

# Realizing the Potential of Land Management for Climate Change Mitigation

Annette Freibauer <sup>1</sup>,  
Hannes Böttcher <sup>2</sup>, Yvonne Scholz <sup>3</sup>, Vincent Gitz <sup>4</sup>, Philippe Ciais <sup>5</sup>,  
Martina Mund <sup>1</sup>, Thomas Wutzler <sup>1</sup>, Ernst-Detlef Schulze <sup>1</sup>

<sup>1</sup> MPI-BGC Jena; <sup>2</sup> IIASA Laxenburg; <sup>3</sup> DLR Stuttgart;  
<sup>4</sup> CIRED - CNRS/EHESS Paris;  
<sup>5</sup> LSCE Gif-sur-Yvette

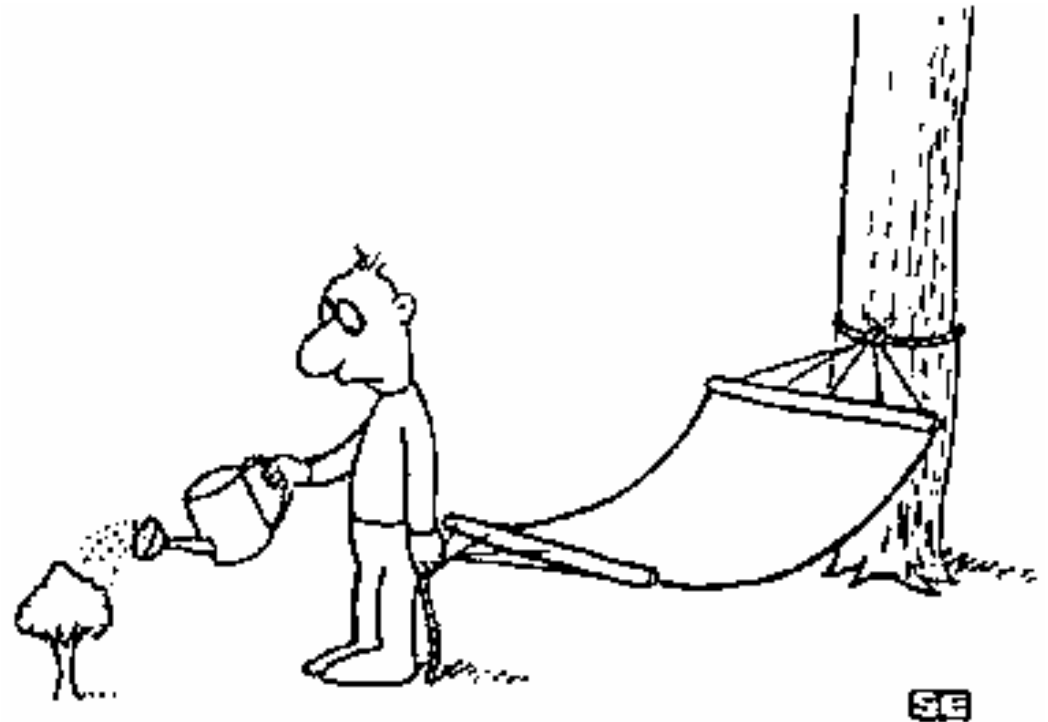
15th Annual Conference of the European Environment and  
Sustainable Development Advisory Councils EEAC

*Biomass panel*



Évora, 11 October 2007

# Realizing potentials



# Cascade of mitigation potentials

- **Biological** potential: theoretical biologically achievable capacity, most or all practical constraints are ignored
- **Technological** potential: biological capacity constrained by suitability of land and availability of resources and technology; socio-economic and policy drivers optimistic
- **Economic** potential: conservative technical potential taking into account costs, optimistic assumptions about social barriers, incentives and speed of implementation
- **Realistic** potential: short-term capacity taking into account present policies, presence or lack of incentives and the competition of different land-uses



# Global mitigation potentials

Region	Time horizon [years]	Biological potential [Pg C yr <sup>-1</sup> ]	Economic potential [Pg C yr <sup>-1</sup> ]	Realistic potential [Pg C yr <sup>-1</sup> ]	Biological cumulative capacity [Pg C]	Source
Globe	40	1.5 - 2.1	n. e.	n. e.	100-140	(1)
Globe	50	2 - 4 *	1 - 2 *	0.2 - 1 *	100-200	(2)
EU-15	50-100	0.2 - 0.5 *	0.05 - 0.1 *	0.02 - 0.05 *	20-30	(2)
Globe	50-100	2 - 5 **	1 - 5 **	0.2 - 1 **	-	(2)
EU-15	50-100	0.6 - 0.9 **	0.2 - 0.3 **	0.1 - 0.2 **	-	(2)
<b>% of biological</b>		<b>100</b>	<b>25-50</b>	<b>(0) 10-20</b>		

n.e. not estimated

\* Sum of C sequestration in agriculture and forestry; \*\* Bioenergy substitution



