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Improved modeling & mitigation of iLUC

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Seminar: iLUC related to biofuels and bioliquids
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Copernicus Institute
Research Institute for Sustainable Development and Innovation

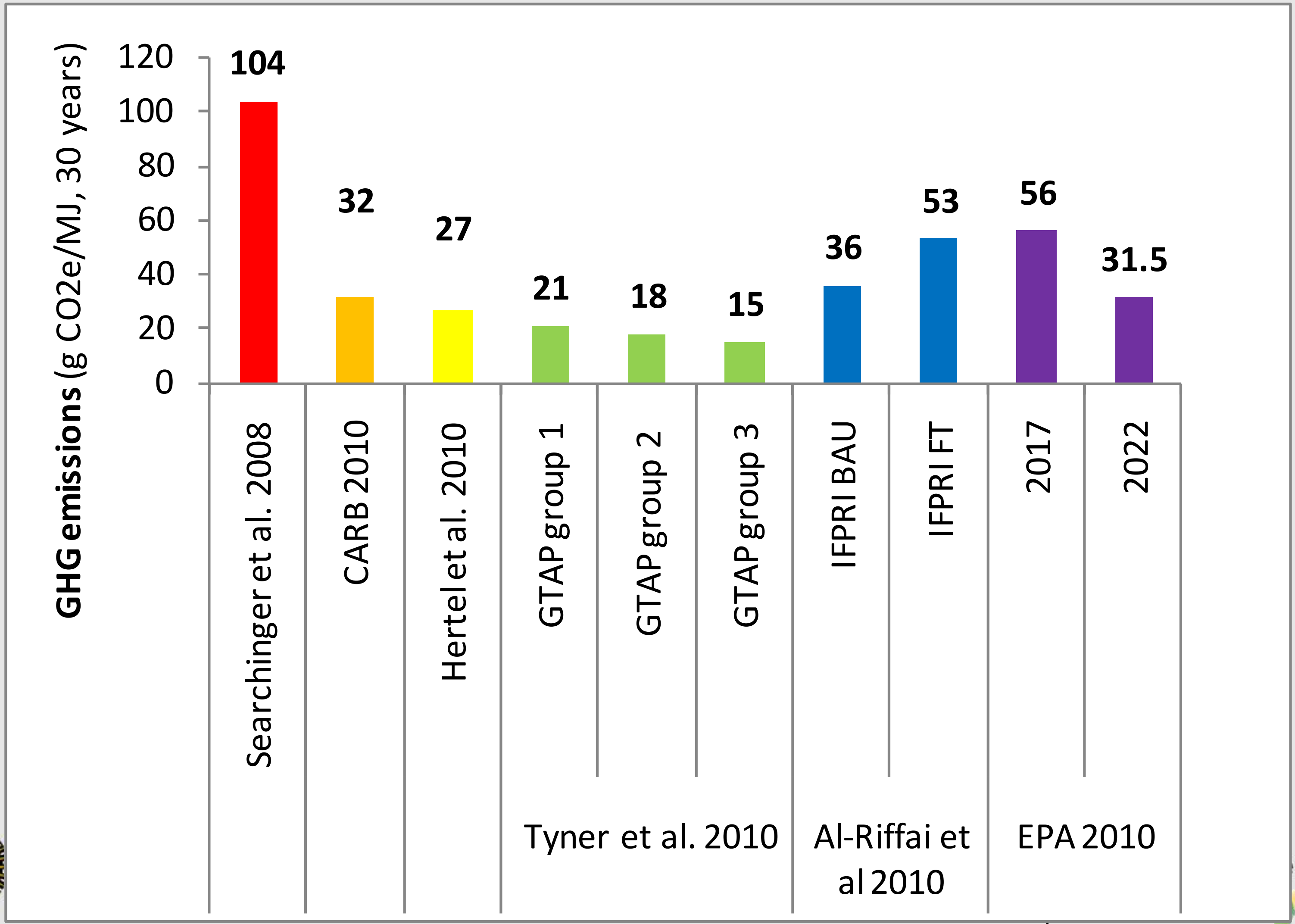
Overview

- Introduction
- Uncertainties/Shortcomings of existing modeling efforts
- Further analysis/improvements
- Mitigation options
- Policy options
- Conclusions

