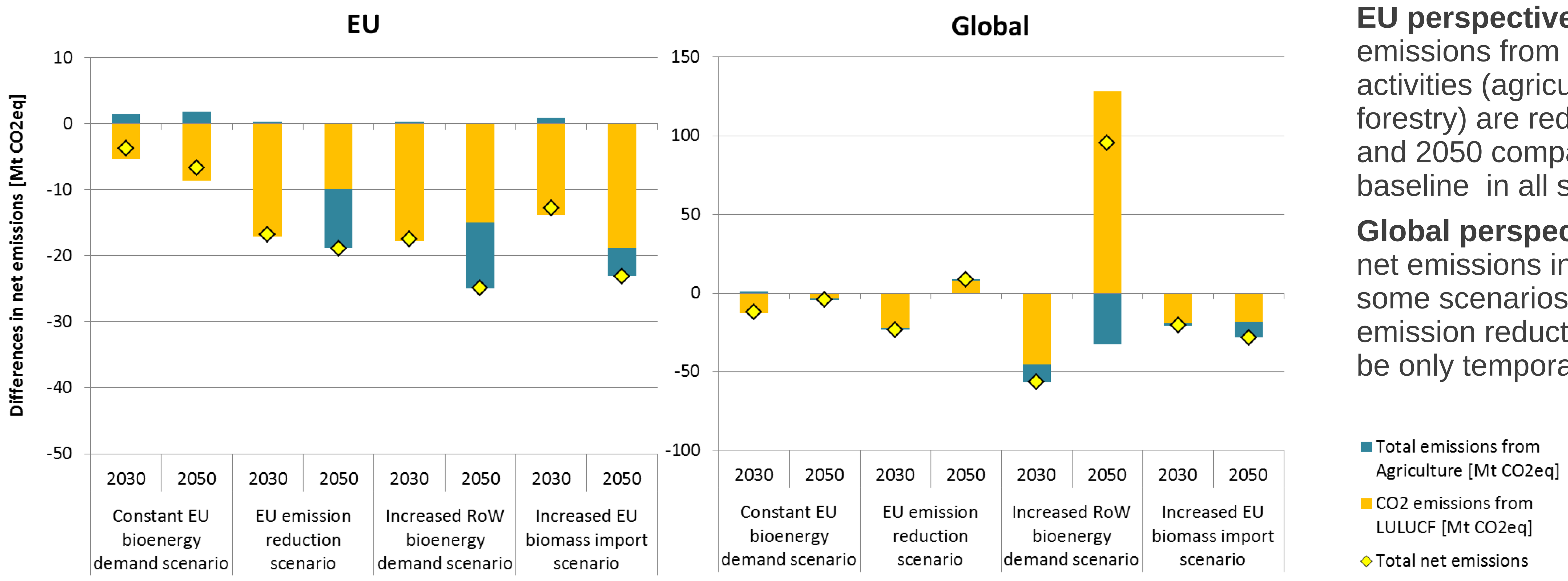
We use results of a partial equilibrium land use model (GLOBIOM) and a forest sector simulation model (G4M) running at IIASA to assess the GHG impacts of alternative scenarios of bioenergy use. GHG estimates include deforestation, afforestation, forest management and agriculture.

		Main model parameters		
		Bioenergy demand in EU28	Bioenergy demand in RoW	Biomass import to EU28
Baseline	Baseline Scenario			
Policy scenarios	EU Emission Reduction Scenario	↗		
	Constant EU Bioenergy Demand Scenario	↗		
	Increased RoW Bioenergy Demand Scenario	↗	↗	
	Increased EU Biomass Import Scenario	↗		↗

The scenarios describe a baseline scenario of current policies and various alternative developments of bioenergy demand until 2050

- demand in EU stagnates,
- demand in EU is largely met by imports and
- demand in the rest of the world increases more strongly.

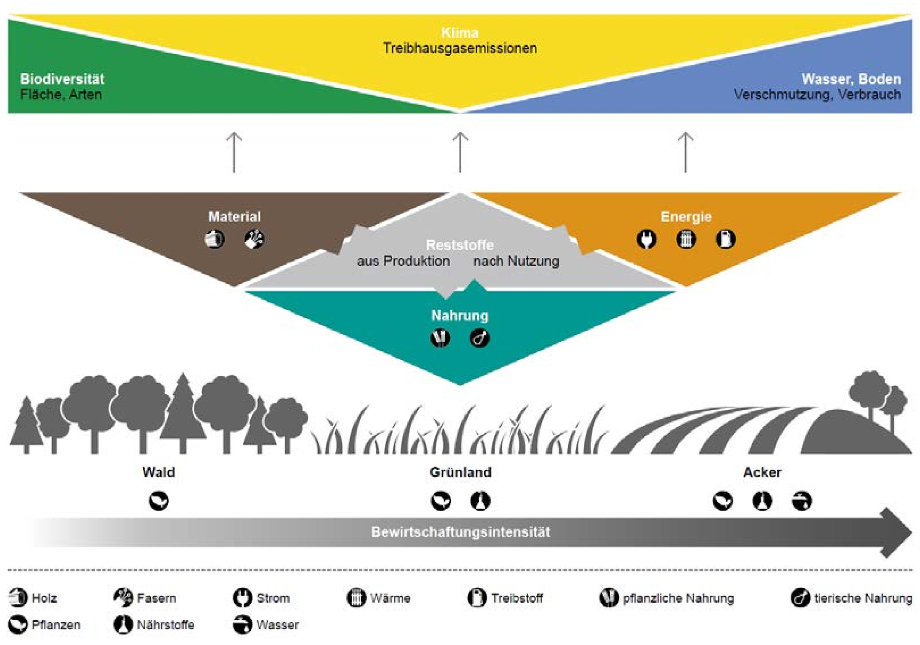
Preliminary results



EU perspective: net GHG emissions from land use activities (agriculture and forestry) are reduced in 2030 and 2050 compared to the baseline in all scenarios.

Global perspective: in 2050 net emissions increase for some scenarios. Globally emission reduction might thus be only temporary.

Lessons-learned and Recommendations



Only an integrated view, i.e. considering different sectors, environmental impacts, development over time etc. enables to explore sustainable pathways of biomass use.

Land use models can assist to find and sketch robust pathways and to point to important feedbacks that need to be considered.

Impacts of different scenarios of biomass use in the EU affect both, net land use emissions in EU and abroad significantly.

Assessing such impacts in an integrated way using models enables to explore sustainable pathways for the bioeconomy.

Contact

Dr. Hannes Böttcher

Energy&Climate Division
Öko-Institut e. V., Office Berlin
Tel.: +49 (0) 30 405085-389
Email: h.boettcher@oeko.de

Acknowledgements

Research is funded by the European Commission, DG Environment, “Study on impacts on resource efficiency of future EU demand for bioenergy”

Key influence factors of the transition towards a wood-based bioeconomy in Germany

Erik Gawel[A], Nina Hagemann[A], Grit Ludwig[B], Wolfgang Köck[B], Nadine Pannicke[A], Alexandra Purkus[A]

Helmholtz Centre for Environmental Research GmbH – UFZ, Permoserstr. 15, 04318 Leipzig

[A]Department of Economics, [B]Department of Environmental and Planning Law

erik.gawel@ufz.de | nadine.pannicke@ufz.de

SPONSORED BY THE Federal Ministry of Education and Research

BioEconomy Cluster

(1) Drivers of the bioeconomy

- The **complex economic and societal transition** from the hitherto predominant fossil-based "throughput economy" towards a circular flow economy based on renewable resources, the so-called bioeconomy, faces **significant uncertainties**.
- Based on a **scenario analysis** we identified and characterised **six key influence factors of the bioeconomy**, such as biomass availability (5B) and oil price development (2A, see Fig. 1).
- As **key actor groups** of the bioeconomy in Germany we identified the public and the private sector (comprising consumers/voters and companies/pressure groups), each of them with a conceivable **bioeconomy-friendly or a bioeconomy-averse attitude** (see Fig. 2).

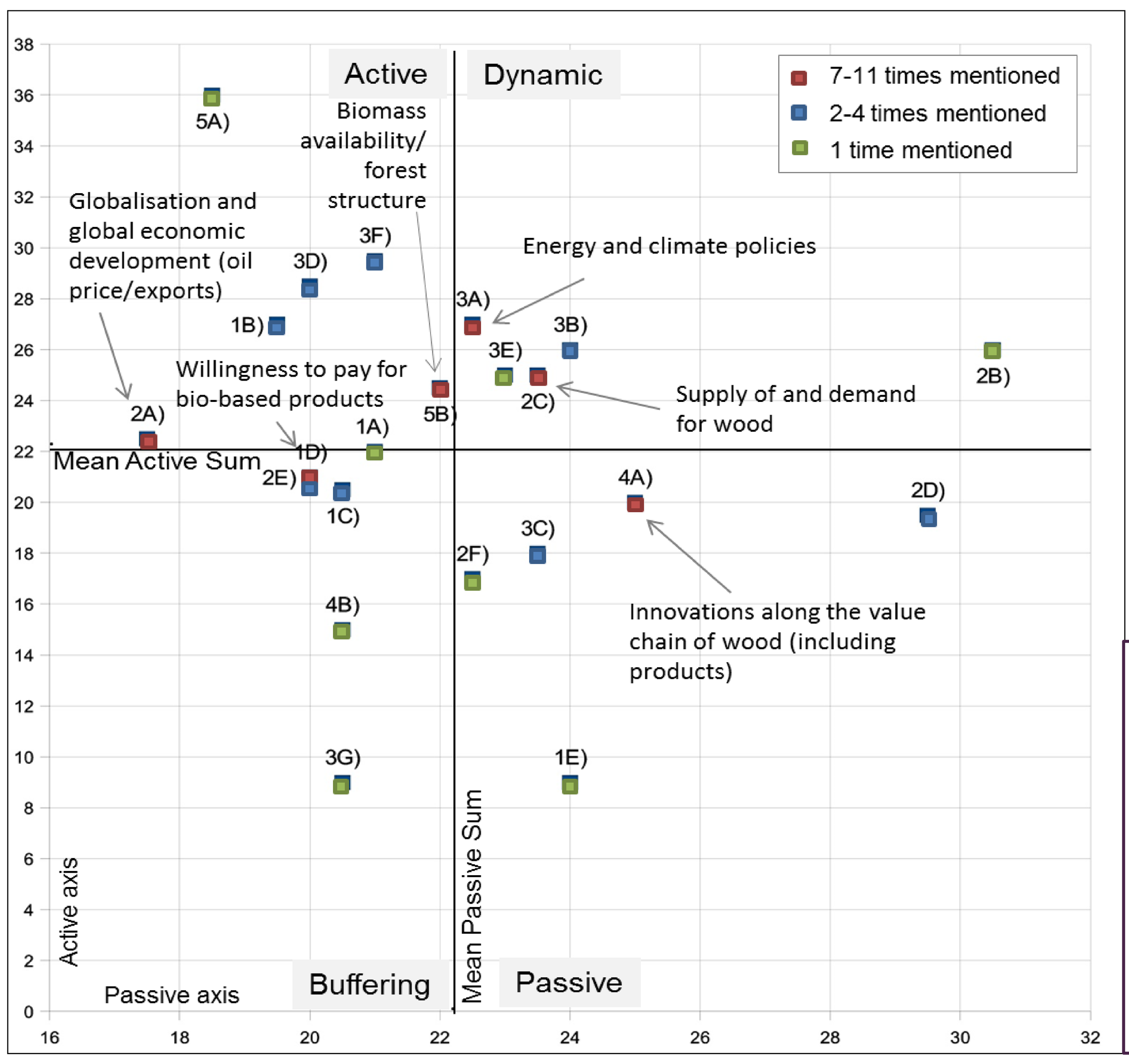
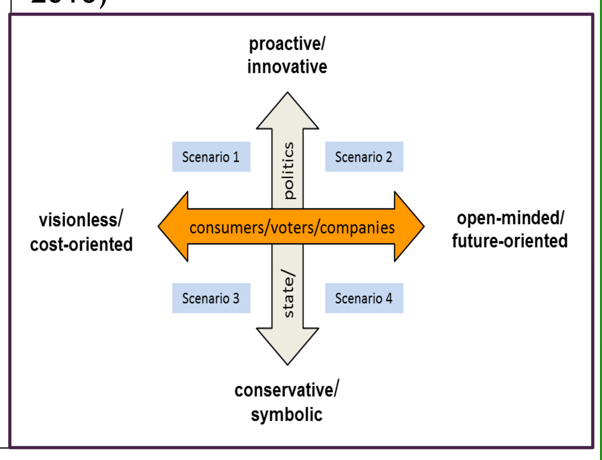


Fig. 1: Key influence factors for the development of the bioeconomy (Hagemann et al. 2016)

Fig. 2: Definition of four scenarios (Hagemann et al. 2016)



(2) What is bioeconomy policy?

- **Direct policies** (see Fig. 3) deal with bio-based raw materials, processes and products, either by supporting their supply or by creating a **direct demand pull for bio-based products.**
- **Indirect policies** (see Fig. 3) deal with fossil resources, products and waste, with the aim of **reducing overall fossil resource use.** This may create an **indirect demand pull** for bio-based processes and products.
- We differentiate between **quantity-oriented approaches** which expand conventional uses beyond the current lock-in equilibrium and **quality-/innovation-oriented approaches** targeted at new harvesting methods.
- Moreover we distinguish between **general resource substitution policies** and bioeconomy **policies with explicit sustainability guidelines** (represented by blue shadings).

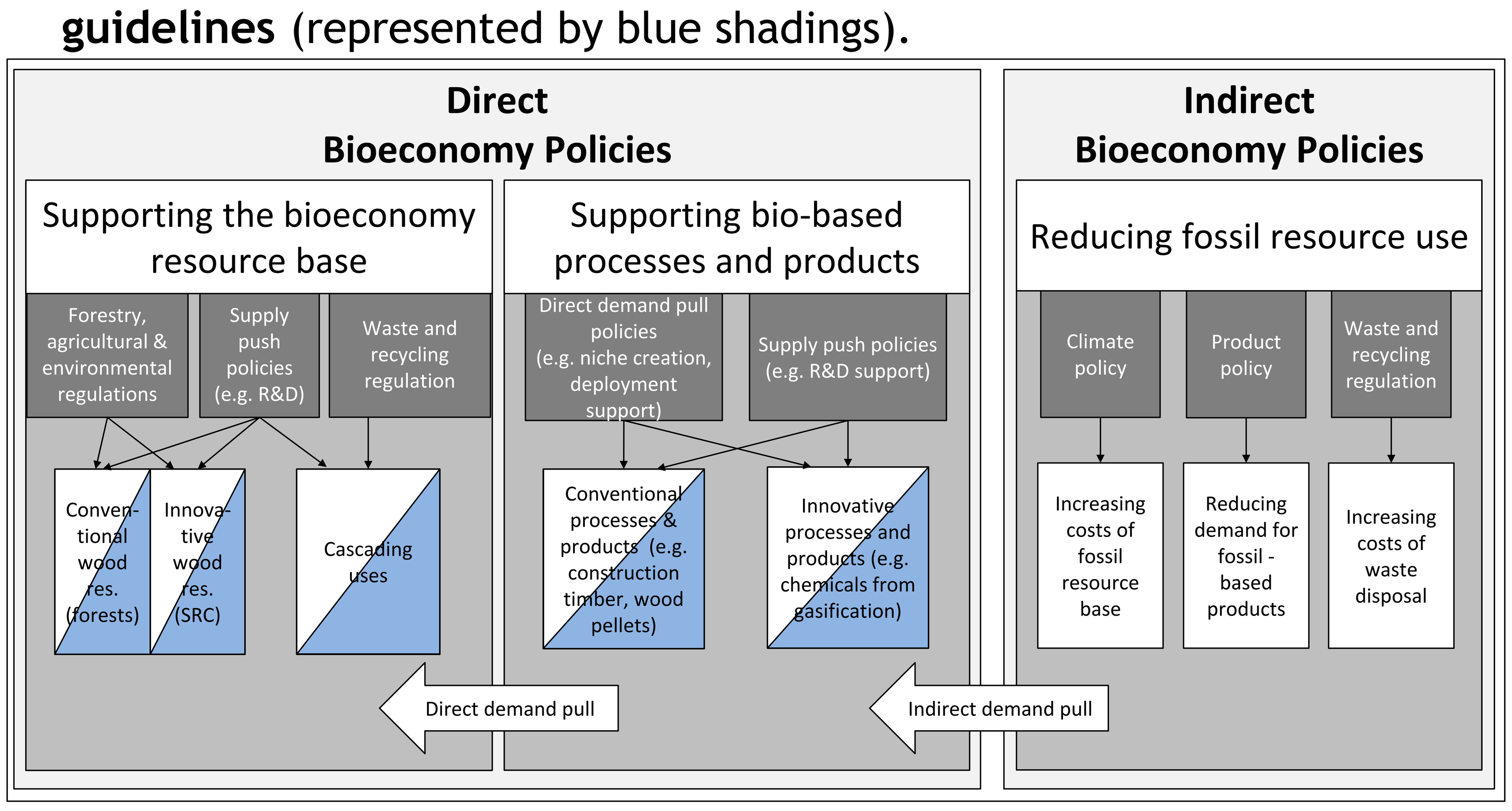


Fig. 3: Three pillars of wood-based bioeconomy policies (Pannicke et al. 2015)

(3) Legal framework of the bioeconomy

- In our analysis we differentiate between the **"law on bioeconomy in the narrow sense"** (see Fig. 4) and the **"law on bioeconomy in the wider sense"**.
- The study identified some legal norms that **support the objectives of a sustainable bioeconomy**, such as the law on the circular economy.
- Nevertheless, the current legal framework holds **significant room for improvement** of the conditions for the bioeconomy. An example is the functioning of the emissions trading scheme.