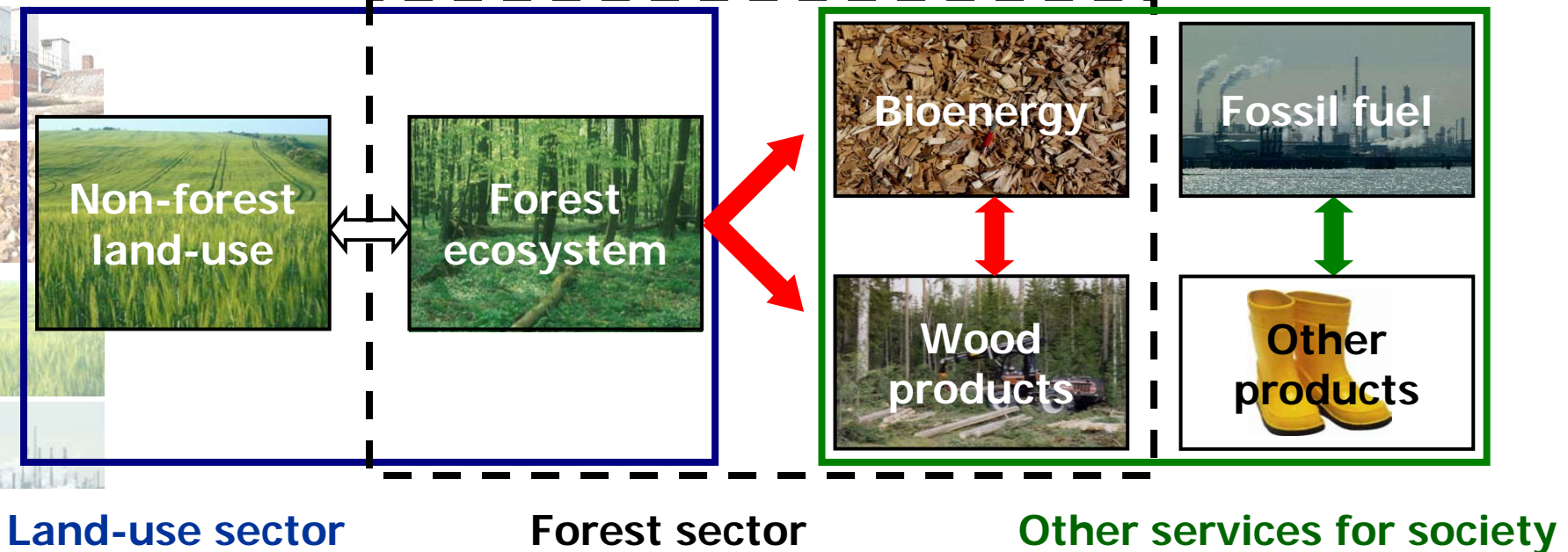
(1) Watson et al., 2000; IPCC, 2001;  
(2) Cannell, 2003

# What is climate effective?

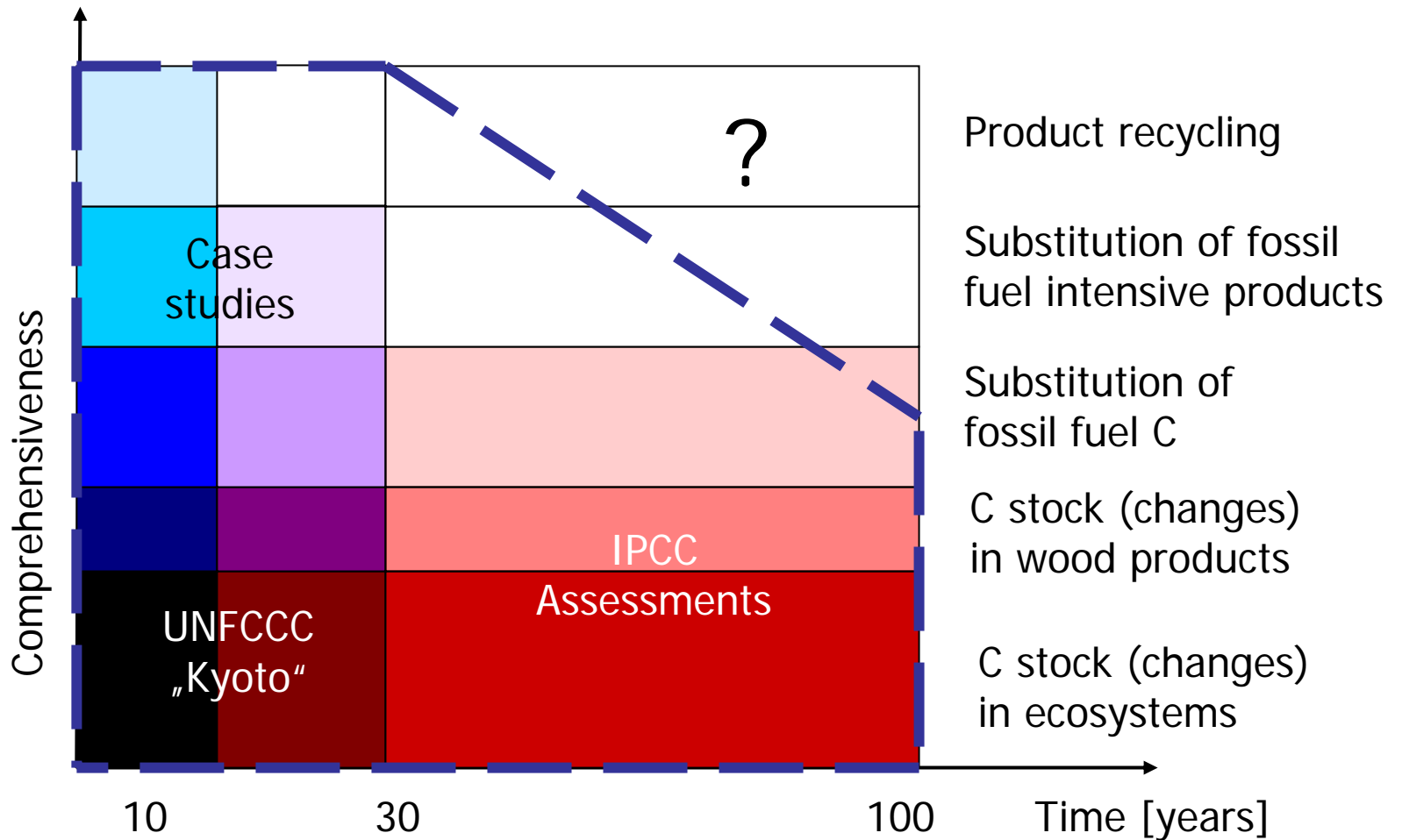
Minimize net emissions to atmosphere



Maximize carbon stocks



# System boundaries



# Case study: Thuringia

- Carbon budget model
- Reference: hectare
- Criteria
  - Accumulated C
  - Net revenue
- Agriculture
  - Plains
  - Rich soils
- Forest
  - Low mountain ranges
  - Poor soils
- Afforestation of cropland
- No deforestation