Introduction

- There is no question about the existence of iLUC but the magnitude and how best to deal with it is uncertain
- Different types of models
  - Macro-economic / biophysical models
  - Deterministic and other models
- Large ranges in results
- Let’s look at the example of corn ethanol

Example: iLUC of corn ethanol



Introduction

- iLUC modeling of US corn ethanol is the most developed – Refinements have let to a reduction of the iLUC factor of US corn ethanol
- But how certain are we about these results?
- Similar trends for other fuels?

→ What are uncertainties/shortcomings of existing modeling efforts and how can modeling be improved?

- But even low iLUC factor is undesirable

→ How can we mitigate the iLUC effect?

Uncertainties/Shortcomings (I)

- Underlying datasets
  - SAM
  - Land use
  - Learning rates
- Key feedback relations: price, innovation and policy ←→ productivity increases
  - E.g. GTAP model in JRC-IE study (Edwards et al 2010):

$$\frac{yields\ new\ cropland}{average\ yields\ existing\ cropland} = 0.66$$

for all crops, all regions

- Land elasticities

Uncertainties/Shortcomings (II)

- Future production and trade patterns of bioenergy
- Land use change
- By-products from bioenergy
- Technology changes over time (2^{nd} generation)
- Impacts from iLUC
- Dynamic nature of iLUC

Further analysis

- Include scenarios with sustainability criteria
- Include perennial crop production
- Pro-active iLUC modeling
  - How can iLUC be minimized?

  → Include scenarios with iLUC mitigation options (next slides)

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iLUC mitigation measures (I)

- 2 main types of strategies
  - Controlling extent of LUC
    - Using agricultural and forestry resides
    - Increasing efficiency in agriculture, livestock and bioenergy production
    - Increasing chain efficiencies
    - Minimizing degradation and abandonment of agricultural land
  - Controlling type of LUC
    - Appropriate zoning of land use and land cover; e.g. excluding high carbon stock and biodiversity areas
    - Using degraded and marginal land
    - Using unused or abandoned agricultural land

iLUC mitigation measures (II)

- Use of biomass residues and wastes
  - no iLUC and large GHG emission savings if residues and wastes are used that are otherwise disposed off
  - BUT: negative effects if existing uses!
  - Study: Ecometrica 2009

iLUC mitigation measures (III)

- Use of arable & pasture lands: only when surplus capacity is available or created via increased efficiency/output:
  - Livestock management
  - Co-products
  - Productivity increases of conventional crops
  - Inter- and multiple cropping systems
  - Multiple rotations
  - Optimized yields total biomass output
  - Biorefining of crops (e.g. grasses)

Example: Increasing livestock density Brazil

Lapola et al., 2010, PNAS:

Indirect land-use changes can overcome carbon savings from biofuels in Brazil

But: if livestock density is increased by 0.13 head per hectare (instead of 0.09 as in baseline) between 2003 and 2020, then iLUC could be avoided (Lapola et al. 2010)!