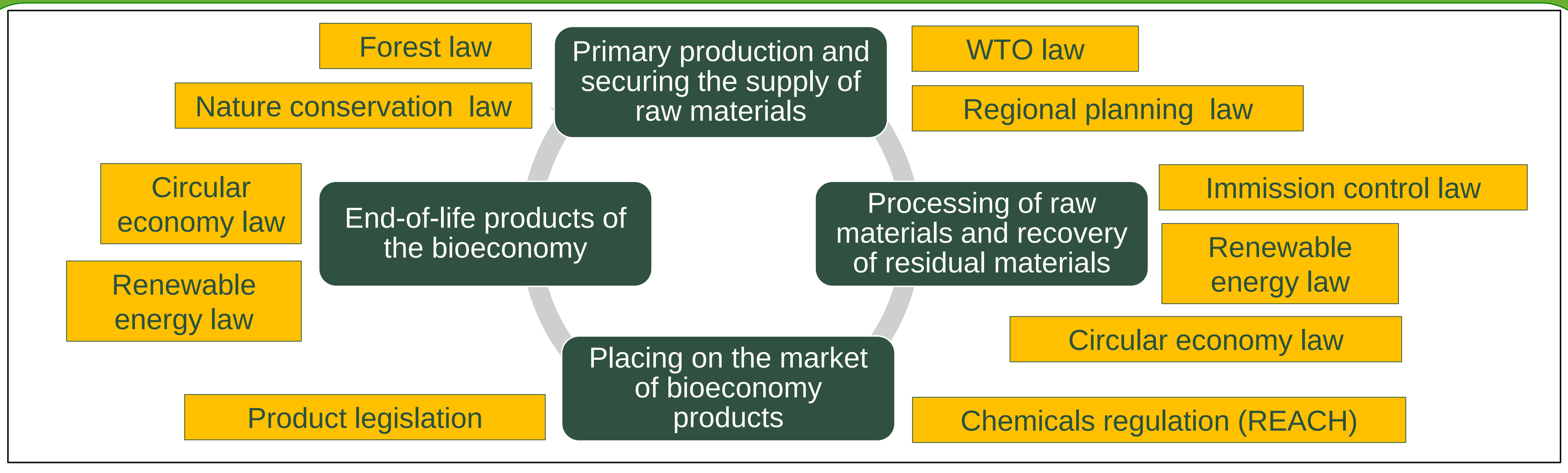


Fig. 4: Aspects of the bioeconomy law in the narrower sense (Ludwig et al. 2015)

(4) The political economy of transitioning towards a bioeconomy

- The **legal framework** for the bioeconomy is **fragmented.** This constitutes an **obstacle for the pursuit of a coherent bioeconomy policy**.
- The current instruments have failed to constitute a coordinated policy mix that could foster a **long-term transition** to a bioeconomy equilibrium.
- **Three major problems** regarding a long-term transition to a bioeconomy equilibrium are apparent:
  - uncertainty about the **resource base**,
  - **insufficient demand pull** for material wood-based products,
  - safeguarding the **sustainability** of wood-based products.
- The competition between renewable and fossil resources is distorted because of the **limited internalisation of environmental costs.**
- **Political costs of a path change are high**, because a **significant "demand"** for a strong bioeconomy-oriented policy by consumers, producers or the electorate is also **missing** due to **competing interests.** However, a successful transition requires a **twofold equilibrium**: the **economic sustainability equilibrium** and a **corresponding political equilibrium** providing the corresponding transition policies (see Fig. 5). For this, several **challenges** have to be met, for instance:
  - a **political majority** has to be found to **cross a critical threshold**,
  - **consumers' willingness to pay** for bio-based products could increase if products **combined** credible **environmental benefits** with **quality advantages** over fossil fuel-based products.

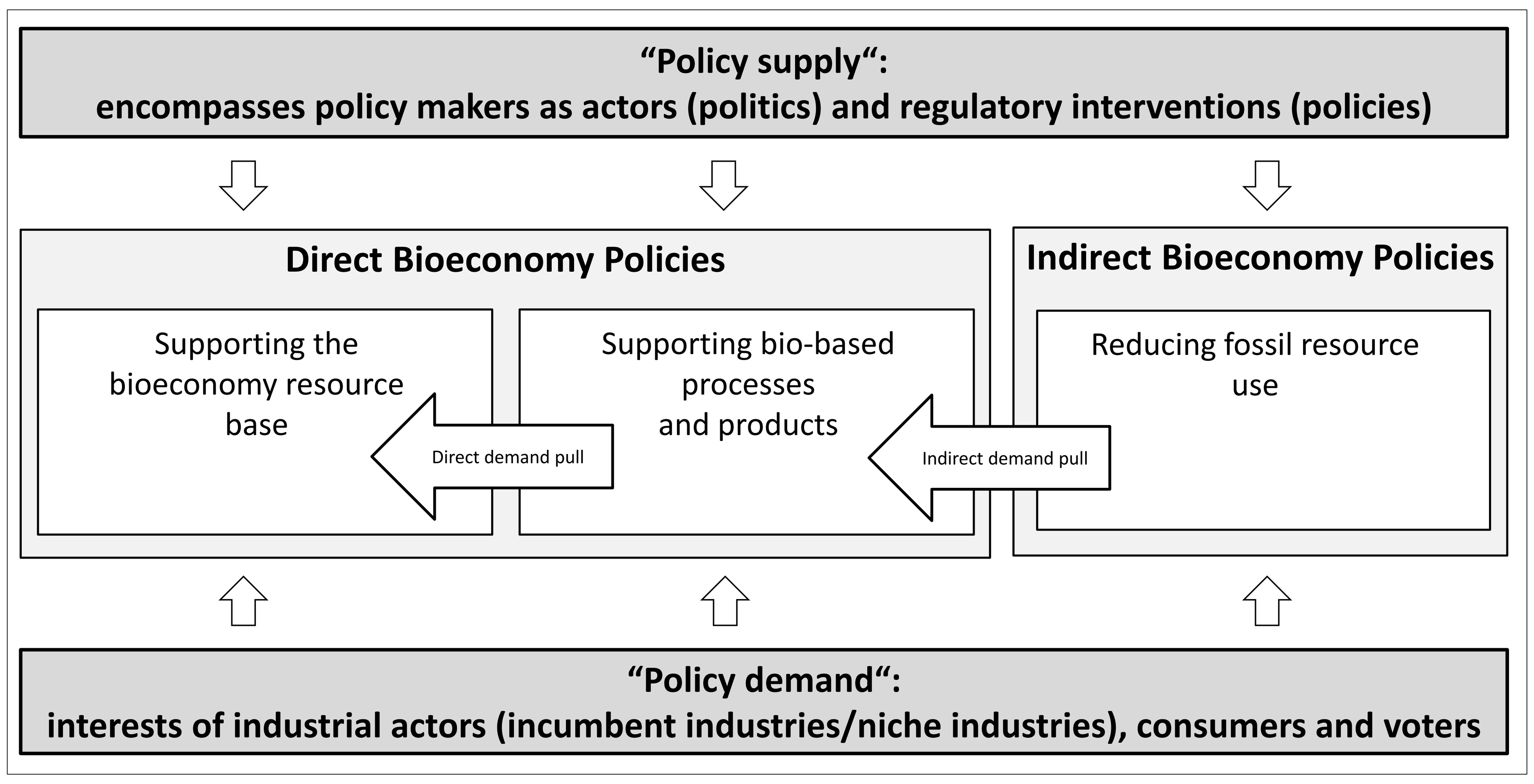


Fig. 5: The market for bioeconomy policies (Pannicke et al. 2015)

(5) Recommendations for transition policies

1. To **overcome** potential **lock-in effects** a **critical threshold** towards the bioeconomy **needs to be crossed**; **afterwards**, the transition process might be **self-sustaining.**
2. It is advisable to **combine** a **gradual development** of **existing policies** with efforts to **identify and support innovative niche products and processes** and to create **conditions for a market-induced selection** of the most sustainable and cost-effective ones.
3. **Reforming framework conditions** such as climate and waste policies.

References

- Hagemann, N., Gawel, E., Purkus, A., Pannicke, N. and Hauck, J. (2016): Possible futures towards a wood-based bioeconomy: A scenario analysis for Germany. (forthcoming)
- Ludwig, G., Köck, W., Tronicke, C. und Gawel, E. (2015). Der Rechtsrahmen für die Bioökonomie in Deutschland. In: Die Öffentliche Verwaltung 68(2): 41-54.
- Ludwig, G., Pannicke, N., Gawel, E. (2015): Schließung von Stoffkreisläufen am Beispiel von HTC-Brennstoffen. In: Wasser und Abfall 10: 26-30.
- Pannicke, N., Gawel, E., Hagemann, N., Purkus, A. and Strunz, S. (2015): The political economy of fostering a wood-based bioeconomy in Germany. German Journal of Agricultural Economics 64(4). (in press)
- Homepage: www.ufz.de/biooekonomie

Integrating Environmental Concerns in the Bioeconomy Discourse : a Cross-Country Comparison*

Kleinschmit D. [a], Arts B.[b], Giurca A.[a], Mustalathi I.[c], Pülzl H.[d] ,Sergent A.[e]

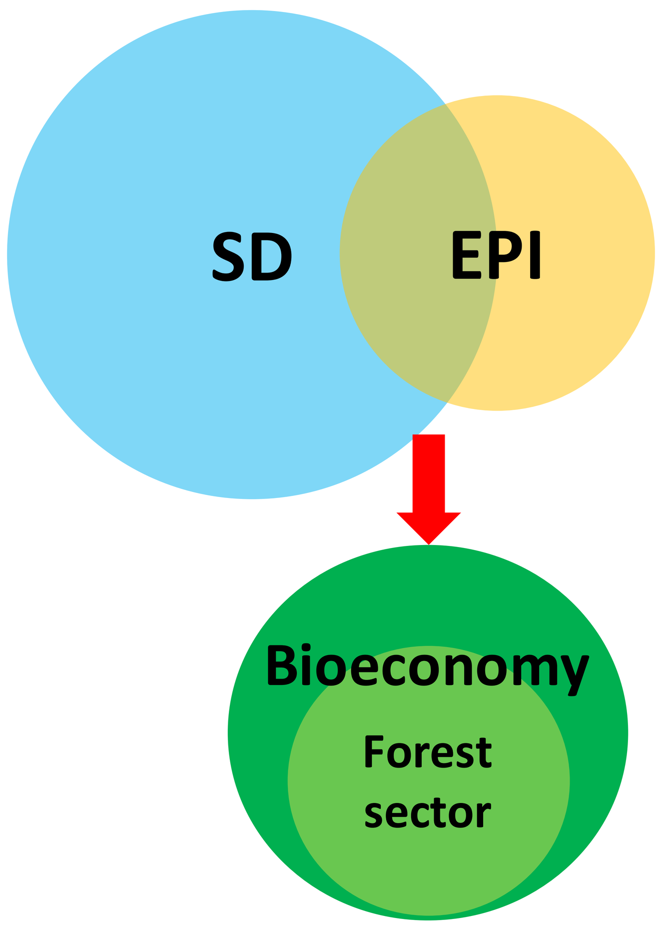
a. Chair of Forest and Environmental Policy, University of Freiburg, Germany
b. Forest and Nature Conservation Policy Group, Wageningen University , the Netherlands
c. Department of Geographical and Historical Studies, University of Eastern Finland
d. European Forest Institute – Central Eastern European Regional Office EFICEEC, c/o University of Natural Resources and Life Sciences, Austria
e. National Research Institute of Science and Technology for Environment and Agriculture, Bordeaux, France

Alexandru Giurca
alexandru.giurca@ifp.uni-freiburg.de

BACKGROUND

Bioeconomy has been identified as **a new (meta-)discourse** (Pülzl et al., 2014) fueled by different political organizations and at different political levels **highlighting sustainable development (SD) as a major goal.** Addressing major societal and economic challenges and at the same time create a more favorable environment is promised in different bioeconomy strategies. The bioeconomy in itself however **cannot be considered as self-evidently sustainable** as visions about the relationship between bioeconomy and sustainability differ substantially (Pfau et al., 2014) . How SD is approached and ensured in bioeconomy strategies remains therefore an empirical question (Kleinschmit et al., 2014). To answer this question the integration of environmental policy is understood as an operational principle to implement SD.

OBJECTIVES



1. To assess whether and how national political discourses on bioeconomy integrate environmental concerns.
2. To assess the role of the forest sector in the different bioeconomy strategies and whether environmental concerns are integrated in the forest sector discourse.
3. To reveal differences in the integration of environmental concerns in bioeconomy discourses between different EU member states.

THEORETICAL CONCEPT

Environmental Policy Integration (EPI) bases on the aim that environmental aspects are considered (weak EPI) or prioritised (strong EPI) in other policy areas (Jordan and Lenschow, 2010). **SD and EPI are two related concepts that have developed in parallel.** Lenschow (2002) resumes that linking EPI to the powerful paradigm of SD contributed to its political acceptance, though it has had less facilitated implementation on the operational level (Lenschow, 2002). Instead **SD has taken attention away from EPI** and creating confusion about what should be integrated into the sectors – environmental objectives or SD (Pallemaerts et al 2006). Additionally there has been so far only weak evidence that political sectors support the integration of environmental objectives (Jordan & Lenschow, 2010a). Instead strong prevailing interests among the sectors lead to resistance (Lenschow 2002). **Basing on the cognitive logic of EPI this poster aims to contribute to understand if the political discourse on bioeconomy offers a new chance to support SD and EPI and the interrelations of both.**

EMPIRICAL APPROACH

Empirically the study is outlined as a **cross-country comparison** applying a **qualitative frame analysis.** The comparison comprises the political discourse of **the EU** and four EU member states: **Germany, Finland, France and the Netherlands.** Analyzed documents cover national and EU political strategies as well as political programs of the forest sector addressing bioeconomy.

MAJOR FINDINGS

SD is the overarching concept included in the political bioeconomy discourses. It is **mainly addressed in a technocratic way** highlighting the relevance of **efficiency**;

The used SD concept supports the **dominance of the frame of economic sustainability** emphasizing economic growth, new job opportunities and the importance of entrepreneurship and innovation;

Environmental concerns are addressed but mainly as a **challenge rather than an independent goal** or as part of a win-win solution, **strategic path towards EPI are lacking** or remain superficial in most of the political bioeconomy discourses;

Table 1. Forests in the bioeconomy discourse

EU and Member states	Main Frames
EU, DE, FR, NL,FI	Forest sector and provision of woody biomass highlighted as important
FI	Forests play a central major role in the development of the bioeconomy
EU, DE, FR, NL,FI	Highlighted role in climate change mitigation
EU,DE,FR, NL	Challenges in the forest sector (e.g. provision of sufficient biomass, competition for land use) highlighted
FI	Self-sufficiency of woody biomass -able to provide for both the national and international market
DE, FR, NL	Acknowledging need of imports of woody biomass
DE, FR, NL	Importance of SFM

LESSONS LEARNED

Though making **rhetorical use of the SD** concept the bioeconomy discourse is mainly **aligned with the concept of ecological modernization.** Hence, it is less about balancing economic, social and ecological objectives but placed on a continuum between economic growth and ecological concerns with clear emphasize on the former. **Environmental objectives are in the backseat** of the bioeconomy discourse.

To not overrule already existing SD and environmental policies the **need for policy integration and coordination** becomes even more relevant and has been addressed as well in some political bioeconomy strategies.

The **cross-sectoral character** of the bioeconomy discourse offers the chance for EPI. This chance has not been used yet.

REFERENCES

Jordan, A. & Lenschow, A. (2010). Policy Paper Environmental Policy Integration - a State of the Art Review, EnvPolGov 20, 147–158.

Kleinschmit D.,Lindstad B.,ThorsenB.J., Toppinen A., Roos A. and Baardsen S., (2014). Shades of green: a social scientific view on bioeconomy in the forest sector. Scandinavian journal of Forest Research, 12: 402-410.

Lenschow, A. (2002). Greening the European Union – An Introduction. In: Lenschow, A. (ed): Environmental Policy Integration: Greening Sectoral Policies in Europe. London, Earthscan: 3-21.

Pallemaerts M, Wilkinson D, Bowyer J, Brown J *et al*. 2006. Drowning in Process? The Implementation of the EU's Sixth Environmental Action Programme. IEEP: London.

Pülzl, H., Kleinschmit, D., Arts, B.,(20149. Bioeconomy – an emerging meta-discourse affecting forest discourses? Scandinavian Journal of Forest Research 29, 386–393.

Pfau, S.F., Hagens, J.E., Dankbaar, B., Smits, A.J.M.,(2014). Visions of sustainability in bioeconomy research. Sustainability 6, 1222–1249

Söderberg, C., (2011). Environmental Policy Integration in Bioenergy Policy learning across sectors and levels ? Umeå University.

* This poster is based on
Kleinschmit, D., Arts B., Giurca A., Mustalathi I., Pülzl H. ,Sergent A.: Longing Towards Sustainability: Integrating Environmental Concerns in the Bioeconomy Discourse. Submitted to *International Forestry Review* in October 2015.

Find out more about our research

UNIVERSITY OF HOHENHEIM

Competence Network Modeling the Bioeconomy

Susanne Wagner[a], Stefan Albrecht[b], Elisabeth Angenendt[c], Markus Blesl[d], Patrick Breun[e], Harald Grethe[a], Witold-Roger Poganietz[f], Sebastian Voigt[g]

BIOECONOMY RESEARCH BADEN-WÜRTTEMBERG

Introduction and Goals

The competence network modeling the bioeconomy is part of the bioeconomy research program Baden-Württemberg, in addition to the research areas biogas, lignocellulose, microalgae and the accompanying sociological and ecological research teams. It analyzes the potential of the bioeconomy, taking into account linkages between the natural environment and the economy. For that purpose, it exchanges data and results with the research areas and presents them with prospective bioeconomy scenarios.

The goal of this competency network is to compare and evaluate the direct and indirect effects (economic, material and ecological) of different biomass usage pathways. This will create a framework for assessing biomass usage options, primarily focusing on those of biogas and lignocellulose, but also serving as a basis for the analysis of other usage alternatives and integrated bioeconomy conditions.

Methodology

The competence network modeling the bioeconomy combines technology and economic models; hence, bioeconomy scenarios are analyzed in a comprehensive manner at different scales (e.g. European Union, Germany, Baden-Württemberg) and for different dimensions of sustainability (e.g. economic, environmental). The agricultural economic-ecological farm model (EFEM) depicts the biomass supply, jointly with the partial equilibrium agricultural sector model (ESIM). The use of biomass is simulated with ESIM, the energy system model TIMESPanEU and the general equilibrium model PACE. Additionally, optimal technologies and locations for the energetic and material use of biomass are evaluated with the BIOLOCATE model. The environmental impacts are analyzed with the material flow model CarboMoG and the life cycle assessment model GaBI. The interactions among the different research groups, models and teams of the bioeconomy research program Baden-Württemberg is illustrated in the figure below.