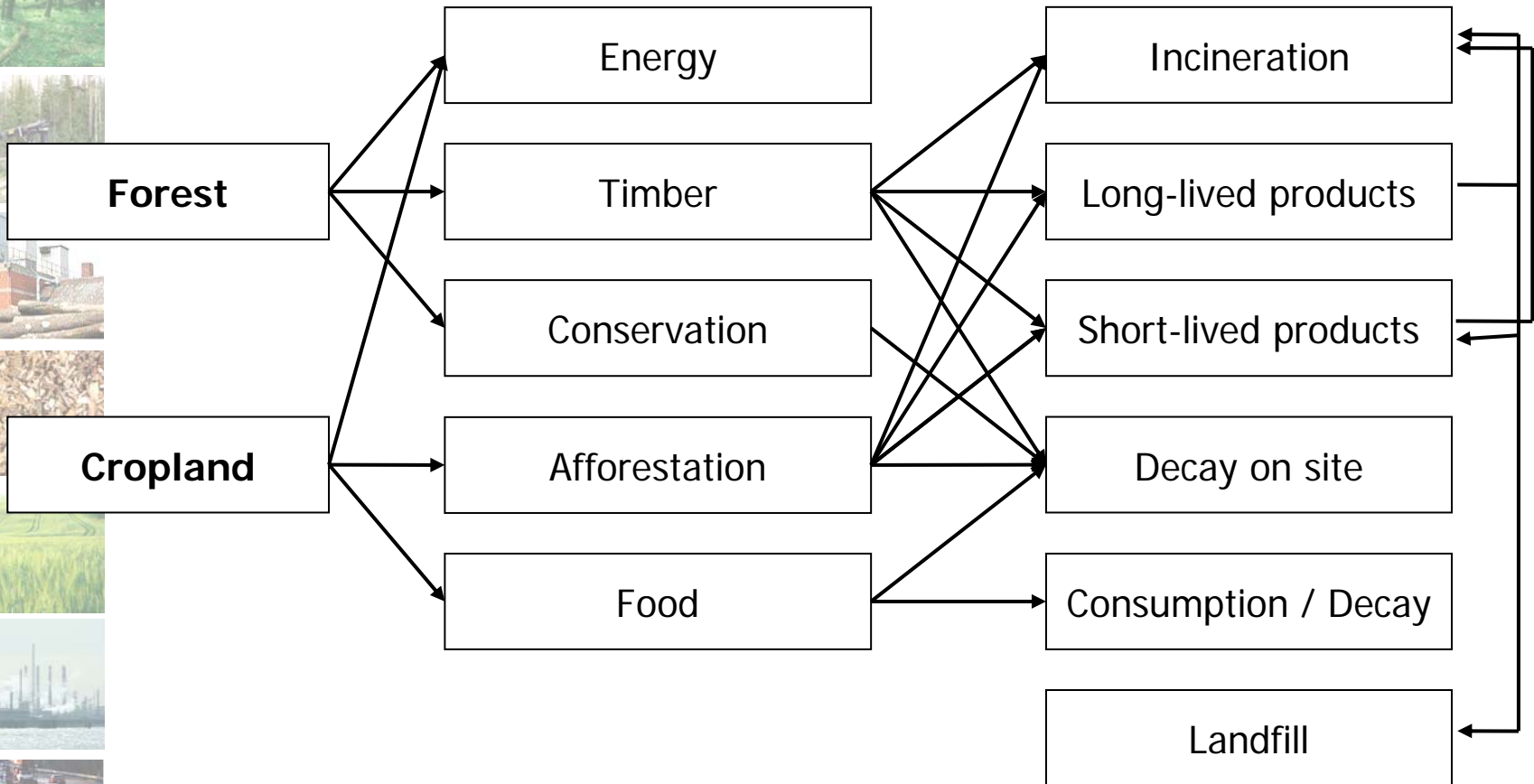
# Elements of study



**Original land use**

**Purpose**

**Products**



Recycling / reuse



# Forestry: a hectare of beech or spruce

- Reference: Timber production
- Product use: No organic material in landfills: waste incineration (assumed: 80%)
- Switch to short-rotation bioenergy
- Sequester carbon on-site: conservation
  - no fire risk
  - age-dependent mortality by storms (spruce)
- Subsidies for old-growth hardwood forests for non-use (FFH)



# Cropland: a hectare of cereals

- Reference: Food only
- Food + straw energy
- Bioenergy (Poplar)
- Afforestation
- Subsidies:
  - Area-based, independent of product
  - Extra for renewables



# Fossil C substitution

t fossil-C saved per t bioenergy-C

	Heat plant; <b>natural gas</b>	Combined heat and power plant; <b>natural gas</b>	Combined heat and power plant; <b>light heating oil</b>	Heat plant; <b>light heating oil</b>	Power plant; <b>hard coal</b>	Power plant; <b>lignite</b>	<b>Regional substitution effectiveness in Thuringia</b>
<i>Wheat</i> , whole crop	0.36	0.38	0.53	0.54	0.70	0.75	<b>0.49</b>
<i>Wheat</i> , straw	0.45	0.47	0.66	0.67	0.86	0.92	<b>0.61</b>
<i>Poplar</i> , short-rotation coppice	0.42	0.44	0.62	0.63	0.80	0.86	<b>0.57</b>
<i>Spruce</i> , wood for energy (spruce)	0.42	0.44	0.62	0.63	0.81	0.87	<b>0.57</b>
<i>Spruce</i> , slash	0.44	0.45	0.64	0.65	0.83	0.89	<b>0.59</b>
<b>Weighting factor</b>	<b>0.27</b>	<b>0.27</b>	<b>0.11</b>	<b>0.11</b>	<b>0.07</b>	<b>0.17</b>	