Example: Yield projections Europe

Observed yield

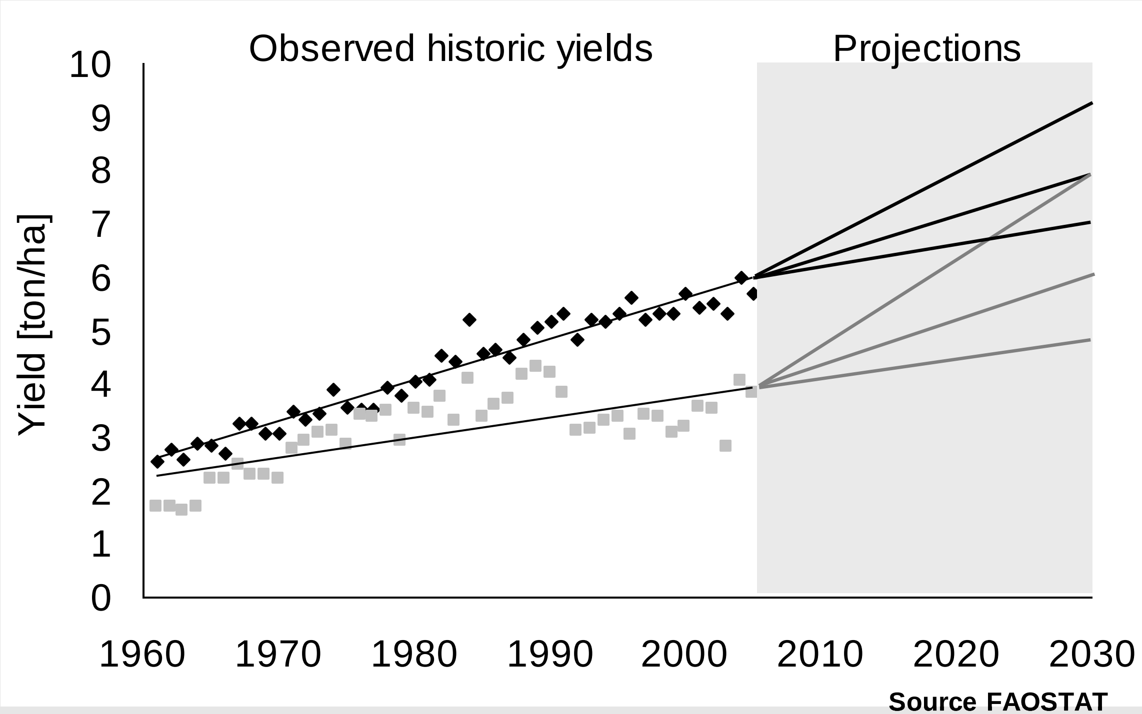
- CEEC and WEC

Linear extrapolation of historic trends

- Widening yield gap

Applied scenarios

- Low, baseline and high

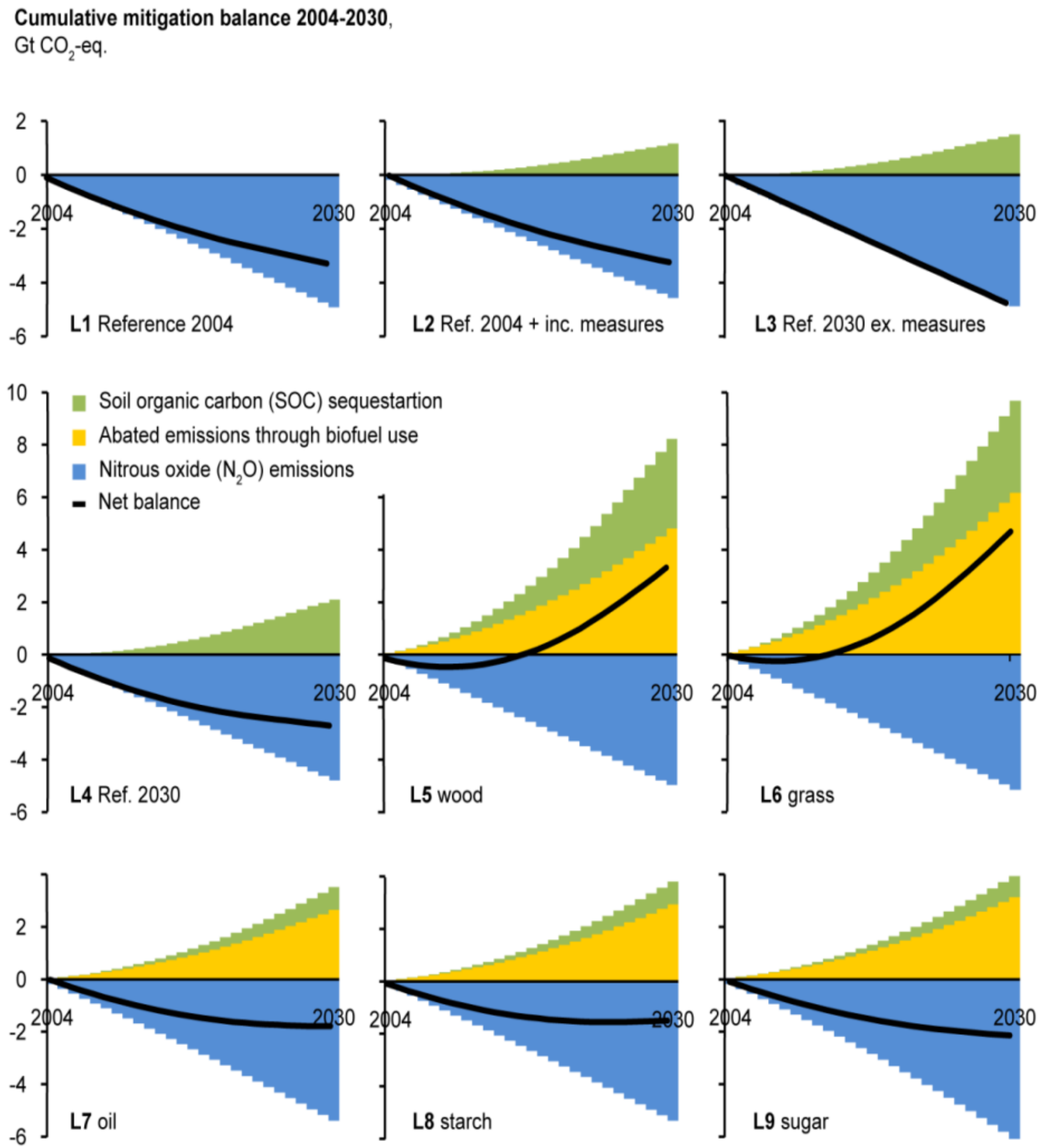


[Wit & Faaij, Biomass and Bioenergy, 2010]

Absolute productivity increases and relative growth rates for the period 1961-2007 and per decade

De Wit, et al., RSER, 2011

		Absolute 1961-2007 kg ha^{-1} y^{-2} kg $animal^{-1}$ y^{-1}	Relative **1961-2007**	'61-'69	'70-'79 % y^{-1}	'80-'89	'90-'99	'00-'07
France	Wheat	104	**3.6**	5.2	2.5	2.5	1.6	-0.9
	Rapeseed	40	**2.5**	1.4	0.3	-0.3	2.1	1.2