Subprojects

EFEM: Modeling of regional biomass supply (University of Hohenheim)

ESIM: Modeling of the agricultural sector (University of Hohenheim)

PACE: Macroeconomic modeling (Center for European Economic Research)

TIMES PanEU: Modeling energy systems (University of Stuttgart)

BIOLOCATE: Modeling technology and site selection for biomass utilization (Karlsruhe Institute of Technology)

CarboMoG: Analysis of environmental effects (Karlsruhe Institute of Technology)

GaBI: Life Cycle Assessment (University of Stuttgart)

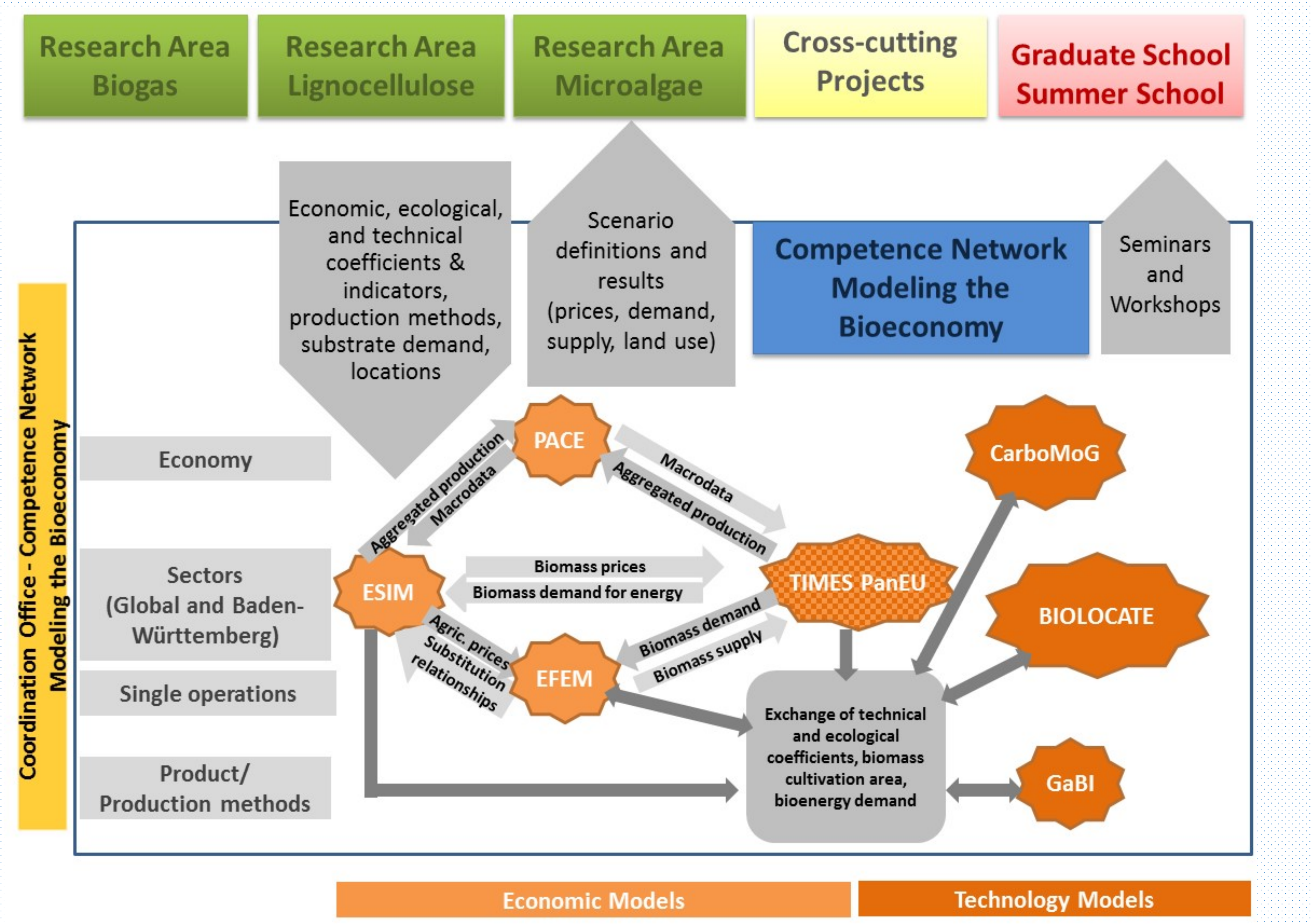


Figure: Model interfaces within the competence network and integration into the bioeconomy research program Baden-Württemberg

Expected Results

The competence network modeling the bioeconomy creates an assessment framework that investigates the transformation pathways from a predominantly fossil fuels based economy to a renewable raw materials and energy centered economy. The appraisal structure allows comparisons between economic benefits of certain bioeconomy scenarios (e.g. environmental improvement or development of certain economic sectors) joined with their economic costs (e.g. loss of income).

Contact:

Prof. Dr. Harald Grethe (Chair), Susanne Wagner
Coordination Office
University of Hohenheim
Institute of Agricultural Policy and Markets (420a)
70593 Stuttgart
susanne.wagner@uni-hohenheim.de

Partner Institutions:

- [g]Center for European Economic Research (ZEW)
- Karlsruhe Institute of Technology (KIT)
  - [e]Institute for Industrial Production
  - [f]Institute for Technology Assessment and Systems Analysis
- University of Hohenheim
  - [a]Institute of Agricultural Policy and Markets
  - [c]Institute of Farm Management
- University of Stuttgart
  - [b]Department of Building Physics
  - [d]Institute of Energy Economics and the Rational Use of Energy

Baden-Württemberg
MINISTERIUM FÜR WISSENSCHAFT, FORSCHUNG UND KUNST

Potsdam Institute for Climate Impact Research

PIK

Investigating the sustainability of large-scale bioenergy production

Authors: F. Humpenöder, A. Popp, J. P. Dietrich, B. L. Bodirsky, H. Lotze-Campen, A. Biewald, I. Weindl, U. Kreidenweis, M. Stevanovic, C. Müller, S. Rolinski, D. Klein

PIK FB III Sustainable Solutions
PIK FB II Climate Impacts & Vulnerability

Background

Bioenergy use in the energy sector, particularly in combination with carbon capture and storage (BECCS), is projected to play a key role in the coming decades for climate change mitigation. However, the production of bioenergy for use with CCS in the energy sector might come along with various negative side effects in the land-use sector. For instance, conversion of forests to arable land for bioenergy production might cause CO_2 emissions that would not occur in the absence of bioenergy (additional emissions). To avoid such negative side effects, bioenergy deployment could be accompanied by a forest protection scheme. But limiting the available land might require an intensification of agricultural production, which could result in increasing food prices. Thus, bioenergy production combined with forest protection might have positive environmental (biodiversity, carbon stocks) but negative socio-economic effects (food security).

Research objective and approach

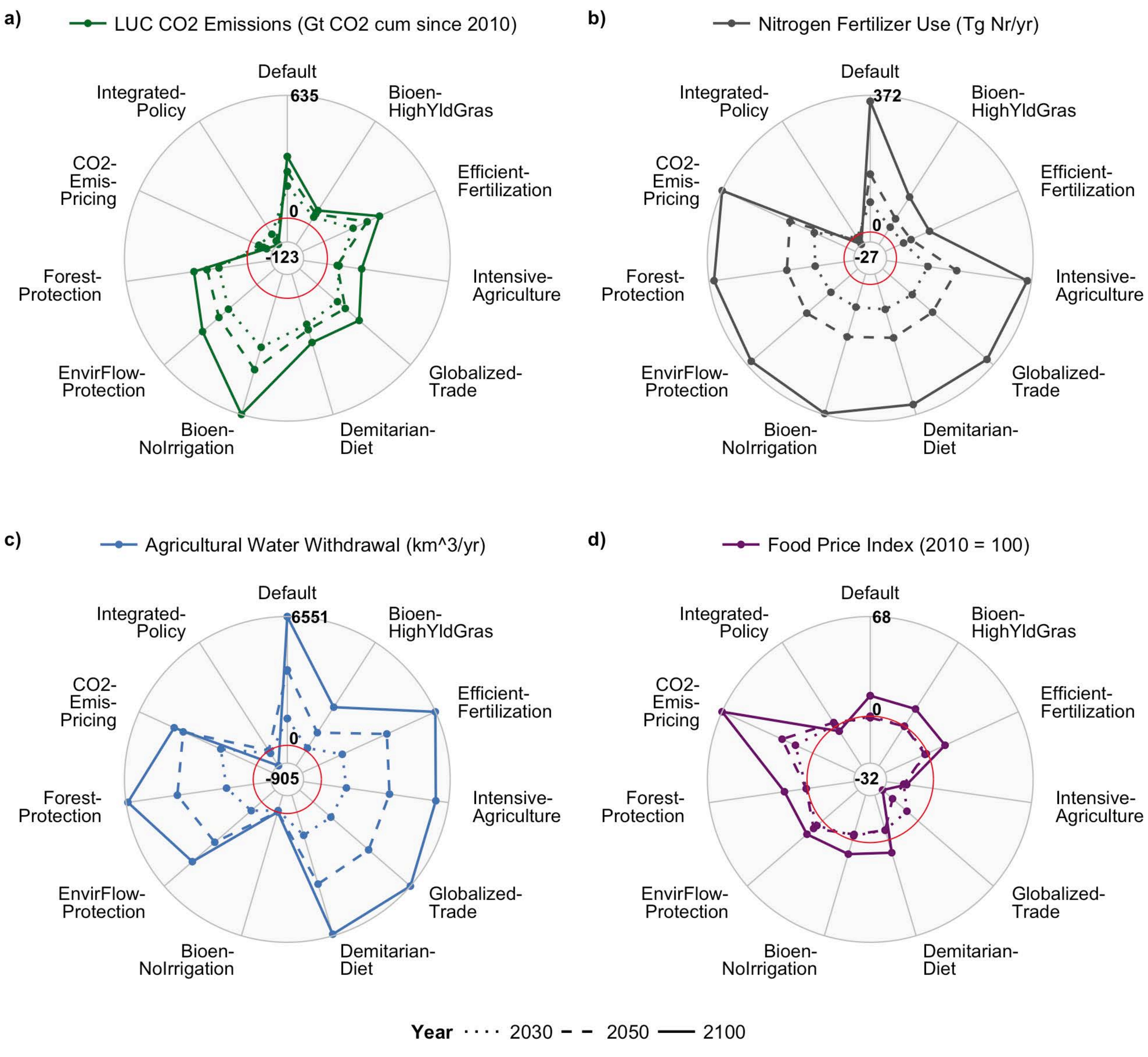
In this study, we aim to assess to what extent changes in the agricultural system could improve the sustainability of large-scale bioenergy production in terms of a) CO_2 emissions from land-use change, b) nitrogen fertilizer use, c) agricultural water withdrawals and d) development of food prices. The sustainability of large-scale bioenergy production depends on a multitude of factors in the agricultural system such as food and bioenergy crop yields, efficiency of fertilization, international trade, food demand, land and water use for bioenergy production, and CO_2 emissions from land-use change. Starting from a set of rather pessimistic assumptions in these domains, we investigate how a switch towards more optimistic assumptions (based on the current literature) could improve the overall sustainability of large-scale bioenergy production. In a first step, we identify the most effective measures in agricultural system for each sustainability dimension as well as trade-offs between sustainability objectives for a given measure. In a second step, we explore if the combination of the most effective measures could improve the sustainability of large-scale bioenergy production in several dimensions simultaneously.

Methods

MAgPIE is an economic land-use optimization model featuring spatially explicit coverage of biophysical constraints. Here, we use the MAgPIE model to investigate the long-term global-scale sustainability effects of identical bioenergy production under nine different scenarios for the agricultural system. The underlying global bioenergy demand trajectory increases linearly from 0 to 300 EJ/yr between 2010 and 2100.

Results and Conclusions

There are measures in the agricultural system that have substantial potential to improve the sustainability of large-scale bioenergy production. However, some measures come along with trade-offs between sustainability objectives. For instance, CO_2 emission pricing is effective in lowering CO_2 emissions from deforestation, but at the same time competition for land between food and bioenergy production increases food prices. Our results suggest that a combination of the most effective measures could eliminate such trade-offs between sustainability objectives.



Sustainability effects of large-scale bioenergy production under different assumptions in the agricultural system

Contact: Florian Humpenöder, humpenoeder@pik-potsdam.de

A Measure of the Forest Protected Areas Benefits for the Surrounding Population: A Case Study of the Bouaflé Protected Forest (CÔTE D’IVOIRE).

Kouame Bossombra Nadege-Parfaite

WASCAL, West African Science Service Center on Climate Change and Adapted Land –Use/ www.wascal.org

University Cheikh Anta Diop, Dakar/ Senegal

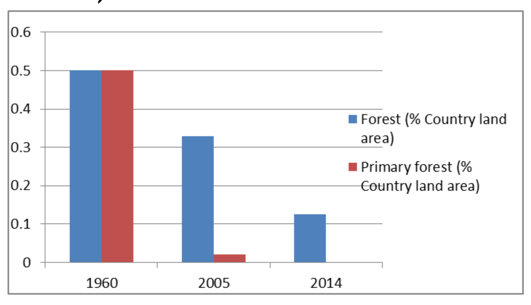
degeofr@yahoo.fr

BACKGROUND / INTRODUCTION

Côte d'Ivoire, in West Africa, has a high level of biodiversity, with around 1,200 animal species and 4,700 plant species. Most of this diversity is located in the interior part of the country especially on forest land.

According to FAO 2005, deforestation is responsible for the loss of 13 million hectares of the world’s forests. Africa is the most affected continent. Data covering the period 1990-2000 shows that the highest rate of deforestation is in Africa 0.8%, before Latin America with 0.4%, and Asia with 0.1% (Naoto, 2006). South America and Africa are still ranked first in deforestation rates today, with 4 million hectares and 3.4 million hectares respectively recorded per year between 2000 and 2010.

Specifically, Cote d’Ivoire has suffered severe deforestation (~90% of forest loss since 1960)



Evolution of Forest in Cote d’Ivoire

Forest conservation is a matter of international concern. The Food and Agricultural Organisation (FAO) reports that the most diverse terrestrial ecosystems are located in primary forests, especially tropical moist forests (FAO 2010).

For Beke(2010) deforestation in Côte d’Ivoire reflects the forest management problems that exist in most African countries. A key reason for deforestation in Côte d’Ivoire is cultivation. This is driven by the growing population and the lack of clearly defined property rights for forest land.(Ehui et al., 1989).

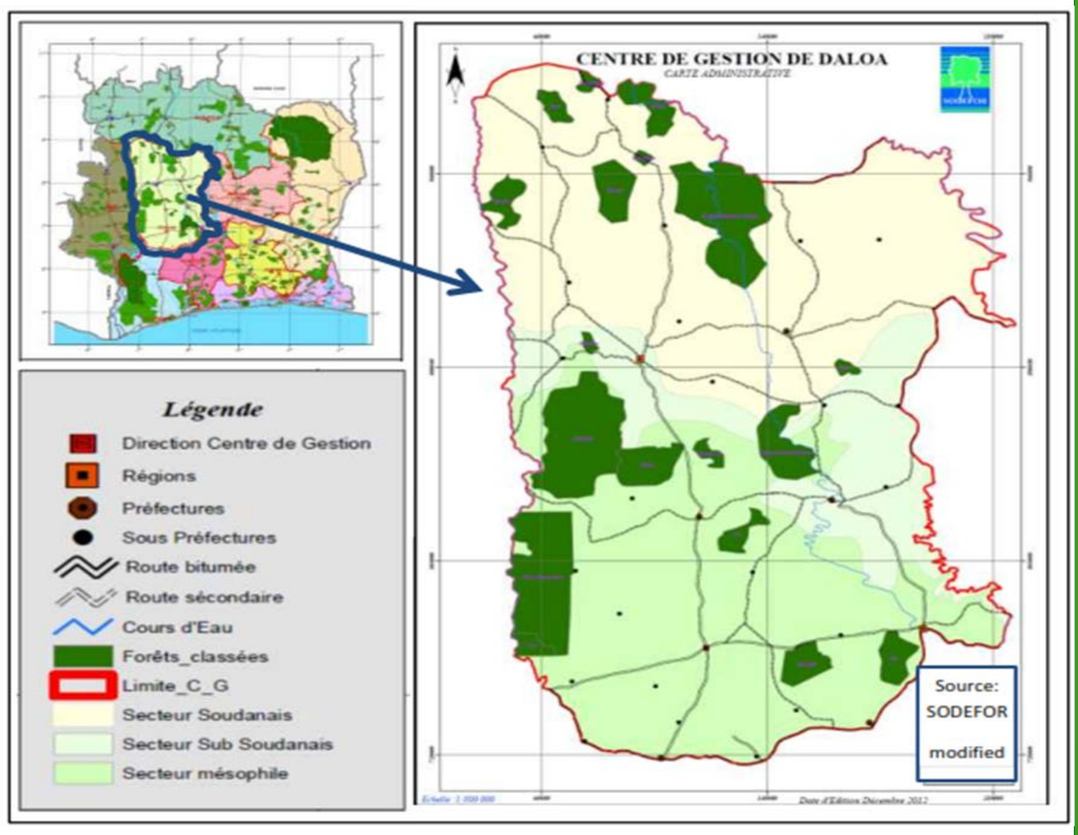
In order to address the issue of deforestation, many actions are taken globally and locally, one of which is the implementation of protected areas within countries. Forest conservation measures put restrictions on the access of local communities to forest services.

However, local communities supplement their daily livelihood from forests, especially from timber and non-timber forest products. Tropical forests are a major income source for these communities and they contribute between 20% and 40% of total household income for people living in forest areas. The dependence on forest-related services is higher for the poor population, especially on fuel wood and fodder.

ACTIVITIES (Methodology)

This study focuses on the Bouaflé protected forest (foret classée de Bouaflé) in the western part of Côte d’Ivoire. The forest is 20350 ha and was made a protected forest in 1974. It is one of the most deforested protected areas in the country.

A Village inside a classified forest in Cote d’Ivoire (Lobikro in “Foret Classee de Bouafle”), source:Author, 2014



We conduct a survey. The questionnaire was administered to a stratified sample of five (5) villages of the protected forest of Bouaflé. Three of the villages (Abbekro, Petit Gohitafla, Yobouekro) are located inside the protected forest whereas the other two (Djakro and Saa-Nguessankro) are outside the protected forest. The villages were chosen either according to their accessibility by transport means, or according to their size of big villages among other surrounding settlements.