Freibauer et al., submitted

# Effectiveness of product substitution

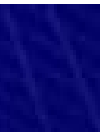
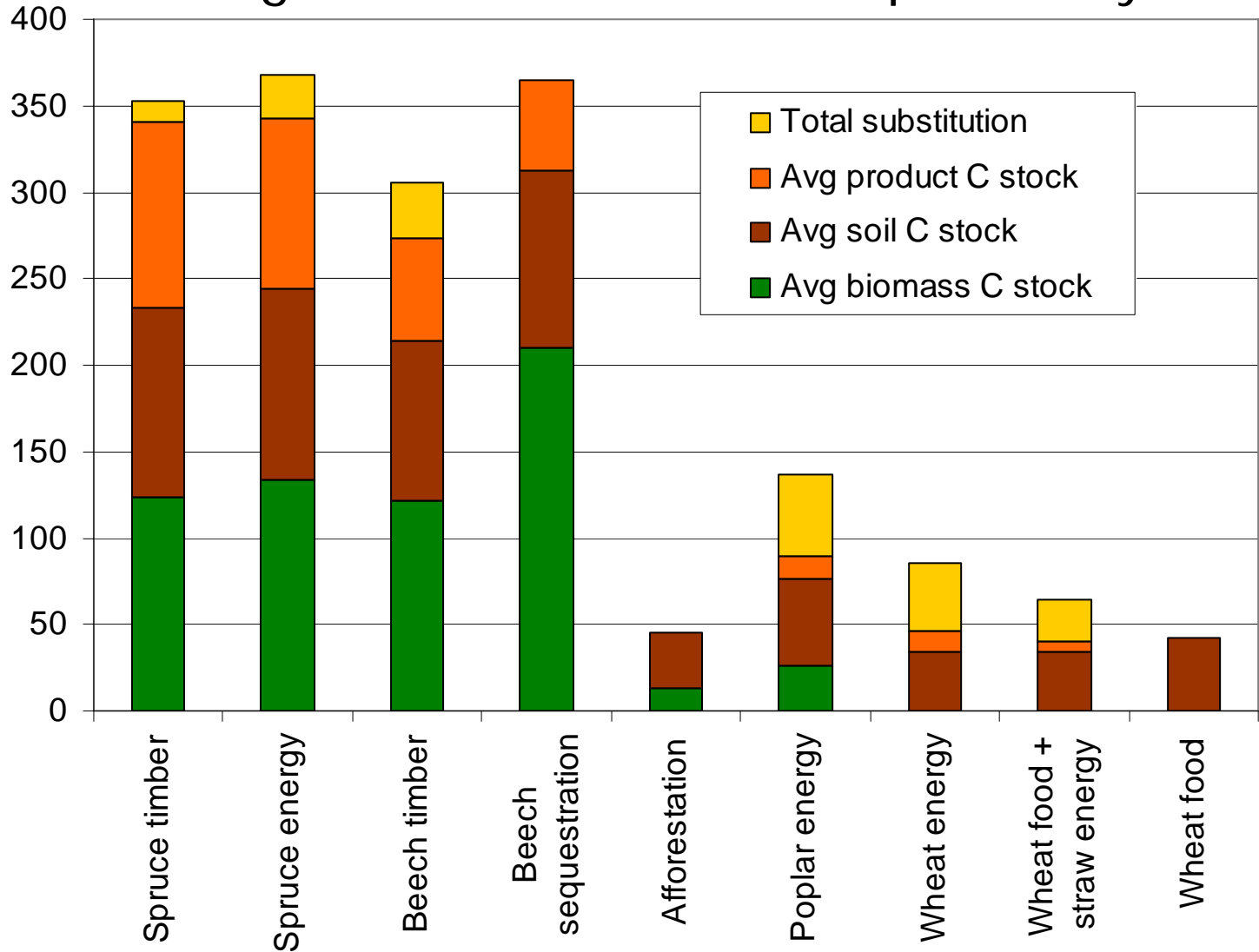
t fossil fuel-C substituted per t of wood-C harvested

Wood product	Substituted material	Substitution effectiveness		
		Mean	Low	High
Sawn wood: <i>spruce</i>	Building construction (concrete, steel, plaster)	<b>0.24</b>	0.046	0.56
Sawn wood: <i>beech</i>	Building construction (concrete, steel, plaster)	<b>0.16</b>	0.029	0.36



