

SUSTAINABLE BIOENERGY SUPPLY STRATEGIES: UNCERTAINTIES, SYNERGIES AND TRADE-OFFS

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Continued controversy about bioenergy...

- Strategies are needed to avoid undesirable land use change and food security effects of bioenergy (bioelectricity and 1st and 2nd generation biofuels) use.
- Potentially promising strategies are:
 - The use of 2nd generation biofuels instead of 1st generation biofuels
 - The use of residues from agriculture and forestry
 - The use of biomass from plantations

Objectives

- To investigate the land use change and food security effects of large scale use of bioenergy (bioelectricity and biofuels) from residues and plantations
- To investigate synergy and trade-off effects of strategies to avoid undesirable effects on land use and food security

Approach

- Extended version of CGE model MAGNET (Modular Applied GeNeral Equilibrium Tool); new sectors:

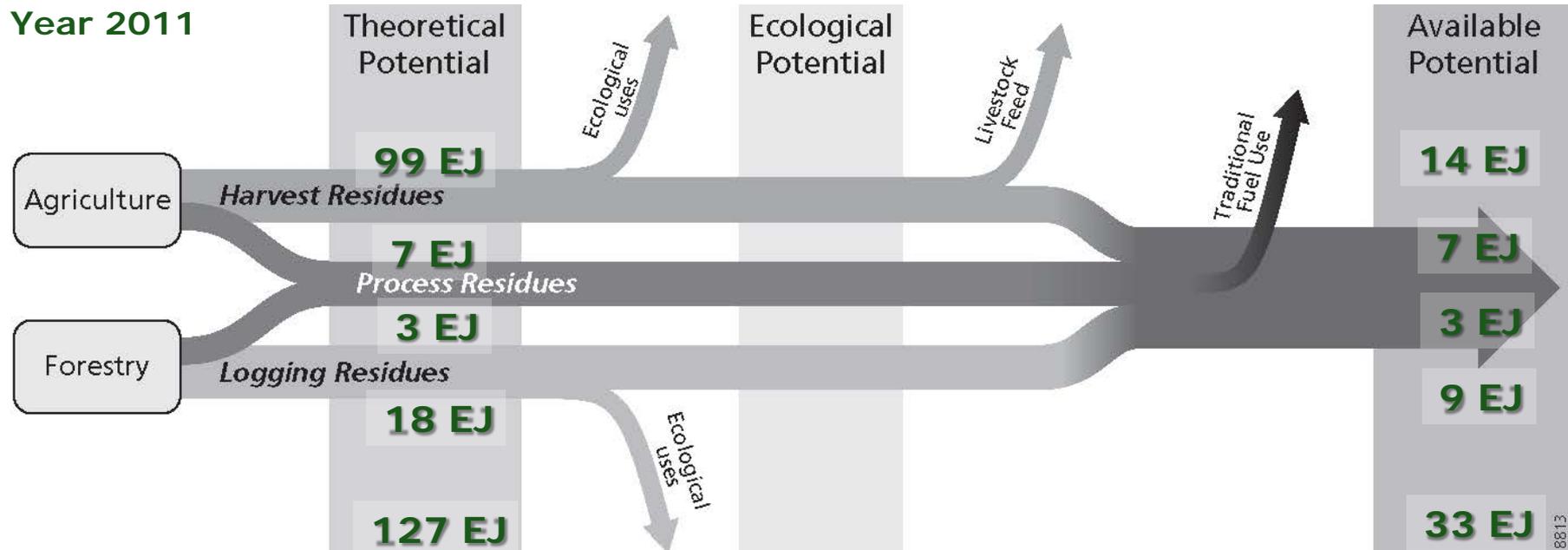
Biomass demand
Bioelectricity
2 nd generation biofuels
(1 st generation biofuels)

Biomass supply
Residues (agriculture, forestry)
Plantations
Pellets

- Two extreme options of biomass plantations are considered:
 - ✓ plantations on land that competes with agricultural land
 - ✓ plantations on areas that are not suitable/interesting for conventional agriculture