Sample size 159 household heads.

. Legal & institutional framework

National forest domain includes among others (ie. national parks & reserves, community forests…) the classified forests.

Classified forest is a forest area defined and delimited according to legislation and regulation in order to provide it with the legal necessary protection (4212331 ha~ 13% of the national Territory)=> managed by an State-own structure.

Rights of use of forest by the surrounding population (Collect of dead wood, fruits, food, medical forest-based products, NTFP, wood for habitat construction not for sale, drinking water, animals for traditional consumption, cultural use … Article 46). The law 2014-427 of July 2014 aims to (Sustainable management of forests, protection of biodiversity, Participatory protection approach…)

A positive improvement: Provision for strong punishment for infraction: imprisonment from 5 months up to 5 years, Restriction on the tree ownership and cutting (Only little punishment was provided by the previous forest law (law 65-425 of 20 Dec 1965, modified in 1966).

OBJECTIVES

The surrounding population benefits in many ways from the forest and we wish to measure the effects of forest conservation on these communities.

This paper aims to:

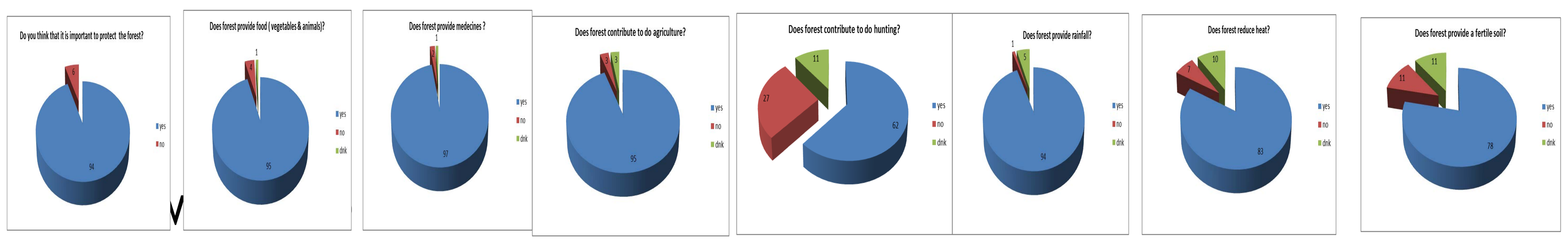
Firstly describe the perception of forest benefits by the population

Secondly, estimate the benefits of forest conservation perceived by the population using a contingent valuation approach, particularly the Willingness to Pay (WTP) methodology.

Thirdly, we will recommend innovative conservation policies which rely mainly on population appropriation of the conservation.

RESULTS

The survey in the Bouafle Protected forest provides the following results.



Mean WTP= 1658.491 FCFA

Zero willingness to pay accounts for 42.14 % of our sample size based on the following reasons given by the respondents.

	Percentage (%)
	58.33
It is not me who should pay	16.67
The forest is not mine	8.33
Others	16.67

LESSONS LEARNED / RECOMMENDATIONS

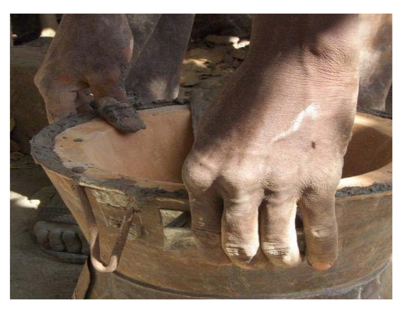
Local people should appropriate conservation measures, policies.

-Develop sustainable agriculture (intensive agriculture, agroforestry, no/low tillage…)

-Sensitize to sustainable use of forest resources/ services.

For reducing the use of fuelwood:

-Encourage the use of “foyer ameliores” (a sustainable use of fuelwood) in each household.



You add ember in these container made of terracotta. Then you can put your pot on it for cooking. It is based essentially on raw materials. It reduces fuelwood consumption and is adapted to cooking practices of rural African people. It is also a more sanitary way of cooking than ordinary charcoal and firewood. It is more accessible to poor population. It should be generalized (through sensitization, training, subsidies…)

-Make accessible to local people a technic of fuel production using animal waste.

-Train local people to NTFP-related economic activities.

-Vegetable oil production and sale. ie, palm oil production, palm oil-related products, coconut oil.

-Traditional fabrique (traditional shoes made of sheep skin, traditional cloth…)

-Develop activities around local drink “bandji” and some local food (cassava, plantain, yam powder/couscous)

Ricinodendron heudelotii, (Euphorbiaceae), commonly called Eho / Baoulé language : Akpi

-Develop ecological tourism around the protected forest.

-Establish entrance fees for the Bouafle protected forest that could be used to fund conservation policies and also that could benefit to surrounding population through social needs care subsidies (health care, education…)

ACKNOWLEDGEMENT: WASCAL which funded the PhD studies (www.wascal.org).

Prof Aly Mbaye and Prof Von Braun (WASCAL)

SODEFOR, CNRA, ANADER, OIPR, Ministry of Forest and water based in Cote d’Ivoire.

Orante Sisters Catholic community in Arusha, Tanzania.

University of Stuttgart
IER Institute for Energy Economics and the Rational Use of Energy

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

INTERNATIONALES ZENTRUM FÜR ETHIK IN DEN WISSENSCHAFTEN (IZEW)

Making Bioeconomy measurable

BIOECONOMY RESEARCH BADEN-WÜRTTEMBERG

Natalia Matiz[1], Birgit Kröber[2], Thomas Potthast[2], Marlies Härdtlein[1], Ludger Eltrop[1]
[1]Institute for Energy Economics and the Rational Use of Energy, University of Stuttgart
[2]International Centre for Ethics in the Sciences and Humanities, University of Tübingen

BACKGROUND & OBJECTIVES

Due to the intensified material and energetic use of biomass in the last years, social controversies and acceptance issues have emerged around biomass production for Bioeconomy purposes. Moreover most of the globally traded biomass is produced under questionable conditions with respect to ethical and societal aspects (Kroeber, Potthast 2015). Hence, the future biomass utilization pathways have to be carefully assessed along the whole product life cycle in order to establish sustainable regional and global Bioeconomies.

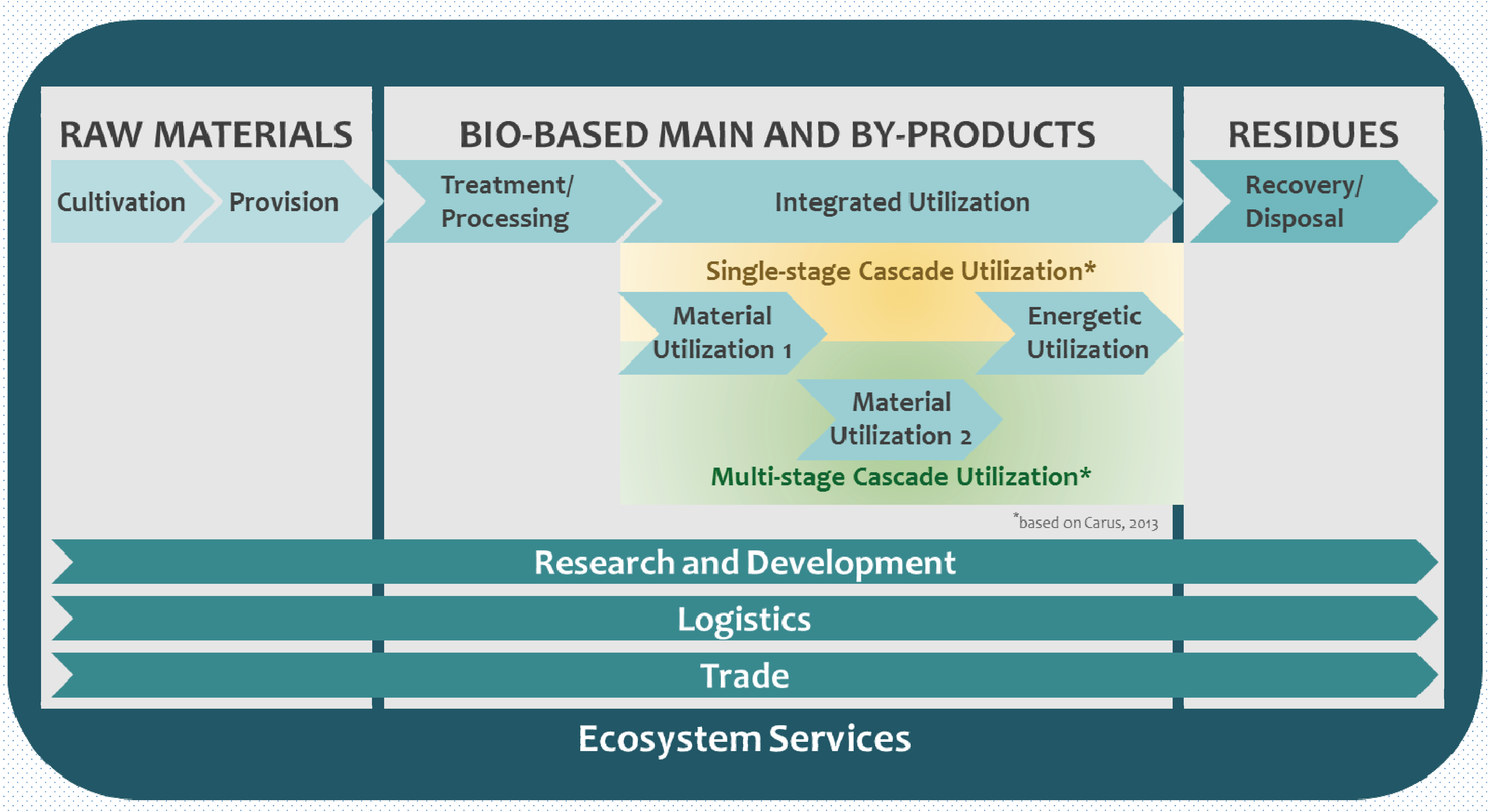


Fig. 1: Biomass Value Chains (own representation)

Monitoring instruments making Bioeconomy measurable are needed. The aim of our work is to develop a **Biomass Value Chain Index (BVC-Index)** that enables the comparison between them, even if they are based on different raw materials and pursue competing final uses. Furthermore, the Life Cycle approach will be combined with a Top-Down-Model in cooperation with the *Competence Network Modeling the Bioeconomy* in order to **evaluate the impacts of the Bioeconomy System** using a scenario analysis.

APPROACH & METHODS

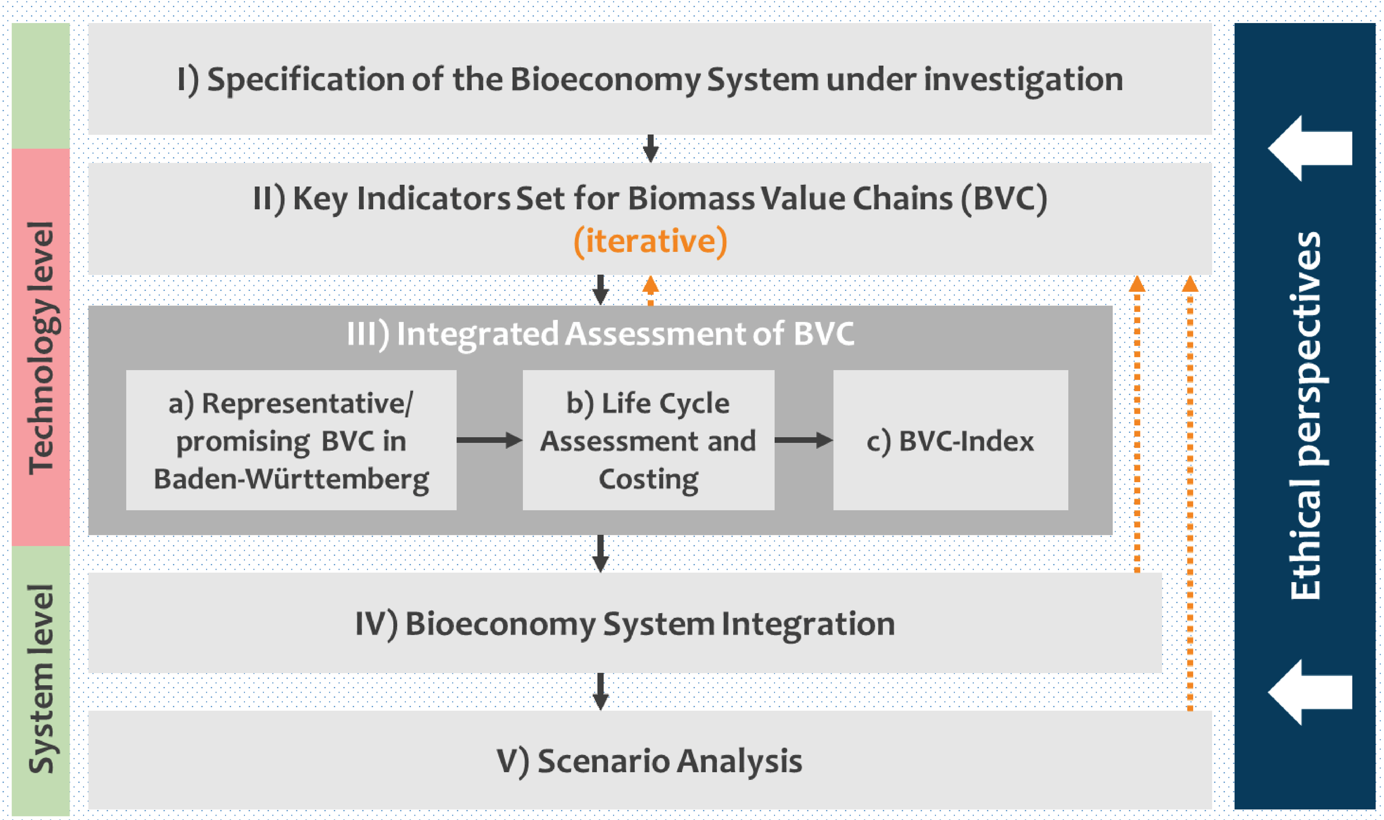


Fig. 2: Project Approach

RESULTS

(I) We understand Bioeconomy as the part of the economic system based on the **production, conditioning, trade and use of biogenic resources**. From a normative perspective, these activities should be conducted in a way that increases the **ecological and social resilience** of the systems they take place in.

(II) A **preliminary KI-Set for an Integrated Assessment of BVC** was established. The selection was made based on the necessity of integrally address diverse relevant aspects in the Bioeconomy:

- Land use impacts on ecosystem services and biodiversity (1-3)
- Cascade utilization of biomass (4)
- Internalization of social costs (5)
- Acceptance issues (6)

	Impact	Indicator	Method/Reference
1	**Biotic Production Potential**	Variation of carbon stock due to land use [SOM/ha·a]	(Brandão und i Canals, Llorenç Milà 2013)
2	**Climate Regulation Potential**	Carbon flows change due to land use [tC/ha·a]	(Müller-Wenk und Brandão 2010)
3	**Biodiversity loss**	Species diversity lost per area for a specific land cover relative to reference land cover [%]	(Baan et al. 2013)
4	**Resource efficiency**	Cascade utilization factor	To be developed
5	**Externalities**	Social costs [€/ha]	(Bickel und Friedrich R. 2005) (Rabl et al. 2014)
6	**Acceptance of biomass utilization pathways**	Population with a positive valuation of the pathway [%]	(Dethloff 2004 in Schweizer-Ries 2008)

OUTLOOK

The preliminary KI-Set will be tested on pilot value chains based on maize and winter wheat (III). These crops, i.e. its grains, silage and plant residues, offer a variety of utilization pathways e.g. bread, cornmeal, fodder, bioplastics and biofuels. The KI will be evaluated on the suitability for utilization pathways from other raw materials and adapted or complemented as necessary.

REFERENCES

Baan, Laura de; Alkemade, Rob; Koellner, Thomas (2013): Land use impacts on biodiversity in LCA: a global approach. In: *Int J Life Cycle Assess* 18 (6), S. 1216–1230. DOI: 10.1007/s11367-012-0412-0.

Bickel, Peter; Friedrich R. (Hg.) (2005): ExternE. Externalities of energy. Methodology 2005 Update. Europäische Kommission. Luxembourg: Office for Official Publications of the European Communities (Sustainable energy systems, 21951).

Brandão, Miguel; i Canals, Llorenç Milà (2013): Global characterisation factors to assess land use impacts on biotic production. In: *Int J Life Cycle Assess* 18 (6), S. 1243–1252. DOI: 10.1007/s11367-012-0381-3.

Carus, M. (2013): Kaskadennutzung von Biomasse. Begriffe und Definitionen. Workshop 1 - Projekt Biomassekaskaden. nova-Institut GmbH. Köln, 2013. Online verfügbar unter https://biomassekaskaden.de/info/downloads/, zuletzt geprüft am 23.09.15.

Kroeber, B.; Potthast, T. (2015): Bioeconomy and the future of food – ethical questions. In D. E. Dumitras, I. M. Jitea, S. Aerts (Eds.): Know your food. Food ethics and innovation. Wageningen: Wageningen Academic Publishers, pp. 366–371.

Müller-Wenk, Ruedi; Brandão, Miguel (2010): Climatic impact of land use in LCA - carbon transfers between vegetation/soil and air. In: *Int J Life Cycle Assess* 15 (2), S. 172–182. DOI: 10.1007/s11367-009-0144-y.

Rabl, Ari; Spadaro, Joseph V.; Holland, Mike (2014): How much is clean air worth? Calculating the benefits of pollution control. 1. publ. Cambridge u.a.: Cambridge Univ. Press.

Schweizer-Ries, Petra (2008): Energy sustainable communities: Environmental psychological investigations. In: *Energy Policy* 36 (11), S. 4126–4135. DOI: 10.1016/j.enpol.2008.06.021.