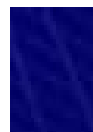
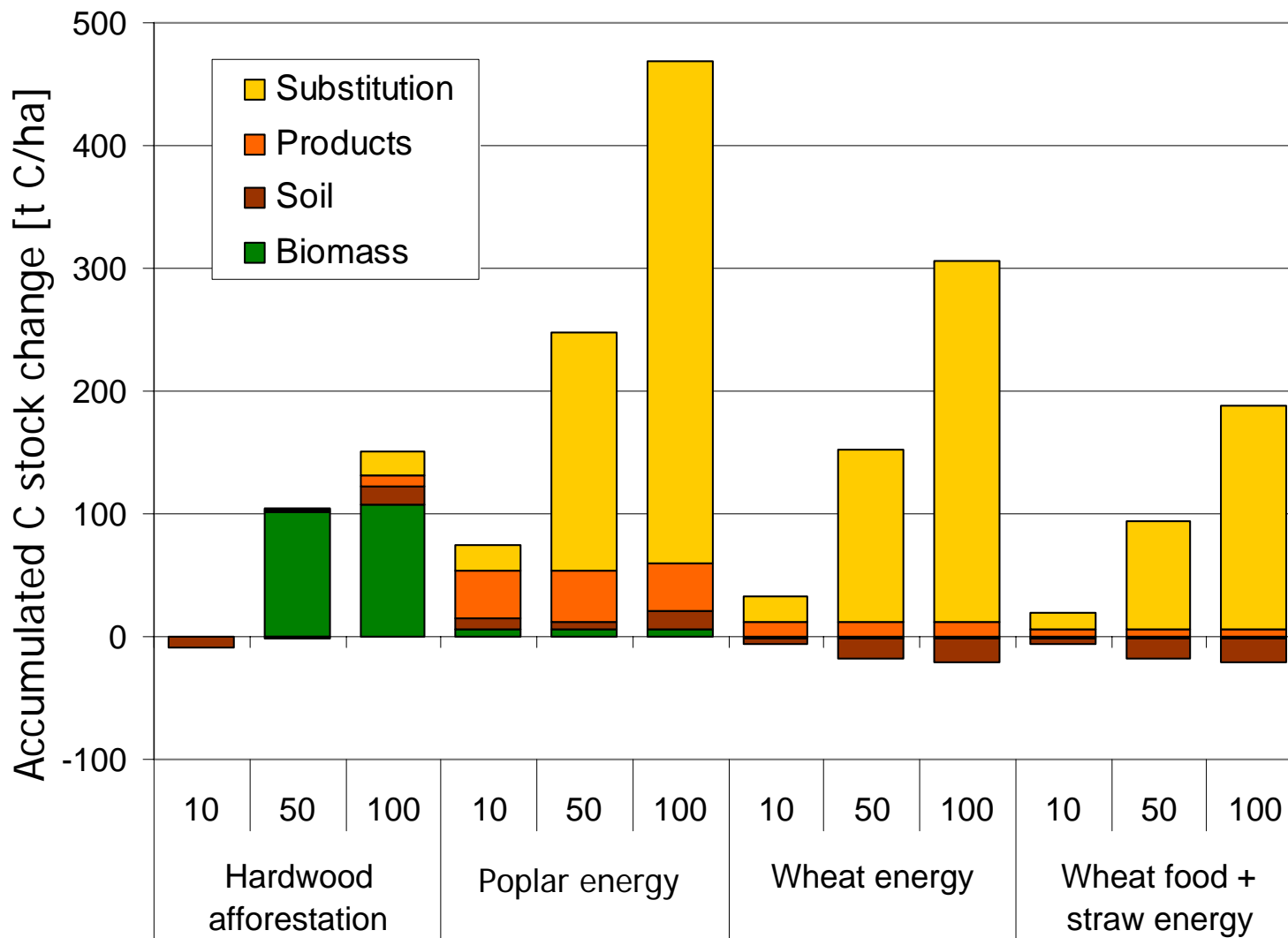
# Full C budget of land management

Average over rotation time, cropland 30 years



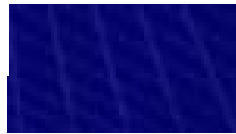
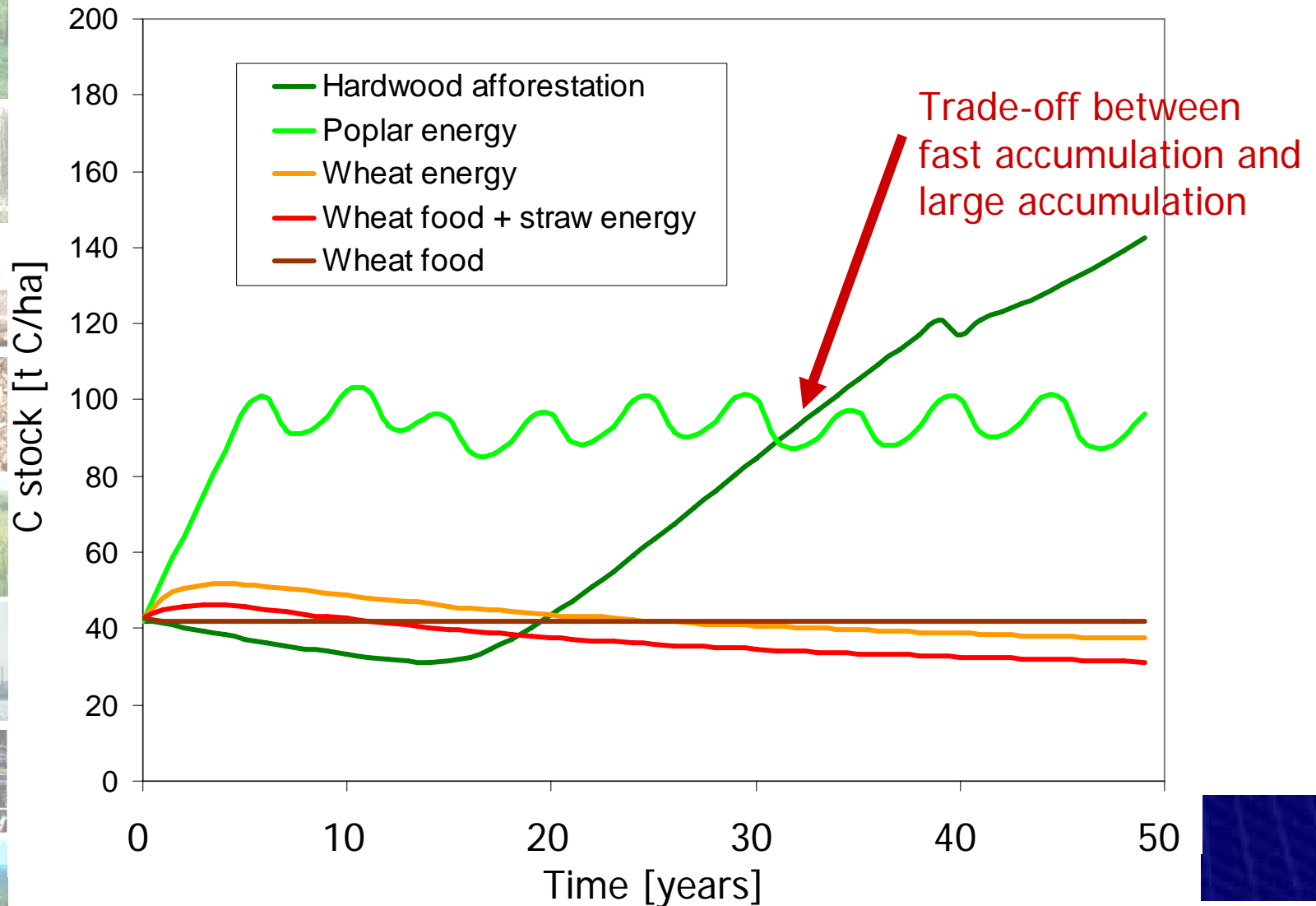
# Cumulative climate benefits of agriculture in Thuringia