	Sugarbeet	1024	**3.1**	3.6	0.2	2.4	1.0	2.8
	Cattle	2.8	**1.6**	0.5	1.2	0.9	-0.1	0.9
Netherlands	Wheat	110	**2.7**	0.7	3.8	1.4	0.5	-0.6
	Rapeseed	25	**1.0**	-0.6	-1.8	-0.1	0.6	0.2
	Sugarbeet	489	**1.2**	2.6	0.1	1.4	-1.9	2.5
	Cattle	1.1	**0.6**	0.7	0.9	2.1	-0.9	-1.0
Poland	Wheat	39	**1.8**	3.6	2.3	4.1	-0.6	1.6
	Rapeseed	21	**1.4**	1.7	0.4	-0.4	-0.6	4.0
	Sugarbeet	319	**1.2**	3.5	-0.5	2.6	1.0	3.7
	Cattle	2.5	**2.7**	3.6	6.1	4.9	0.6	10.1
Ukraine *(USSR)* [a]	Wheat	*n.a.*	*n.a.*	5.1	1.0	3.6	-4.5	-0.2
	Rapeseed	*n.a.*	*n.a.*	3.5	-2.7	-0.4	-7.4	9.4
	Sugarbeet	*n.a.*	*n.a.*	9.0	0.3	5.0	-3.2	11.3
	Cattle	*n.a.*	*n.a.*	6.3	2.1	2.1	-4.9	1.2