BIOECONOMY GRADUATE PROGRAM BBW FORWERTS

Natalia Matiz Rubio, M.Eng.
natalia.matiz@ier.uni-stuttgart.de
+49 711 685 87863

funded by
Baden-Württemberg
MINISTERIUM FÜR WISSENSCHAFT, FORSCHUNG UND KUNST

UNIVERSITY OF HOHENHEIM

Impact Assessment of Policies Fostering Biogas in Germany Toward 2050

Perez Sierra, J.*; Grethe, H.; Choi, H.S.; Wagner, S. | Institute of Agricultural Policy and Markets
Department of Agricultural and Food Policy (420a) | Schloss, Osthof Süd - Stuttgart 70593, Germany

BIOECONOMY RESEARCH
BADEN-WÜRTTEMBERG

Introduction and Goals

As part of the national bioeconomy strategy and in pursuit of a sustainable and diversified energy supply, the German government is encouraging the generation of biogas and biomethane with the Renewable Energy Source Act (EEG) and the Gas Network Access Ordinance (GasNZV).

With the EEG of 2014 producers are encouraged to use less silage, but rather manure and biowaste as substrates (KTBL 2014). The GasNZV of 2010 sets a target of 6 billion normal cubic meter per year (Nm^3/year) biomethane to be fed into the natural gas grid by 2020, equivalent to 60 terawatt-hours (TWh), and additionally, 10 billion Nm^3/year biomethane (100 TWh) by 2030 (Erler et al 2013). In 2013, a total of 520 million Nm^3 biomethane were injected into the natural gas grid from 151 plants (EurObservER 2014). As a reference, a typical biogas installation is presented in figure 1.

Moreover, Germany has energy and environmental targets for a carbon neutral country till 2050, which also impact the biogas sector and its potential biomass demand (BMWi 2014).

Methods and Approach

In order to achieve the objectives of this project, the European Simulation Model (ESIM) will be further developed. ESIM is a large scale agricultural and partial equilibrium model. Extensions will be in the field of feedstock assessment for biogas production and GHG accounting. Data about technically available biowaste are collected from official publications; some agricultural residues (Agr) will be contrasted with a share of the ESIM crop supply function.

Crop supply in European countries is calculated in ESIM by:

$$\begin{aligned} SUPPLY_{one,crops} &= ALAREA_{one,crops} \cdot YIELD_{one,crops} \\ ALAREA_{one,crops} &= f(PI_{one,crops}, LP1_{one}, cost\_ind_{one}) \\ YIELD_{one,crops} &= f(PP_{one,crops}, cost\_ind_{one}, tp\_gr_{one,crops}) \end{aligned}$$

Where: Area is a function of crops own and cross incentive prices (PI); land price (LP1) and intermediate-costs (cost_ind). Yield is a direct function of own producers price (PP), intermediate-costs (cost_ind) and technical progress (tp_gr).

Emission coefficients to simulate GHG will be introduced into the model based on the database of the Common Agricultural Policy Regional Impact Analysis (CAPRI) modeling system. CAPRI follows the Intergovernmental Panel on Climate Change (IPCC) GHG emissions accounting for agriculture.

Interfaces will be developed with models of different sectoral coverage, such as the TIMES PanEU, PACE and EFEM model.

Scenarios

- Reference – 40% manure + 60% maize silage
- $Biogas_{mix}$ – 80% manure + 20% biowaste/Ag_r
- $Biogas_{mix}$ – 80% manure + 10% biowaste/Ag_r + 10% maize silage
- $Biogas_{mix}$ – 30% manure + 60% biowaste/Ag_r + 10% maize silage

Figure 1. Research biogas plant "Unterer Lindenhof"- Universität Hohenheim

Expected results

This study will serve to answer following questions:

- How much GHG emissions could be avoided by dismantling a crop-based biogas industry in Germany?
- Which crops could substitute the available arable land until 2050?
- Will be the biomethane targets of the GasNVZ achieved?
- Which role will biogas play in the German carbon neutrality strategy?
- What could be the impact of changes in the biogas production structure on agricultural products in Germany, the EU and globally?
- Which agricultural commodities will be affected the most?

References

1. BMWi (2014): Zweiter Monitoring-Bericht "Energie der Zukunft". Bundesministerium für Wirtschaft und Energie.
2. Erler, R. et al. (2013): Abschlussbericht Potenzialstudie zur nachhaltigen Erzeugung und Einspeisung gasförmiger, regenerativer Energieträger in Deutschland (Biogasatlas).
3. EurObservER (2014): Biogas Barometer.
4. KTBL (2014): Finanzielle Förderung von Biogasanlagen gemäß EEG 2014. Kuratorium für Technik und Bauwesen in der Landwirtschaft.

* Corresponding author:
Johanny Perez Sierra, M. Sc.
Email: j.perezsierra@uni-hohenheim.de
Phone: +49 711 459 24670

Project start: 01.01.2015
Project end: 12.31.2017

*Member of the
BIOECONOMY GRADUATE PROGRAM BBW FORWERTS

This project is funded by
Baden-Württemberg
MINISTERIUM FÜR WISSENSCHAFT, FORSCHUNG UND KUNST

European Commission

INSIGHT INTO THE EU BIOECONOMY AND BIOMASS USE

Nicolae Scarlat[a], Jean François Dallemand[a], Fabio Monforti-Ferrario[a], Viorel Niță[b]

[a]Institute for Energy and Transport, [b]Institute for Environment and Sustainability, 2749 Via E. Fermi, 21027 Ispra, Italy

BACKGROUND / INTRODUCTION

The European Commission has set a long-term goal to develop a competitive, resource efficient and low carbon economy by 2050.
As part of a green economy, the bioeconomy plays a key role, to replace fossil resources on a large scale, not only for energy applications, but also for chemicals and materials.

ACTIVITIES

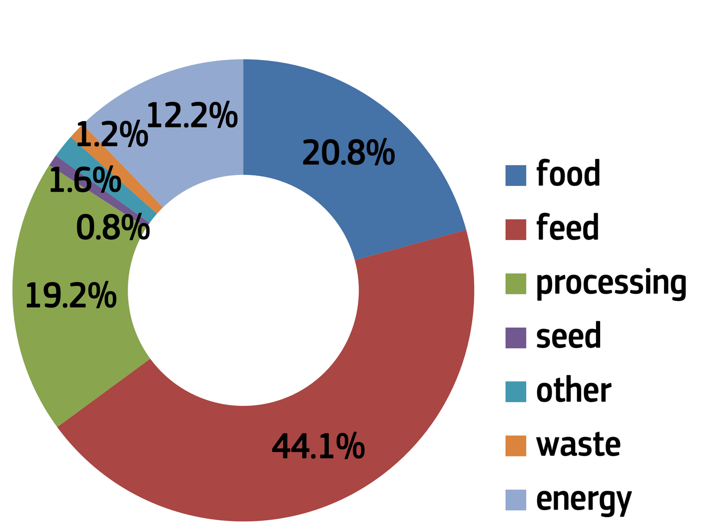
EU bioeconomy policy framework

- A competitive, resource efficient and low carbon economy by 2050.
- Innovating for Sustainable Growth: A Bioeconomy for Europe
- Europe 2020 Strategy for smart, sustainable and inclusive growth: Resource Efficient Europe, Innovation Union flagship initiatives
- Research, development and innovation policy: European Research Area (ERA), Horizon 2020 Framework Programme
- Common Agricultural and Fisheries Policy, EU Forest Strategy for forests and the forest-based sector.
- Industrial policy & competitiveness: Lead Market Initiative, Key Enabling Technologies.

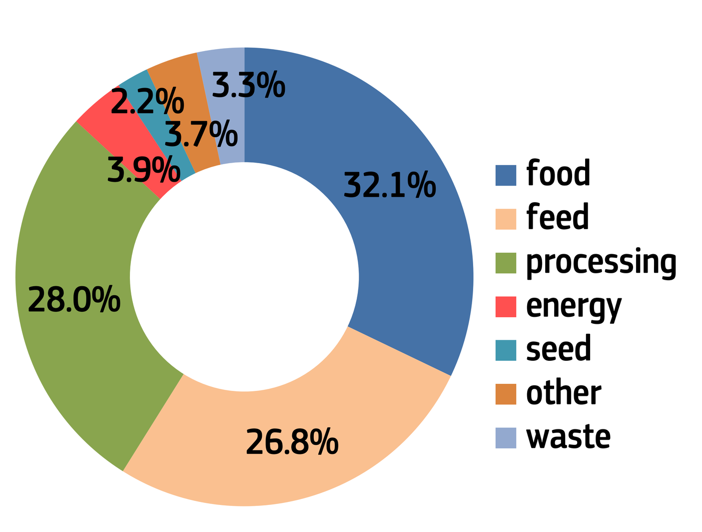
RESULTS

EU bioeconomy: state of play

The EU bioeconomy has well-established traditional bio-based industries (agriculture, food, feed, fibre, pulp and paper, etc.) and biotechnology, chemical and bioenergy industries.



Use of biomass



Use of food crops

Main sources of biomass (Mt)

	European Union	World
Food crops	684	7,573
Fibre crops	0.4	35
Fodder crops	564	1,078
Total crops	1,248	8,686
Crop residues	212	2,359
Agricultural biomass	1,460	11,044
Wood	290	2,389
Total agriculture & forest biomass	1,750	13,434
Meat and animal products	200	1,153
Aquatic biomass	14	181
Total biomass	1,965	14,768

https://ec.europa.eu/jrc

OBJECTIVES

i) current status of bioeconomy in the European Union;
ii) prospects of bioeconomy development until 2020 and beyond;

RESULTS

EU bioeconomy: state of play

Bio-based materials and biochemicals do not account yet for a high share of biomass use.
The chemical industry uses about 9 Mt of renewable raw materials in comparison with 90 Mt tonnes of feedstock used in 2012.

Biomass use for energy (Mt)

	2012	2020
Forestry biomass	**178**	**224**
wood biomass	100	144
wood residues & co-products	78	80
Agricultural biomass	**72**	**136**
energy crops	40	84
agri by-products / residues	32	52
Waste	**30**	**60**
Total	**280**	**420**

Bioeconomy's prospects in the EU

Bioenergy production is expected to account for almost 60% of the renewable energy use in 2020 (according to NREAPs).
More than 20% of all chemicals coming from the traditional chemistry sector could be produced by biotechnological means in 2020.
Up to 30% of oil-based chemicals and materials would be replaced with bio-based materials by 2030.
New bio-materials (bio-plastics, enzymes, biopharmaceuticals, etc.), could have a significant share in the materials demand in the future.
Biomass use for energy could increase to 420 Mt (378-439) in 2030 and up to 432 Mt (562-702) in 2050.

Biomass potential for energy (Mt)

	Present	2020	2030
Forestry	99-274	95-256	128-258
Agriculture	109-119	205-223	163-330
Waste	230-335	230-412	223-400
Total	438-728	530-891	514-989

LESSONS LEARNT / RECOMMENDATIONS

The switch toward bioeconomy will entail high demand for biomass not only for bioenergy, but also for bio-materials such as plastics.
Biomass mobilisation and competition between different uses (food, feed, fibre, bio-based materials and bioenergy) are key issues.
Key factors in the transition to a bio-based economy will be the development of biorefinery systems, sustainable supply and use of biomass and competition between different uses of biomass.

Contact
Nicolae Scarlat
European Commission • Joint Research Centre
Institute for Eneregy and Transport
Renewables and Energy Efficiency Unit
Tel. +39 0332 786551 • Email: Nicolae.Scarlat@ec.europa.eu

Joint Research Centre

Leveling the Field for Biofuels: Comparing the Economic and Environmental Impacts of Biofuel and Other Export Crops in Malawi

Franziska C. Schuenemann[1], James Thurlow[2] and Manfred Zeller[2]

1. University of Hohenheim, Stuttgart, Germany
2. International Food Policy Research Institute, Washington DC, USA

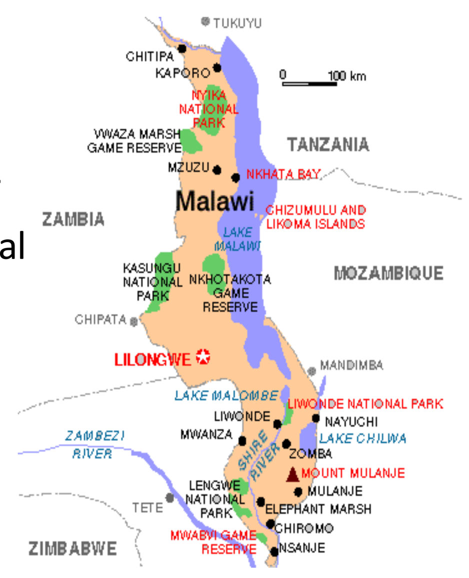
1. Introduction and Problem Setting

- Increasing pressure on natural resources requires an improved understanding of the linkages between food, energy and water systems.
- Biofuels provide a good example of synergies and tradeoffs among the three systems. Producing biofuels in poor countries can foster **economic growth** and rural development, but diverting resources away from food production might exacerbate **food insecurity**. Clearing new lands to cultivate biofuel crops generates **GHG emissions** and irrigated biofuel crops could increase pressure on **water resources**.
- EU **Sustainability Criteria** make it difficult for poor countries to participate in EU biofuel markets. These criteria are not applied to other export crops.
- We develop a comprehensive modeling framework applied to Malawi to evaluate whether biofuels deserve this high-level of scrutiny.

2. Background: Biofuels in Malawi

Country background

- Economy dominated by subsistence agriculture
- Large smallholder tobacco export sector
- 50% of the population live below national poverty line and experience high food insecurity
- Extreme land constraints
- Large water resources but high weather variability

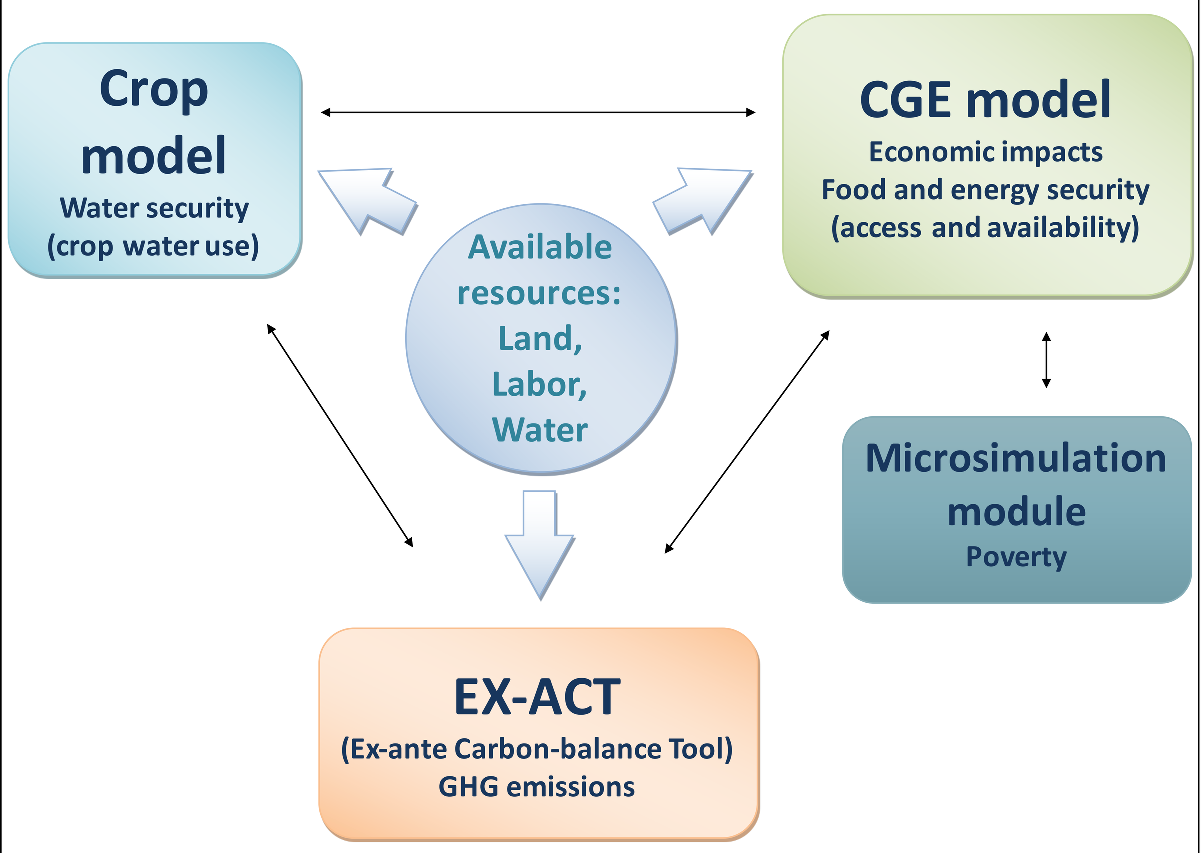


Policy Background

- Sugarcane-ethanol identified as an alternative to tobacco in National Export Strategy
- Sugarcane and ethanol (molasses) production since 1970s
- Generally favorable tariffs in export markets (EU, SADC), but biofuel exports are constrained by Sustainability Criteria (due to GHG emissions)

3. Methodology

Integrated modelling framework



Biofuel scenarios: irrigated vs. rainfed; smallholder vs. estate

- Simulate the establishment of a sizeable sugarcane-ethanol industry with 1000 mil. liters ethanol produced annually under three different scenarios
- Only 14,000 hectares of new lands can be cleared and used for feedstock production due to extreme land constraints (Kassam et al., 2012)
- Ethanol industry is assumed to be entirely financed from abroad

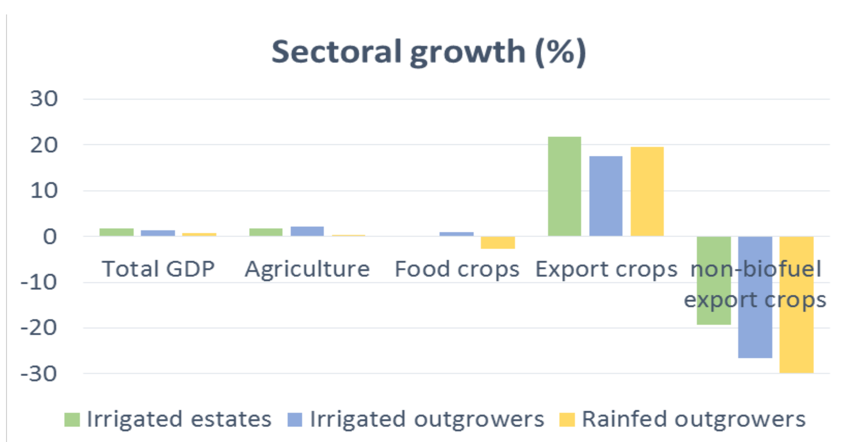
Sugarcane-Ethanol Production Technologies/Scenarios

	Input requirements per 1000 million liters of sugarcane-based ethanol		
	Irrigated estates	Irrigated outgrowers	Rainfed outgrowers
Liquid yield (liter/mt)	70.0	70.0	70.0
Feedstock required (1000 mt)	14,286	14,286	14,286
Land yield (mt/ha)	**108.0**	**99.0**	**42.0**
Land required (ha)	**132,000**	**144,000**	**340,000**
Workers employed (people)	**49,271**	**53,669**	**100,634**
Foreign capital requirements (units)	**23,568**	**12,142**	**9,984**

Source: Own estimates using farm budget survey data (Herrmann & Grote, 2015) & processing cost estimates (Quintero et al., 2012).