## Compared to continued wheat for food



# C stocks: Timing matters!

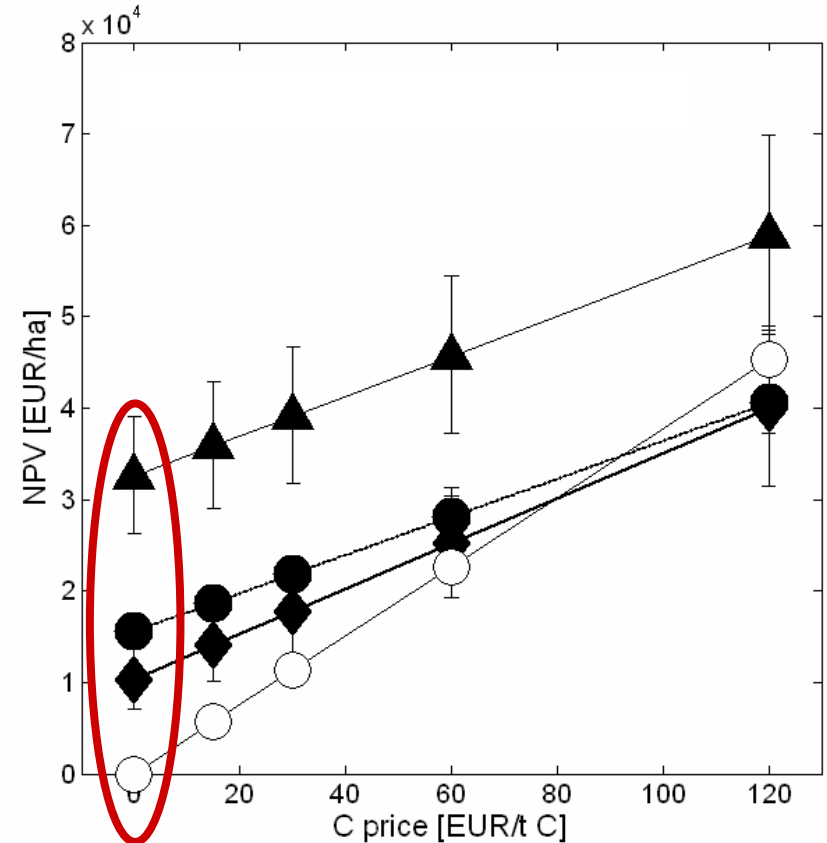
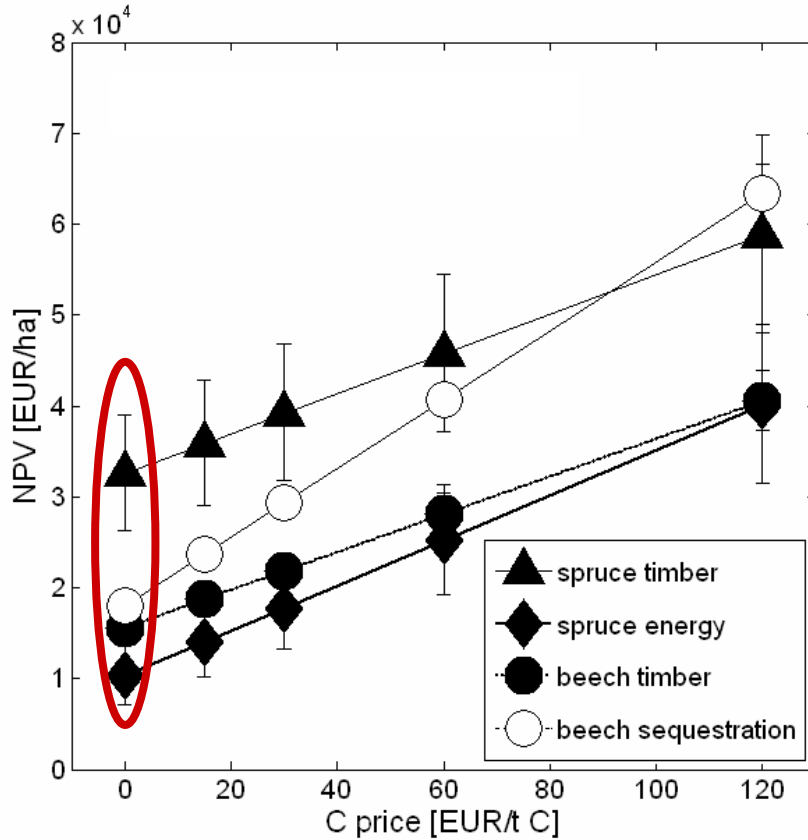
## Ecosystem C stock