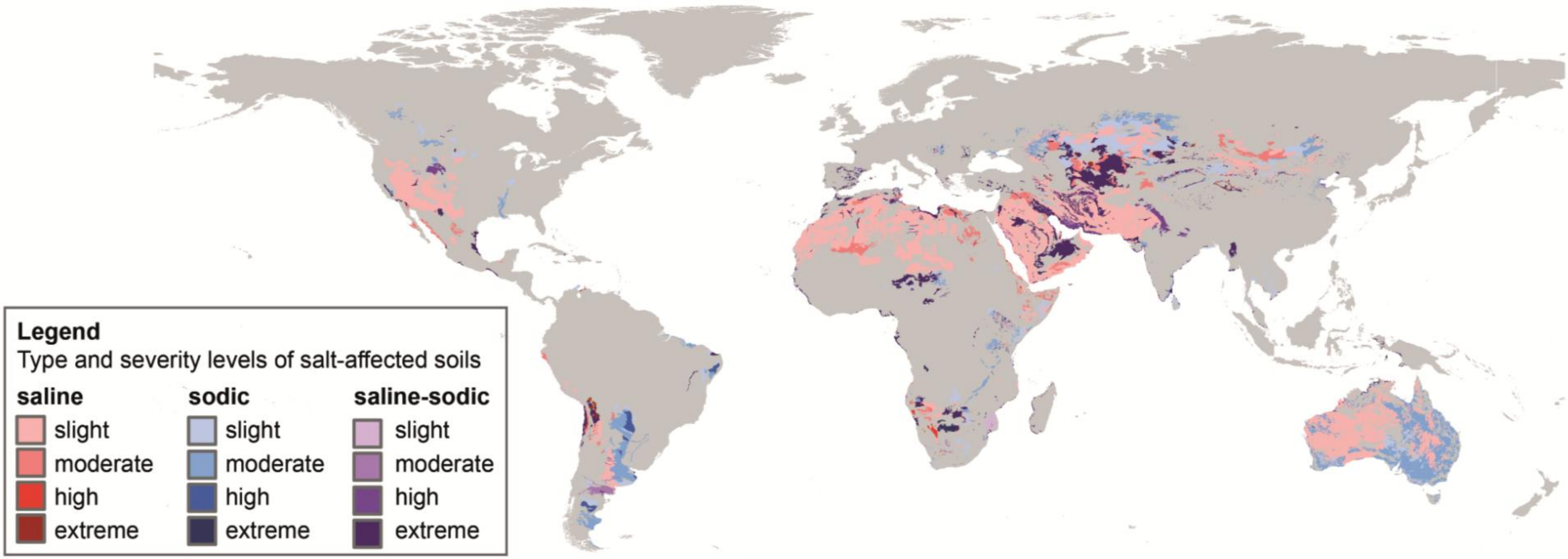
Example:
GHG balance of combined agricultural intensification + bioenergy production in Europe

[Wit et al., forthcoming]

iLUC mitigation measures (IV)