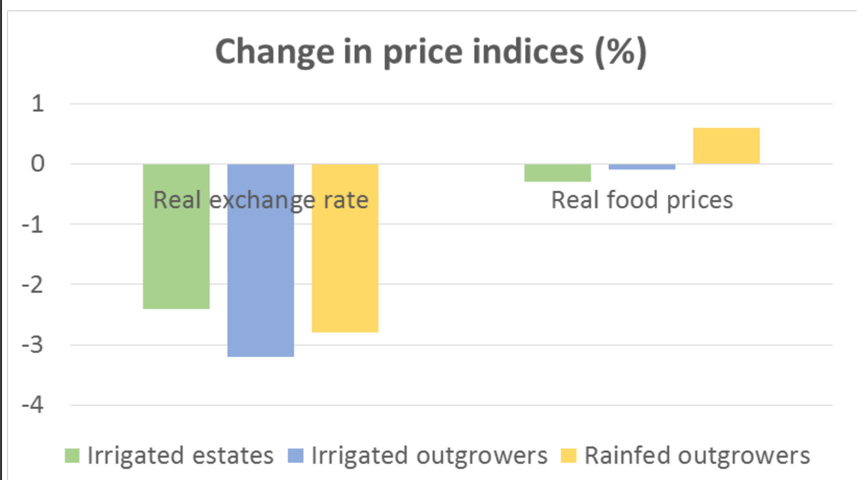
4. Results

Economic Impacts



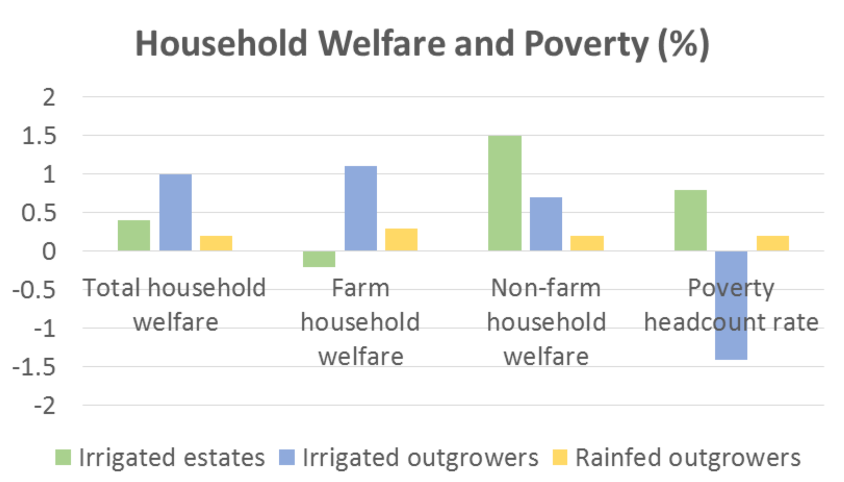
- Positive GDP growth effects in all three scenarios
- In the irrigated scenarios, not food crops but traditional export crops get displaced by sugarcane

Food Security: Positive effects on food output and prices only under irrigated production as yields are higher and land requirements lower



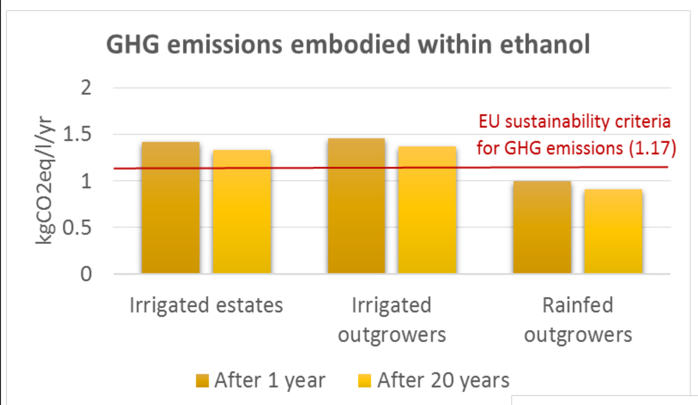
Appreciation of the exchange rate through large increase in ethanol exports: deterioration of traditional export crops such as tobacco as they become less competitive

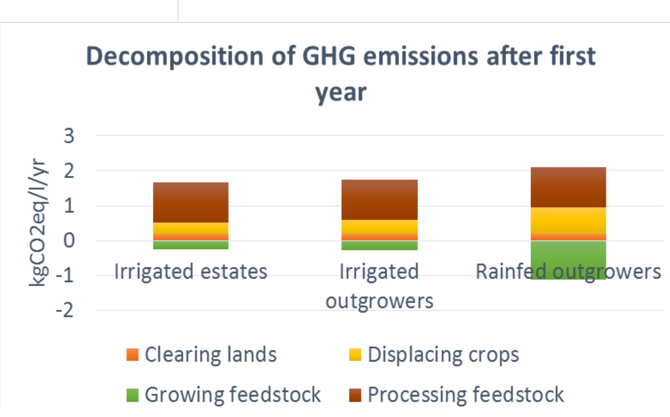
Only outgrower sugarcane production leads to significant decreases in poverty and increases in welfare for all households

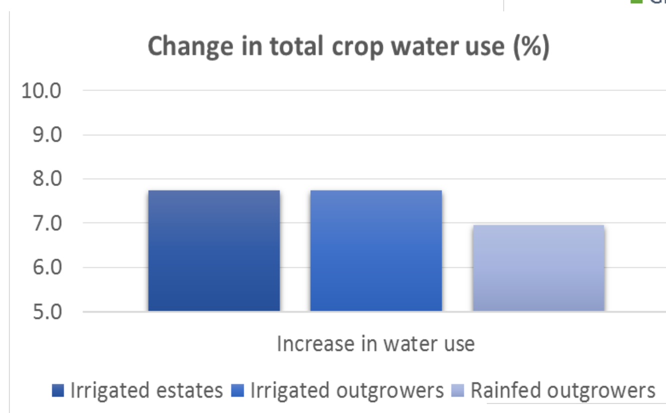


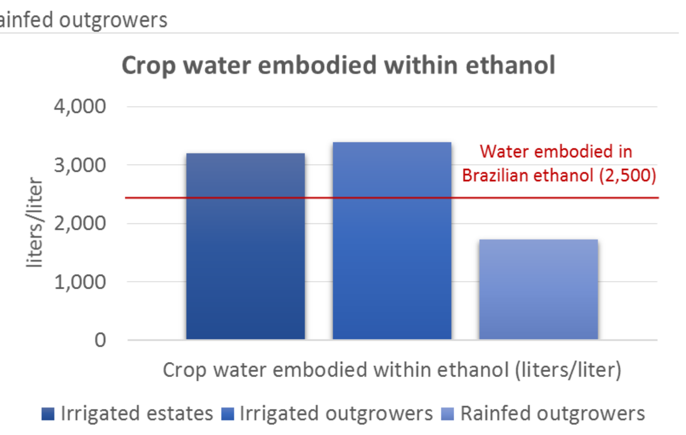
→ Most promising scenario from an economic growth and poverty perspective: Irrigated sugarcane-ethanol by outgrowers

Environmental Impacts







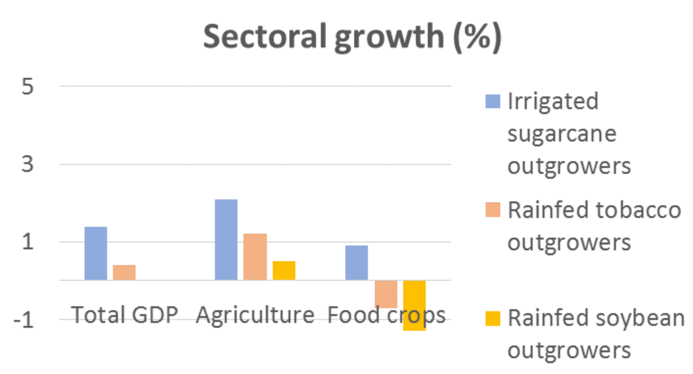


→ Most promising scenario from an environmental and water resource perspective: Rainfed sugarcane-ethanol by outgrowers

Source: Results from the Malawi CGE and microsimulation models, as well as crop models and the Ex-ante carbon balance tool. Notes: Percentage values are deviations from the final year baseline value (%) after simulation. Welfare is measured using real consumption expenditure. Poverty headcount rate is the share of the population with per capita expenditures below the national poverty line.

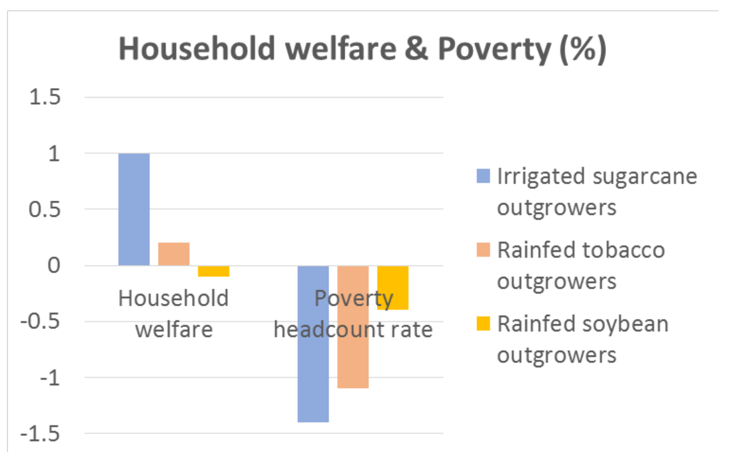
5. Comparison with other export crops

Economic Impacts

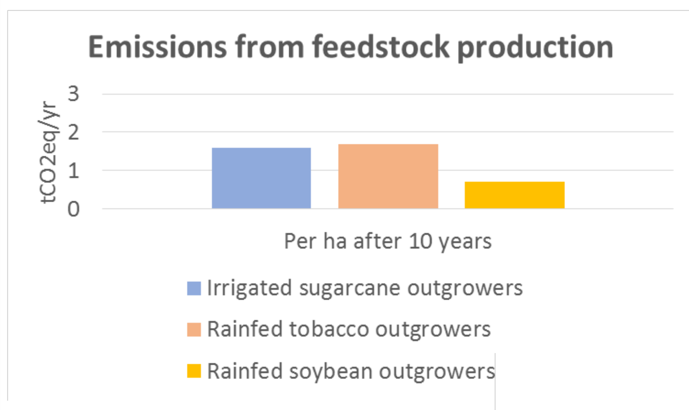


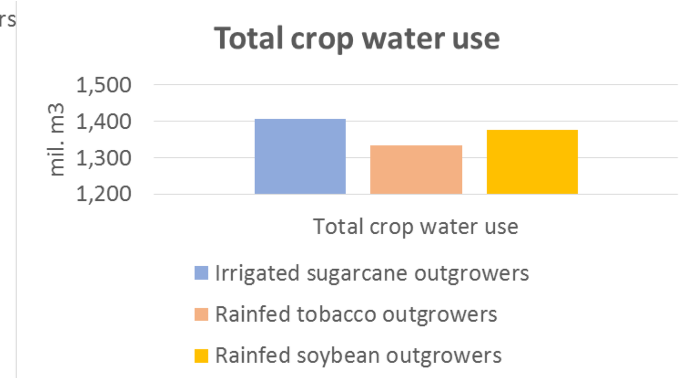
Economic growth and food security effects of sugarcane-ethanol expansion are far more positive for biofuels than for other export crops

Larger increases in welfare and decreases in poverty for sugarcane-ethanol than for other export crops



Environmental Impacts





Although irrigated sugarcane needs more water than rainfed tobacco or soybean, sugarcane exhibits smaller GHG emissions than tobacco.

→ Sugarcane-ethanol is no worse (and may be better) from an economic and an environmental perspective than either tobacco or soybeans.

→ EU Sustainability Criteria should apply to all export crops, not just biofuels.

Source: Results from the Malawi CGE and microsimulation models, as well as crop models and the Ex-ante carbon balance tool. Notes: Percentage values are deviations from the final year baseline value (%) after simulation. Welfare is measured using real consumption expenditure. Poverty headcount rate is the share of the population with per capita expenditures below the national poverty line.

6. Conclusion and Recommendations

- A comprehensive assessment of both environmental and economic effects of development policies is crucial in order to capture synergies and tradeoffs between food, energy and water systems.
- Biofuel exports can increase economic growth and improve food security.
- Concerns about adverse environmental effects are valid and should be considered when designing and implementing biofuel policies.
- Biofuel crops are not much worse than other export crops and may in fact generate larger economic benefits.
- The EU has raised the standards expected of biofuel producers, but it should "level the playing field" by applying similar standards to other export crops from developing countries.

7. References

Gerbens-Leenes, P.W., Hoekstra, A.Y., 2009. The Water Footprint of Sweeteners and Bio-Ethanol from Sugar Cane, Sugar Beet and Maize. Value of Water Research Report Series No. 38, UNESCO-IHE Institute for Water Education, Delft, the Netherlands.

Herrmann, R., Grote, U., 2015. Large-scale Agro-Industrial Development and Rural Poverty: Evidence from Sugarcane Investments in Malawi. *Journal of African Economics*, 1-32.

Kassam, A., Lutaladio, N., Friedrich, T., Kueneman, E., Salvatore, M., Bloise, M., Tschirley, J., 2012. Natural Resource Assessment for Crop and Land Suitability: An application for selected bioenergy crops in Southern Africa region. *Integrated Crop Management*, Vol.14, FAO, Rome, Italy.

Quintero, J.A., Cardona, C.A., Felix, E., Moncada, J., Sánchez, O.J., Gutiérrez, L.F., 2012. Techno-economic analysis of bioethanol production in Africa: Tanzania case. *Energy*, 48(1), 442–454.

8. Contact

Franziska Schuenemann
Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics Chair of Rural Development Theory and Policy (490a)
University of Hohenheim, Wollgrasweg 43, D-70593 Stuttgart, Germany
E-Mail: franziska.schuenemann@uni-hohenheim.de

Evaluating the land use change and food security effects of the use of residues and waste for bioenergy production

Edward Smeets*, Andrzej Tabeau*, Corjan Brink^ Anne Gerdien Prins^, Marijke Kuiper*, Geert Woltjer*, Hans van Meijl*

PBL Netherlands Environmental Assessment Agency

* LEI Wageningen UR, International Policy Division, The Hague, The Netherlands
^ Netherlands Environmental Assessment Agency (PBL), Bilthoven, The Netherlands

LEI WAGENINGEN UR

BACKGROUND

The use of residues and waste is frequently suggested as a way to avoid undesirable land use change and food security effects arising from the use of crops for energy production. Also the EC Renewable Energy Directive (RED) stimulates the use of wastes, residues and (ligno)cellulose material for bioenergy. However, the use of the sustainable potential of residues and waste for bioenergy generates increases the profitability of the sector(s) that produces the biomass. The increase in profitability (i.e. profits, defined as the rent) depends on the price and costs of collecting the biomass. This extra rent is an incentive for these sector(s) to expand production, which has an effect on both land use and food security.

OBJECTIVE

The objective is to evaluate the land use and food security effects of the use of the sustainable potential wheat straw in the EU for bioenergy production in 2030.

ACTIVITIES

First, a conceptual framework for analysing the land use and food security effects of residues is designed and implemented in the Modular Applied GeNeral Equilibrium Tool (MAGNET), which is a global computable general equilibrium (CGE) model.

A baseline scenario for 2030 is implemented in MAGNET in which the use of wheat straw is limited to conventional applications, such as animal bedding and mushroom production.

In two counterfactual scenario we assume that the total sustainable potential of wheat straw in the EU in 2030 of 0.57 EJ (taken from EC Biomass Futures project) is used for bioenergy. The rent obtained from the agricultural residues is calculated at 0.6 billion US$ and 2.6 billion US$ in scenario 1 and 2, respectively. The rent is implemented as a subsidy on the production of wheat in MAGNET on the baseline scenario results for 2030 (ceteris paribus).

RESULTS

Results show that the use of wheat straw in the EU decreases the price of wheat and increases the production and consumption of wheat in this region. The use of land for wheat production in the EU also increases, which is largely compensated by a lower use of pasture land and a reduction in land used to produce other grains and crops. The total use of agricultural land in the EU is nearly constant, namely +0.05 to -0.28 Mha in scenario 1 and 2 resp.

RESULTS

The use of wheat straw in the EU stimulates the production of wheat in the EU, which results in increased exports of wheat and other agricultural commodities from the EU and a reduction in imports to the EU. The production of wheat and most agricultural commodities in the rest of the world goes down, but the consumption of primary agricultural products and also processed foodstuff increases as a result of lower prices.