# Forestry: What pays off most?

with subsidies

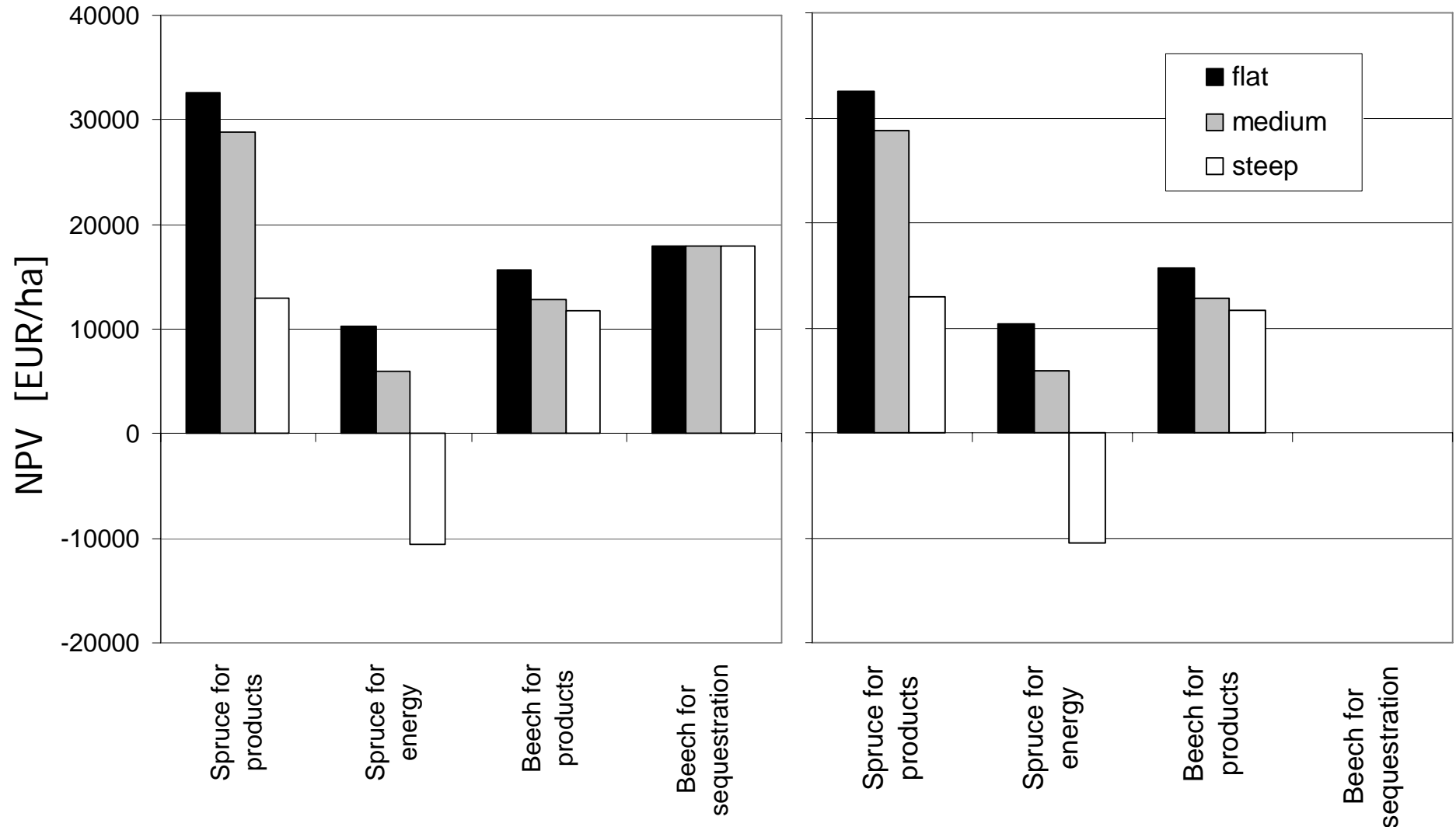
without subsidies



# Forestry: Where it pays off most?

with subsidies

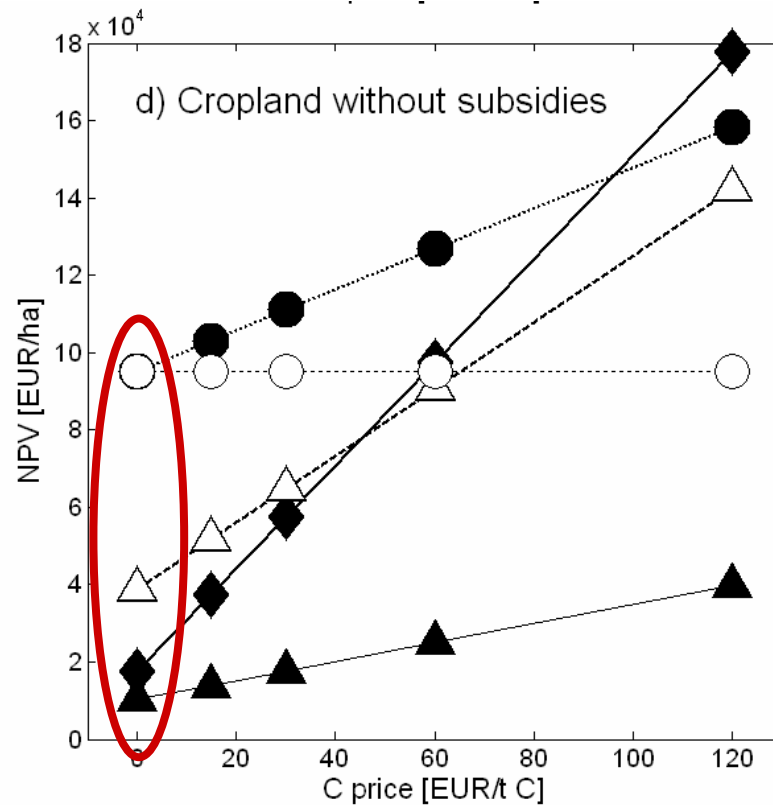
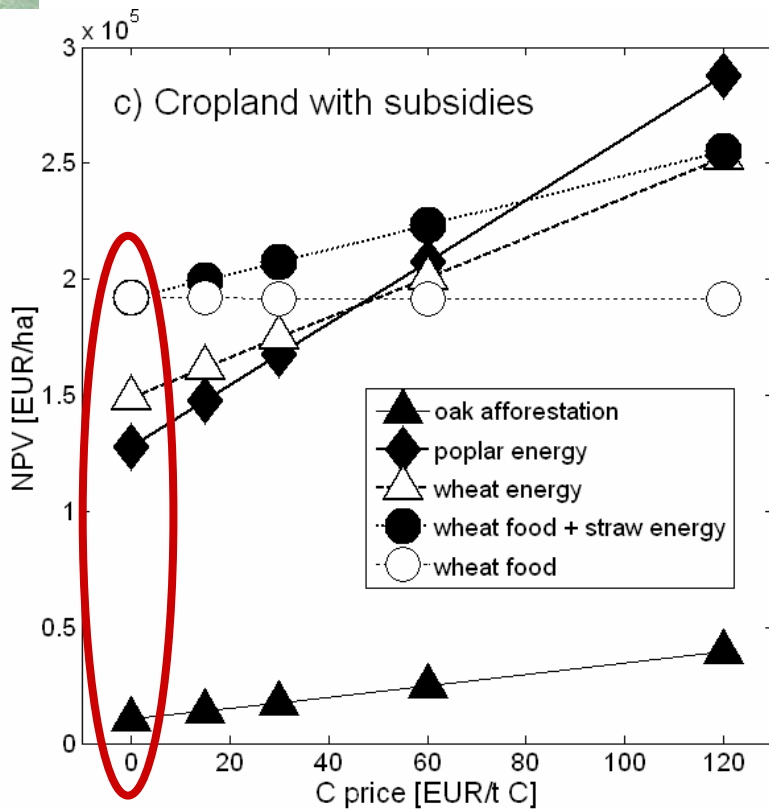
without subsidies