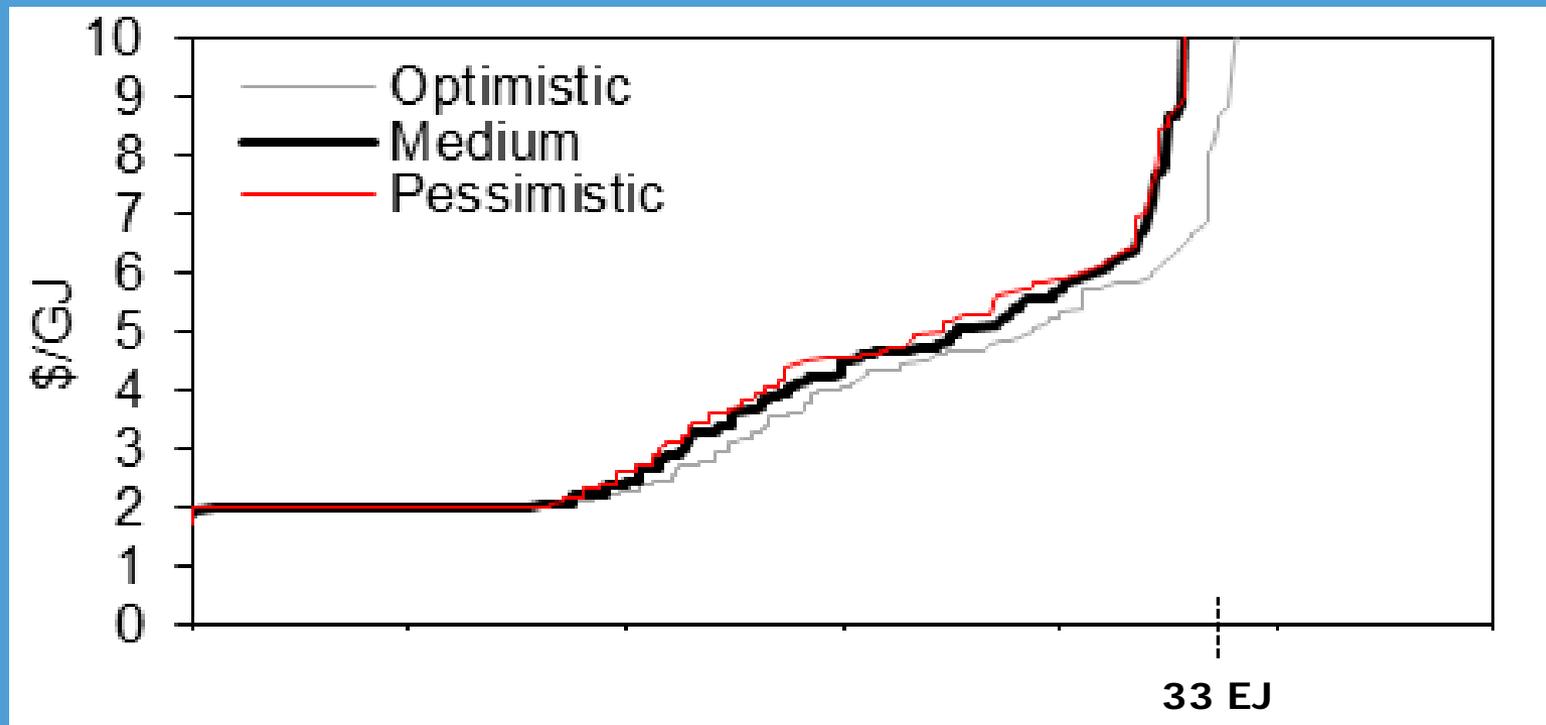
Approach: residues

- Data from a detailed assessment of *sustainable* potential of residues from agriculture and forestry with IMAGE model



Approach: residues

- Cost supply curve of *sustainable potential* of residues from agriculture and forestry implemented in MAGNET



Scenarios

- Baseline scenario: GDP and population growth from SSP 2 scenario; bioenergy demand (TIMER)
 - Technological progress makes 2nd generation biofuels production competitive with 1st generation biofuels and fossil fuel in 2030 (oil @ 123 US\$/bbl in 2030)

Difference in biomass demand in 2030 compared to baseline	EJ
Bioelectricity	7
2nd generation biofuels	28

- High bioenergy use scenario: same as baseline, but with higher bioenergy use to avoid climate change (TIMER)

Impact of large scale use of bioenergy

	Plantations do not compete with agri land	Plantations compete with agri land	
Biomass supply	60% residues 40% plantations	98% residues 2% plantations	
Biomass price	7	100	%
Plantation area	73	1	Mha
	1.4	0.02	% compared to agricultural area
Agricultural land use (exc. plantations)	8	25	Mha
	0.1	0.5	%
Agricultural land price	2	7	%
Production of agri products	0.2	0.6	%
Price of agri products	0.3	-1.0	%

Impacts of residues

- Use of agricultural residues increases profitability of crop production, especially in North America, South East Asia, Indonesia and Russia/Ukraine/Asia Stan region
- Production increases and the price of agricultural commodities decreases, especially in regions with high potential of residues. And also food consumption increases!

Results for scenario plantations compete with agri land = high biomass price	Production agri products	Consumption agri products	Price of agri products
Regions with high pot. residues	1.4	1.6	-2.4
Regions with no/low pot. residues	0.4	0.5	-0.7
World	0.6	0.6	-1.0

LUC and iLUC impacts of residues

- Impact of residues on agricultural land use depends on the price of residues and thereby on the supply of biomass from plantations:

	Plantations do not compete with agri land	Plantations compete with agri land	
	= Low residue price	= High residue price	
Crops	17	60	Mha
Livestock	-9	-35	Mha
Agri total	8	25	Mha

- Global NET land use change effects are very limited
- LUC effect of 2nd generation biofuels are much lower compared to 1st generation biofuels EU
- GHG effects are however not (yet) calculated

Discussion and conclusions

- The sustainable potential of residues from agriculture and forestry is substantial (33 EJ in 2011) compared to the demand for biomass for energy
- Plantations on agricultural land are potentially unattractive due to higher prices of agricultural land (+200%; 2007-2030)
- Using harvest residues from agriculture is an incentive to expand agricultural production and increase food consumption
- The price of residues and thus the price of biomass from plantation determines production expansion effect of residues:
constant biomass price: production agri products +0.2%;
doubling of biomass prices: production +0.6%



Discussion and conclusions

- The use of residues increases production and consumption in regions with large sustainable potentials; probably favourable for food security, not necessarily for all regions (e.g. India)
- The global net land use change effects of agricultural residues are limited, but involve conversion of pastures to cropland
- Future research topics:
 - Ecological impacts and constraints of using residue (soil organic matter; no-till management)
 - Market interactions with use of residues for other applications
 - Barriers for using residues for modern bioenergy production
 - Feasibility of plantations on marginal land, abandoned cropland, etc.
 - Impact on crop production technology
 - Food security effects; difference between consumers and producers

Thank you for your attention

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