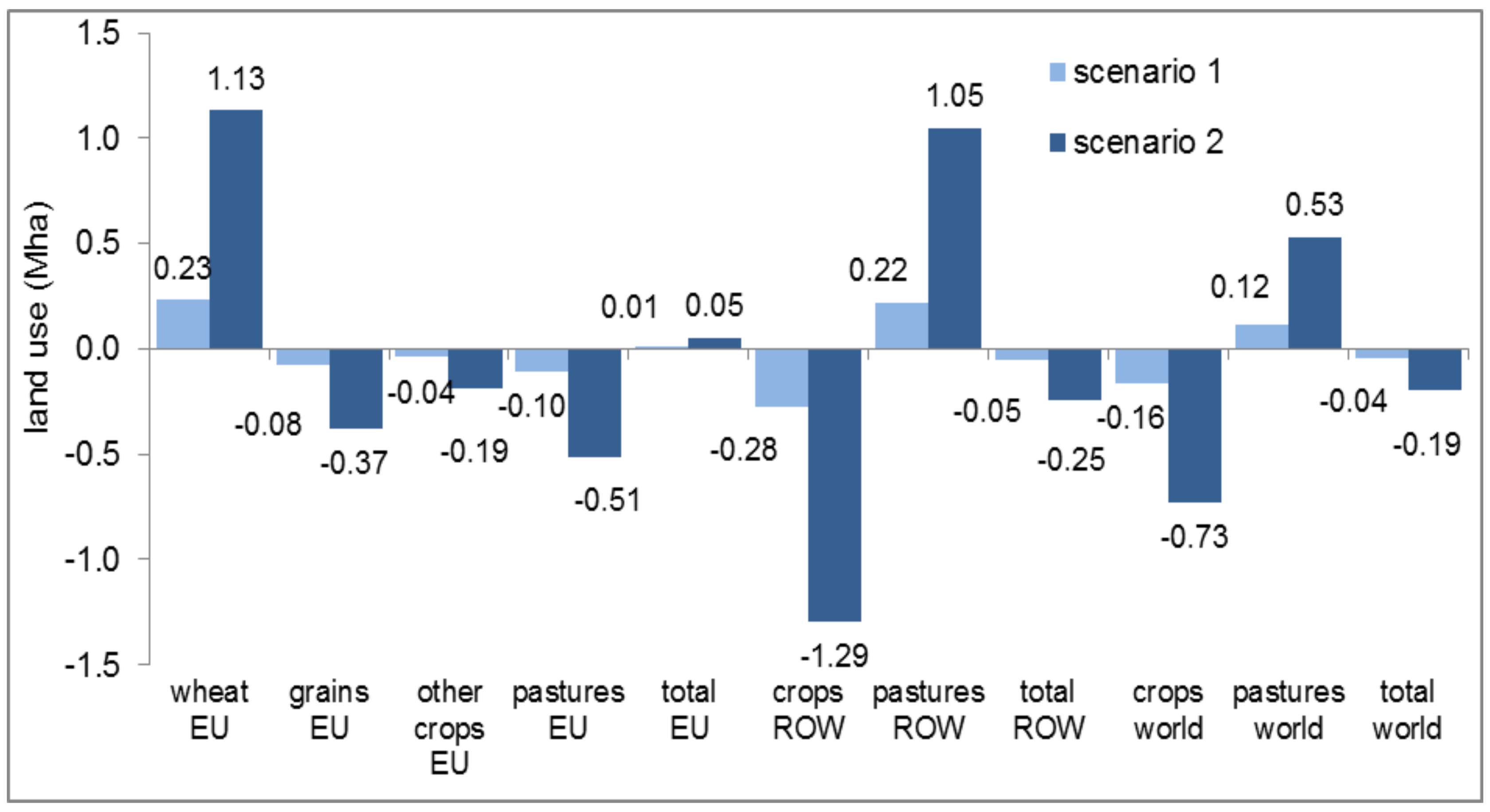


Figure: Land use in the EU, the rest of the world and the world in scenario 1 and scenario 2 compared with the baseline scenario in 2030 (in Mha).

The shift of agricultural production from the rest of the world to the EU and the high(er) yields per hectare in the EU, result in higher world average yields and slightly lower agricultural land use globally. The use of pastures in the rest of the world goes up (0.22-1.05 Mha) and the use of cropland decreases (0.28-1.29 Mha). The net change area agricultural land is limited to -0.05 to -0.25 Mha in scenario 1 and 2, resp. Further, the consumption of wheat and other food increases in the rest of the world, which means that the use of wheat straw for bioenergy contributes to an improvement of food security.

LESSONS-LEARNED & RECOMMENDATIONS

Consideration of the land use change and food security effects is crucial for a truly sustainable use of residues and waste for bioenergy and therefore also for the effectiveness and efficiency of bioenergy policies. More complex and detailed analyses are needed to evaluate the impact on soil quality, crop production technology and especially the crop harvest index.

REFERENCE

Smeets, E., A. Tabeau, M. Kuiper, C. Brink, A. G. Prins, G. Woltjer and H. Van Meijl (2015). "Evaluating the land use change and food security effects of the use of residues and waste for bioenergy production." Biomass and Bioenergy (in review).

Evaluating the macroeconomic impacts of bio-based applications in the EU

Edward Smeets+, Cristina Vinyes#, Andrzej Tabeau*, Hans van Meijl*, Corjan Brink^, Anne Gerdien Prins^

* LEI Wageningen UR, International Policy Division, The Hague, The Netherlands
^ Netherlands Environmental Assessment Agency (PBL), Bilthoven, The Netherlands
# Joint Research Centre of the European Commission, Institute for Prospective Technological Studies, Seville, Spain

BACKGROUND

A potentially limiting factor for achieving the objectives of the EU Bioeconomy Strategy is the availability of sustainably produced biomass at attractive prices.

This raises the question which bio-based applications generate the highest macro-economic benefits per unit biomass. The macro-economic effects are determined by both the production costs compared to the fossil-based reference, and by indirect economic effects. These indirect economic effects are caused by changes in the use of production factors (labour and capital) and intermediate inputs for bio-based production and by changes in prices, production, consumption and trade.

OBJECTIVE

The objective of this study is to gain insight in the factors and mechanisms that determine the macro-economic effects of different bio-based technologies in the EU.

ACTIVITIES

The macro-economic effects of bio-based applications are evaluated using the global recursive computable general equilibrium (CGE) model MAGNET (Modular Applied GeNeral Equilibrium Tool). Three bio-based applications are considered, namely:

1) bioelectricity
2) biofuel (second generation)
3) biochemicals

The macro-economic effects are compared assuming the use of 1 EJ biomass for each application.

To evaluate the importance of the indirect economic effects two methods are compared to calculate the net GDP effect. First, the expected change in production value is calculated based on the conversion efficiency and costs of bio-based and conventional technologies, these results are reached without the use of a CGE model. The second method calculates the net GDP effect using MAGNET.

RESULTS

	-- Cost calculations (spreadsheet)--			Model based (MAGNET)	
	Change of value of biobased production	Change of value of conventional production	Net change of value of production = Net GDP effect	Net GDP effect	MAGNET effect
1 Biofuel	10.7	-13.7	3.0	5.1	1.7
2 Bioelectricity	10.2	-7.7	-2.5	-3.0	1.2
3 Biochemicals	11.8	-22.4	10.6	6.0	0.6

MAGNET results show that the GDP effect of biofuels is 5.1 billion US$, which is 1.7 times the GDP effect calculated based on the difference in production costs. This multiplier factor 1.7 shows the impact of indirect economic effects on the GDP effect compared to the direct effects. A substantial part of these indirect effects comes from higher wages, which are the result of the labour intensive collection, pre-treatment and transport of biomass. The increase in wages is transmitted to other sectors in the economy, hence production and consumption increases. Another important effect comes from the lower oil price due to the substitution of oil based fuel production by bio-based fuel production. The lower oil price is beneficial for the EU economy and improves the terms of trade effect, as the EU is a net oil importer.

The same mechanisms apply to the calculation of macro-economic impacts of the production of bio-based chemicals and electricity. The production of chemicals results in the highest net GDP effect compared to the other bio-based applications, namely 6 billion US$. The GDP calculated from the change in value of production costs is however 10.6 billion US$. The lower multiplier (0.6) is mainly the result of reduced competitiveness of the services sector and the other industries sector. These sectors are relatively labour intensive and compete for labour with the domestic chemical industry.

LESSONS-LEARNED & RECOMMENDATIONS

The macro-economic effects of competitive bio-based technologies are larger than the change in production costs, but the effects differ per technology. Especially the labour intensive collection, pre-treatment and transport of biomass has a large economy wide effect.

REFERENCE

Smeets, E., C. Vinyes, A. Tabeau, H. Van Meijl, C. Brink and A.-G. Prins (2014). Evaluating the macroeconomic impacts of bio-based applications in the EU. Seville, Spain, Netherlands Environmental Assessment Agency (PBL), Agricultural Economics Research Institute (LEI) Wageningen UR, Joint Research Centre of the European Commission Institute of Prospective Technology Studies (JRC-IPTS).

The impact of the rebound effect of first generation biofuels use in the EU 27 on greenhouse gas emissions

Edward Smeets*, Andrzej Tabeau*, Siemen van Berkum*, Jamil Moorad*^, Hans van Meijl*, Geert Woltjer*

* LEI Wageningen UR, International Policy Division, Alexanderveld 5, 2585 DB The Hague, The Netherlands
^ Seanama Conservation Consultancy - P.O. Box 2327, Gaborone, Botswana; Centre for Applied Research - P.O. Box 70180, Gaborone, Botswana

BACKGROUND

An important objective of the mandated blending of biofuel in conventional gasoline and diesel in the EU is reducing greenhouse gas (GHG) emissions. An important assumption thereby is that biofuels replace the production and consumption of oil.

However, recent literature challenges this assumption, because an increased use of biofuels will lower oil prices and therefore result in increase crude oil consumption. This so-called rebound effect offsets the expected GHG emission saving effects of using biofuels.

OBJECTIVE

The aim of this study is to show the relationship between biofuel policies and GHG emissions by pointing at fuel market dynamics resulting in rebound effects and to indicate the importance of rebound effects, which are missed in most LCA studies. In addition we add to examples in available literature by quantifying rebound effects of biofuels for transport in the EU 27 and its consequences for (expected) GHG emission savings.

ACTIVITIES

First, eight studies are reviewed (Hochman *et al.*, 2010; Stoft, 2010; Drabik and De Gorter, 2011; Laborde, 2011; Rajagopal *et al.*, 2011; Thompson *et al.*, 2011; Chen *et al.*, 2012; Taheripour and Tyner, 2012).

Second, the Modular Applied GeNeral Equilibrium Tool (MAGNET) is used to estimate the rebound effects of biofuel use in the EU. MAGNET is a global computable general equilibrium model that covers the global economy.

RESULTS

Estimates of the rebound effect vary widely due to differences in approaches, models and their parameters used to quantify the economic mechanisms causing the rebound effect, the geographic scope, the timeframe and the biofuel policy regime.

Generally, estimated rebound effects are negative in the country where biofuel use is being promoted (i.e. the use of 1 unit of biofuel reduces oil consumption by less than 1 unit; units on energy basis). The rebound effects in other countries are always positive (biofuel use reduces oil consumption by less than 1 unit so the total fuel consumption is increasing).

RESULTS

The net global rebound effect is usually positive, which means that GHG emissions savings are less compared to as usually is assumed, or emissions may even increase. Biofuel tax credits and other financial incentives typically result in higher net global rebound effects compared to policies based on blending mandates.

Estimations with the global MAGNET computable general equilibrium model indicate a global rebound effect of the 10% biofuel blend mandate in the EU in the year 2020 of 22% to 30% (i.e. the use of 1 unit of biofuel reduces global oil consumption by 0.78 to 0.70 units). This means that GHG emissions will not be reduced as much as usually is assumed, or may even increase. These results show that rebound effects can significantly lower the effectiveness of biofuel policies in reducing GHG emissions.

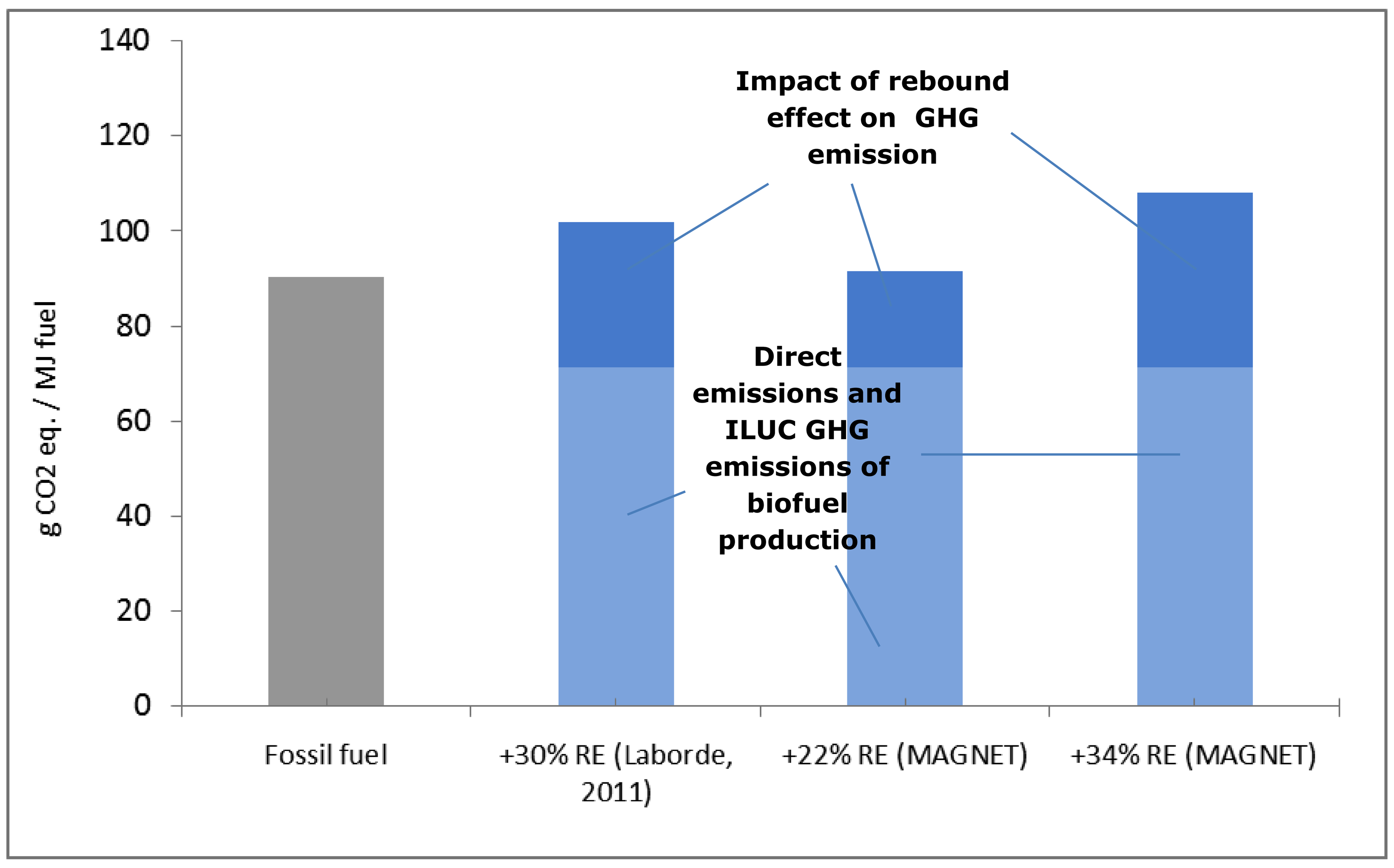


Figure: The impact of the rebound effect of biofuel use in the EU 27 on GHG emissions (in gCO_2eq./MJ fuel). Sources: MAGNET/author's calculations and Laborde (2011)

LESSONS-LEARNED & RECOMMENDATIONS

We conclude that the review and analyses presented in this paper clearly show that the rebound effects of biofuel use can greatly decrease the GHG saving potential of biofuels, even more than indirect land use change (ILUC), and point at the need for detailed economic modelling when evaluating the environmental sustainability, the effectiveness of biofuel promoting policies, but also the economic impacts. Especially the role of the Organization of the Petroleum Exporting Countries (OPEC) cartel of oil producers is deserves further attention, considering the current high level of oil production and low oil price.

REFERENCES

Laborde, D. (2011). Assessing the Land Use Change Consequences of European Biofuel Policies - Final Report. Available at: http://trade.ec.europa.eu/doclib/docs/2011/october/tradoc_148289.pdf. Washington, DC, USA, International Food Policy Research Institute (IFPRI).

Smeets, E., A. Tabeau, S. Van Berkum, J. Moorad, G. Woltjer and H. Van Meijl (2014). "The impact of the rebound effect of first generation biofuels on greenhouse gas emissions in the EU." Renewable and Sustainable Energy Reviews 38: 393-403.

Greenhouse Gas Emission Mitigation And Agriculture, Trade-off Or Win-win Situation: Bioeconomic Farm Modelling In The Sudanian Area Of Burkina Faso

AUTHOR

Tiertou Edwige SOME

PhD student

Email: someedwige09@yahoo.fr

AFFILIATION

WASCAL

West African Science Service Center on Climate Change and Adapted Land Use

BACKGROUND & OBJECTIVES

BACKGROUND:

Climate changes talks regularly underline that developing countries' agriculture could play a stronger role in GHGs mitigation strategies and benefit from the Kyoto Protocol program of subsidies. Scientists explain that agriculture can contribute to carbon mitigation by storing more carbon in the soil through greener cropping systems.

The clean development mechanism (CDM) proposed in the Kyoto protocol is one particular policy instrument that can incite farmers to mitigate the GHG balance towards more sequestration and less emission

OBJECTIVES (O): Assessment whether mitigation strategies imply a trade-off between environmental and economic objectives or a win-win situation.

O1: Impact of perennial crops in farmers' utility

O2: Impact of emission limitation in Farmers' utility

ACTIVITIES

Study area: Village of "Bala" located in the "Satiri" rural commune, located in the "Haut-***Bassins***" region in the Sudanian zone

Main crops activities: cotton, maize, sorghum and small areas of peanut, bean, rice, and perennial such as eucalyptus, cashew-nut and Jatropha, subdivided by traditional crops, intensive crops, and high intensive crops.

Method: Multi-period linear programming model.

Data source: IPCC (2007): emissions of GHGs per crop and carbon sequestration from agroforestry. **Primary data:** crops yields, costs and the inputs collected during a field work in which 45 small farmers.

Farmers' objectives: Maximisation of their utility. The net present value (NPV) of the annual net cash income (NCI) obtained after subtracting of revenues, all current expenses as food consumption and production costs, is used as proxy of the utility. The planning horizon for simulation is 25 years in order to take into account the life cycle or perennial crops.

More the NPV is higher, more the utility is improved, and then farmers' welfare is improved.

They must make decisions about what commodities to produce in which quantity, subject to constraints as the food consumption, resources constraint (land, labour, and treasury) and minimum income.

The treasury is composed by the farmers' own cash and the credit bounded by cotton area. The total farm expenses must not exceed the available treasury.

The household must satisfy the food need by consuming a part of its production or by purchased grains.

Risk is taken into account in the model, because of variability due to many factors (Hazell et al., 2015).

Emission constraint is added to the scenario of emission limitation. Sequestration function is added to perennial crops scenario, to generate the carbon balance.