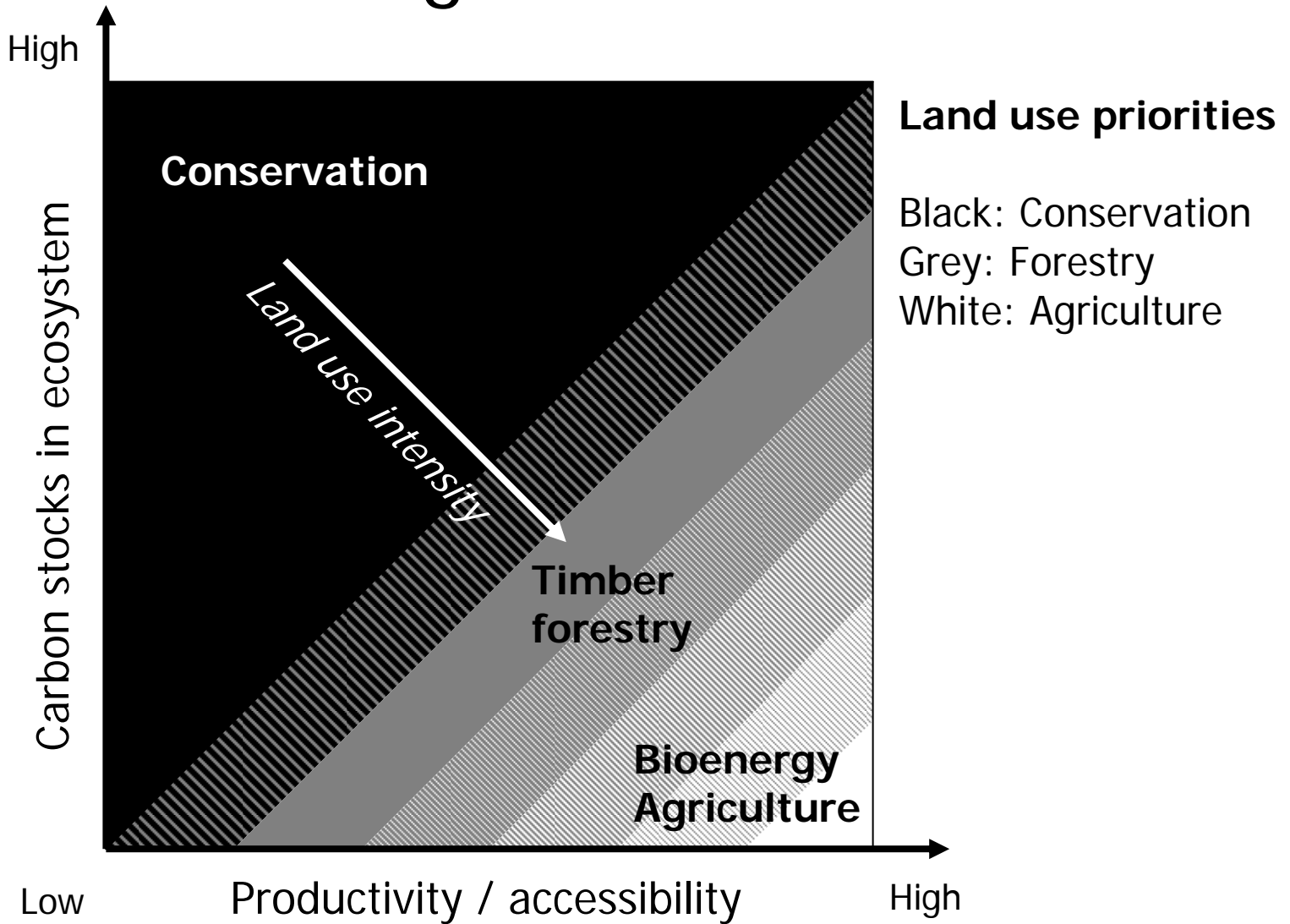
# Cropland: What pays off most?

with subsidies

without subsidies



# Maximizing climate benefits



# Conclusions

- Forestry
  - Ecosystem C stocks matter
  - Fate of C in harvested products matters
  - Risk of C loss by short-term economic considerations and other land pressures
  - Support of long term turnover of natural processes needed
- Croplands
  - Relatively small economic barriers
  - Competition for land?
  - New incentives for effective fossil carbon substitution
- Efficiency frees land for conservation (or food)
- **A land-only view of GHG mitigation is not effective**

**OBRI GADO**