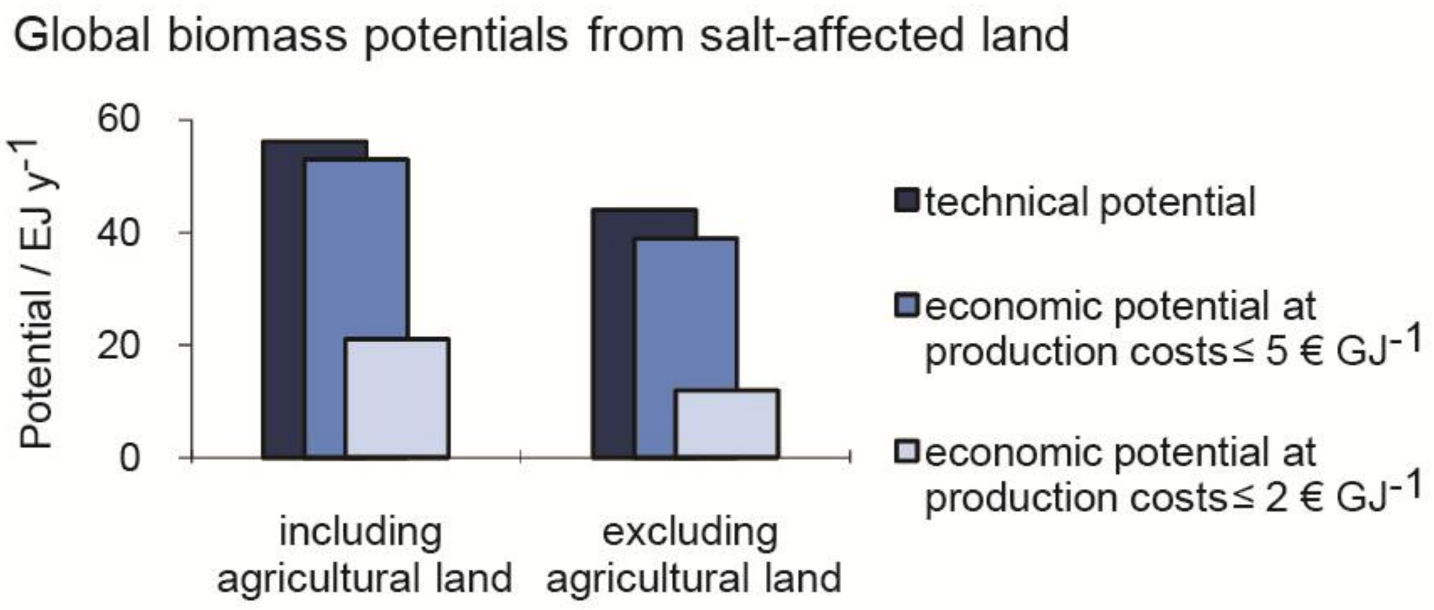
- Use marginal & degraded land
  - Set-aside agricultural land
  - Perennials on marginal land
  - Degraded land (restoration functions/ ecosystem services)

Example: Salt-affected soils



[Wicke et al., Energy and Environmental Science, 2011]

Example: Salt-affected soils



[Wicke et al., Energy and Environmental Science, 2011]

Policy options (I)

- Broaden the CAP; cross compliance via rationalization of agriculture and deployment of perennials; finance CAP with replaced energy expenditures
- Proper zoning + REDD (‘’fence the land & carbon stocks’)
- Balance production increases and bioenergy production
- Manage & mitigate iLUC on EU/national/ regional/local scale…(with related govt-industry governance)

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Policy options (II)

- Moving targets & learning curves for GHG balances & yields
- Monitor yields, volumes, prices for land & food vs. thresholds
- Embed such parameters in certification of production regions; qualify regions in terms of risks and potentials
- Joint ventures between agri- and fuel/bio-refining sectors
- RDD&D; build experience in specific regional settings.

Conclusions

- There is no question about the existence of iLUC but the magnitude and how best to deal with it is uncertain
- Modeling efforts have been improving, but still shortcomings exists and require more improvements
  - E.g. inclusion of perennial crops and sustainability scenarios, reducing key uncertainties, conducting sensitivity analysis, using models in pro-active manner
- iLUC can be mitigated!
  - E.g. using resides and waste, using degraded and marginal land, increasing crop production, improving chain efficiencies

Project: Knowledge infrastructure for sustainable biomass pathways

- **Project partners**
  - Copernicus Institute, LEI, PBL
- **Combining existing models**
  - MAGNET (former LEITAP)
  - IMAGE, IMAGE TIMER
  - bottom-up analysis of technological learning in biomass/bioenergy production

Determine sustainable pathways

- **Funding:** Dutch Ministry of Economic Affairs, Agriculture and Innovation; European Climate Foundation; David & Lucile Packard Foundation
- **Timing:** 5 year project (start Oct. 2010)

Thank you for your attention!

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www.bioenergytrade.org

sciencedirect/scopus