ACKNOWLEDGEMENTS

For their indispensable contributions to advancing the research processes, I am thankful to:

- Prof. Joachim von Braun, Centre for development research, Bonn (Germany)
- Prof. Ahmadou Aly Mbaye, University of Cheikh Anta Diop, Dakar (Senegal)
- Bruno Barbier, Unité Mixte de Recherche, gestion l'eau, acteurs et Usages, Centre de coopération International en Recherche Agronomique pour le Développement (UMR-GEAU, CIRAD)

RESULTS

I. BASELINE:

Crops activities: High income crops with high GHG emission: Intensive maize, cotton, rice and traditional sorghum

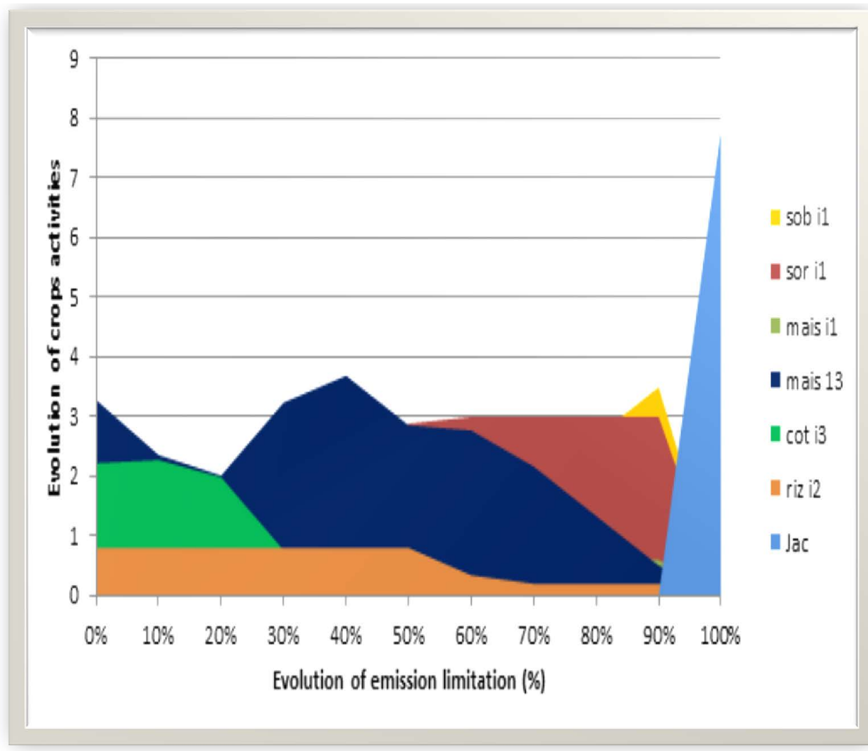
Annual seasonal NCI: Dry 528,500 CFA normal; Normal 848,350 CFA; humid 496,200 CFA with risk 948,160 CFA.

NPV 8,065,300 CFA

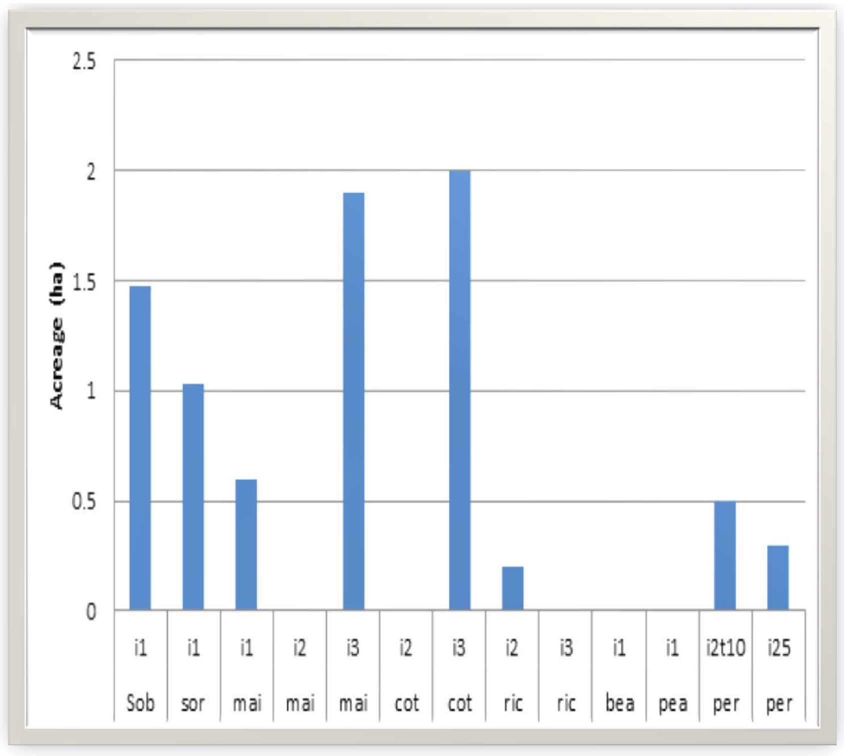
II. Scenario of mitigation strategies

A. CROPS ACTIVITIES

Crops activities in emissions limitation



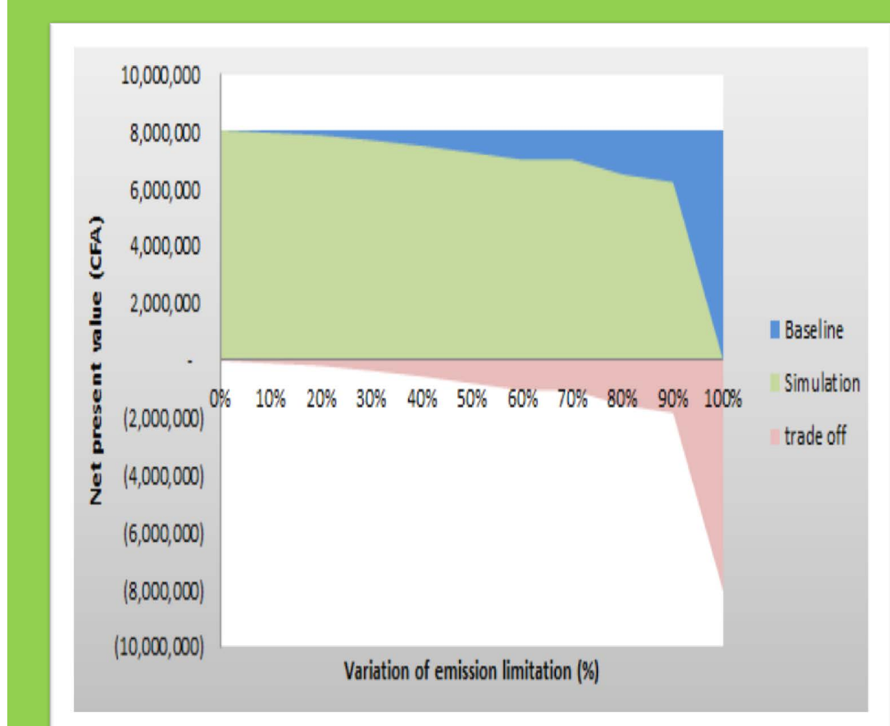
Crops activities with perennial crop scenario

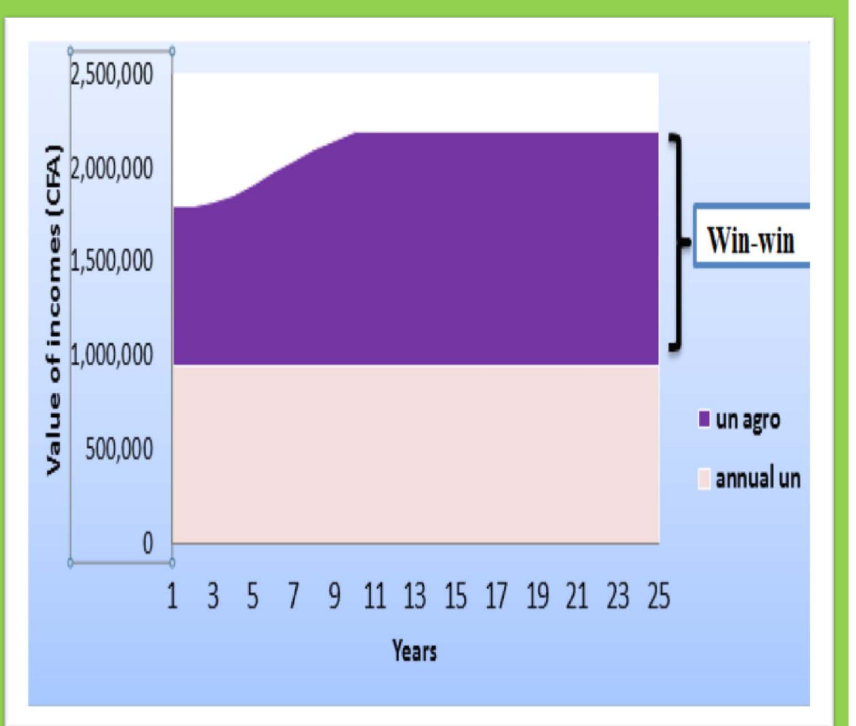


Emission limitation: More emissions are limited, more pollutant crops are replace bye less pollutant

Perennial crops: intensive crops are produced associated to perennials crops.

B. Impact on farmers' utility





Farmers, utility is decreasing in the strategy of emission limitation and improving with the association of perennial crops.

Emission limitation strategy involves trade-off while perennial crops improve farmers' utility.

Perennial crops lead also an individual carbon balance of 6.118 TCO2eq.

LESSONS-LEARNED & RECOMMENDATIONS

Small farmers must integrate perennial crops in their cropping system while limiting emissions will get worse their life conditions. To reduce emissions in annual crops system, subsidies are needed to compensate the income lost. The country can apply to CDM program to get compensation.

REFERENCES

- Hess U., Hazell P. and Kuhn S. (2015), Innovations and Emerging Trends in Agricultural Insurance, ResearchGate
- Porter M. E. and van der Linde C. (1995), Toward a New Conception of the environment-competitiveness relationship, Journal of Economic Perspectives, 9, 97-118
- Babcock B. A., Dumortier J. and Rosas F. (2011), Greenhouse Gas and Nitrogen Fertilizer Scenarios for U.S. Agriculture and Global Biofuels, Working Paper 11-WP 524
- Barnum H. N. and Squire L. (1978), an econometric application of the theory of the farm-household
- Beach, R. H., DeAngelo, B. J., Steven R., Li, C., Salas, W., and DelGrosso, S. J. (2006), Mitigation Potential and Costs for Global Agricultural Greenhouse Gas Emissions, International Association of Agricultural Economists Conference, Gold Coast, Australia
- Bostick, W.M., Bado, V.B., Bationo, A., Soler, C.T., Hoogenboom, G., Jones, J.W. (2007), Soil carbon dynamics and crop residue yields of cropping systems in the Northern Guinea Savannah of Burkina Faso. Soil Tillage Res. 93, 138–151

Gender effects on adoption of Climate Smart Agriculture (CSA) practices in Burkina Faso

GLOBAL BIOECONOMY SUMMIT 2015

Bindayaoba Thomas YAMEOGO
byathom@yahoo.fr
West African Science Service Center on Climate Change and Adapted Land Use (WASCAL) , www.wascal.org

WASCAL West African Science Service Center on Climate Change and Adapted Land Use

BACKGROUND

- Climate change impacts will be differently distributed among different regions, generations, age classes, income groups, occupations and genders (IPCC, 2001).
- There is a need for rural farmers to adopt/develop more sustainable and productive agricultural systems that boost food security while contributing to mitigate climate change and preserving the natural resource base and vital ecosystem services.
- Gender inequality can also hinder adaptation to adapt to climate change, including the adoption of climate-smart strategies.
- Climate-smart agriculture (CSA) is defined as agriculture that "sustainably increases productivity, enhances resilience, reduces/removes greenhouse gas emissions, and enhances achievement of national food security and development goals" (FAO, 2013).

ACTIVITIES

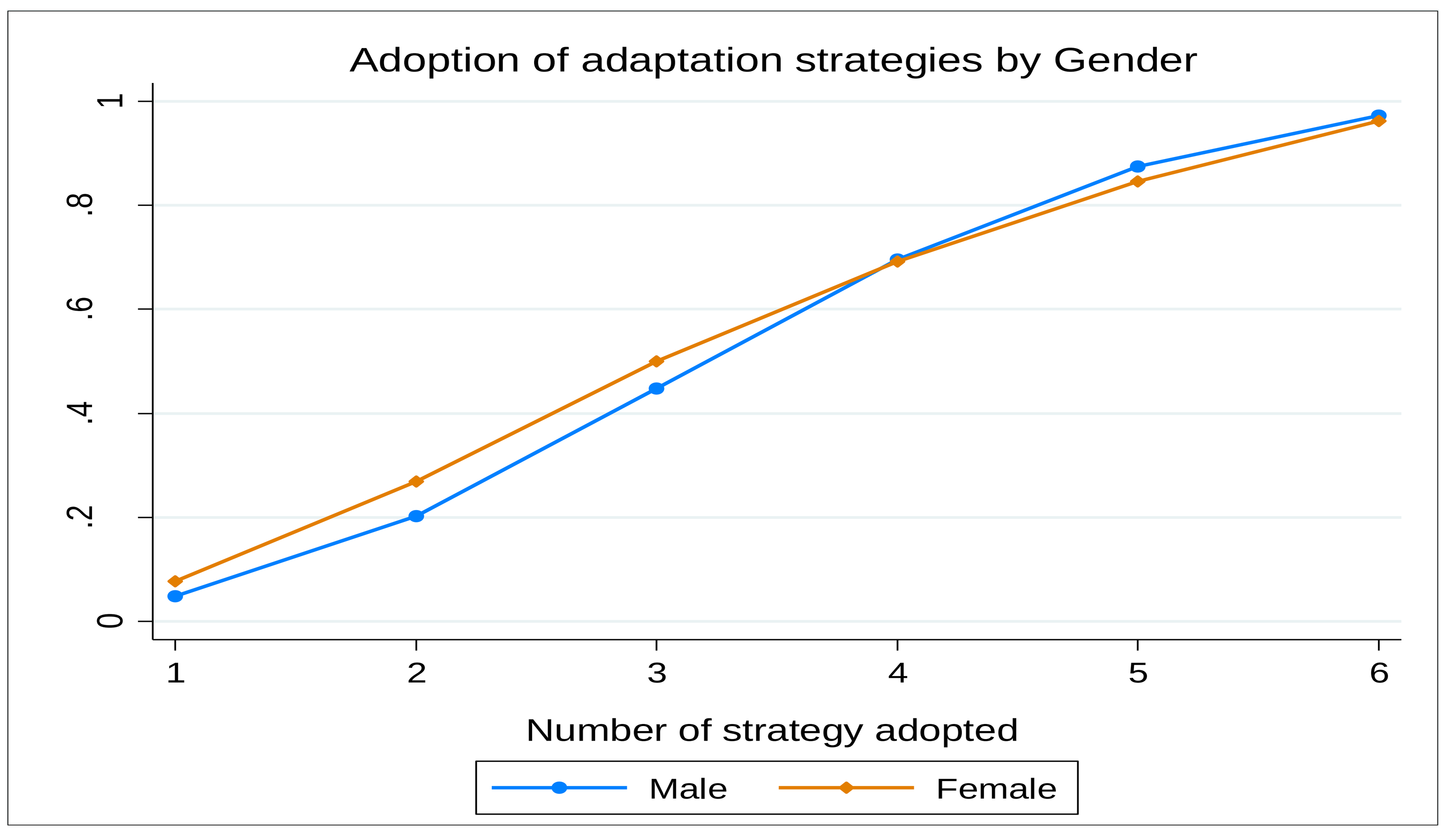
Sampling procedure

- Three sites (Dano, Koumbia and Gourcy) were selected in order to capture differences in weather conditions.
- A sample of 50 households was randomly chosen in each village. Thus a total of 450 households were used for this study;
- Data were collected through two complementary approaches: a household survey and a village survey (focus-group style).

Analytical procedures

- Descriptive Statistics were used to describe farmer's Perceptions of Climate Change and the rate of adoption of adaptation strategies in the study areas by gender;
- A Heckman sample selection model was employed to avoid sample selection bias, since not every farmer who may perceive climate change would respond to changes through adoption of CSA technologies.

Figure 1: Adoption of adaptation strategies by gender



Source: Own elaboration

OBJECTIVES

The objective of this paper is to examine the factors determining farmers' perceptions of climate change and decisions to cope with through the adoption of Climate Smart Agriculture (CSA) practices.

RESULTS

Table 1: Results of the Heckman's Probit Model of Farmers' Perception of and Adoption of CSA

	Perception		Adoption of CSA	
	Coef.	Std. Err.	Coef.	Std. Err.
Gender	-0.583	0.400	**-1.480*** **	**0.398**
Age	**0.010*** **	**0.003**	**0.028*** **	**0.004**
Age2			**-0.000*** **	**0.000**
Gender x Age			**0.013*** **	**0.004**
Informal Education	0.419	0.548	-0.020	0.069
Gender x Infor. Ed.			-0.430	0.514
Formal Education	0.026	0.190	0.050	0.067
Gender x Formal Ed.			**-0.874***	**0.521**
Migration	**0.860***	**0.475**		
Credit			**-0.088***	**0.054**

*Notes: ***, **, * = significant at 1%, 5%, and 10% probability level, respectively*
Source: Computed from Survey Data; 2013

LESSONS-LEARNED & RECOMMENDATIONS

- Households headed by females were less likely to adopt CSA practices than male farmers;
- women face restricted access to some assets and productive resources; Government and others decision makers should channel their efforts toward the development of policies and strategies to alleviate such constraints.

REFERENCES & ACKNOWLEDGEMENTS

References

- Aryal, J.P., C.R. Farnworth, R.Khurana, S. Ray, and T. Sapkota. 2014. Gender dimensions of climate change adaptation through climate smart agricultural practices in India. Innovation in Indian Agriculture: Ways Forward.
- Yaméogo, B. T. 2015. Social Capital and Farmers' Adaptations Strategies to Climate Change in Burkina Faso. A PhD Dissertation, Université Cheikh Anta Diop de Dakar (UCAD), Senegal.

Acknowledgments

The funding for this study is made by the West African Science Service Center on Climate Change and Adapted Land Use (WASCAL) initiative through the support of the German Federal Ministry of Education and Research (BMBF). I would therefore like to offer my sincere thanks to these institutions.