Impacts of bio-fuel expansion on world food systems and the environment

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Outline

- Assessment framework
- Elobio approach & Scenario assumptions
- Results - Food system
- Results - Environment

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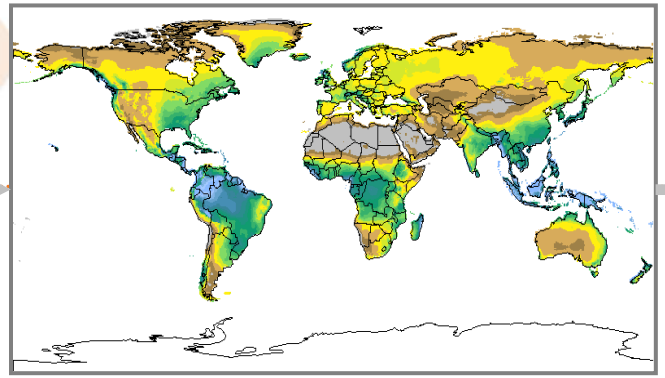
Assessment Framework

Agro-ecological suitability and land productivity



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2 Climate model

1 Development scenario

Climate impact response relations

4

Production

Demand

Trade

Global Food-Feed-Biofuel System

World Market

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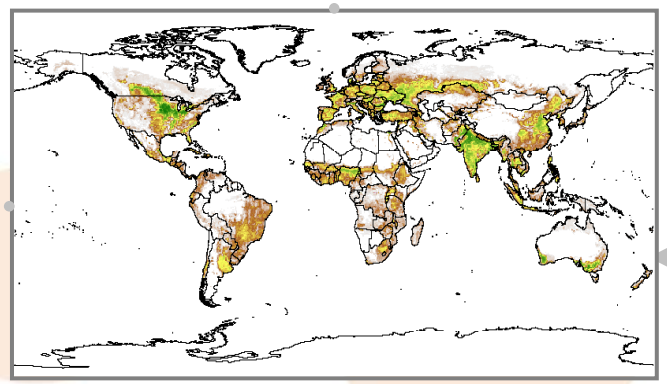

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Spatial distribution of land use

Elobio approach to - "Low disturbing biofuel policies"

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Stakeholder and Elobio team identified …..

Criteria for evaluation:

- FOOD SECURITY
  Commodity price effects, rural income, risk of hunger, trade effects

- ENVIRONMENT
  Land use effects, GHG savings

Key variables:

- Importance of by-products
- Growth in agricultural productivity
- Land use restrictions

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Scenario formulation

Baseline scenario **REF** describes until 2050

Population development
Economic growth
Agricultural policies (further trade liberalization)
Technology (agricultural productivity growth)

Climate change (Hadley, SRES A2, with CO2 effects)
Land use restrictions (safeguard protected areas)

Biofuels: historic biofuel consumption until 2008, constant at 2008 level thereafter

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Biofuel scenario formulation

Biofuel expansion scenarios:

Scenario **WEO** – based on IEA, 2008

Scenario **TAR** – applies announced biofuel targets

Sensitivity variants:

Biofuel production by-products
Growth in agricultural productivity
Land use restrictions

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Transport Fuels in 2020 and 2030

Million Tons Oil Equivalent

	WEO		TAR	
Developed Countries	**2020**	**2030**	**2020**	**2030**
Transport Fuels	1505	1486	1505	1486
Transport Biofuels	63	80	117	178
Biofuels in Transport Fuel	4.2%	5.4%	8%	12%
Share of 2nd Generation	4%	19%	33%	51%

	WEO		TAR	
Developing Countries	**2020**	**2030**	**2020**	**2030**
Transport fuels	1174	1529	1174	1529
Transport Biofuels	31	46	72	116
Biofuels in Transport Fuels	2.7%	3.0%	6%	8%
Share of 2nd Generation	0%	4%	3%	19%

United States, European Union, Japan, Canada, Australia ...

Brazil, China, India, Indonesia, Thailand, South Africa ...

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Sensitivity runs

1. **The importance of biofuel by-products**
   Assume DDGS is not used as animal feed
   Scenario ***WEO-vD*** and ***TAR-vD***
2. **Growth in agricultural productivity**
   Assume higher productivity growth compared to REF
   Scenario ***WEO-vP*** and ***TAR-vP***

   Country Group 1: high productivity growth (Sub-Saharan Africa)
   + 7.5 % by 2025 and + 20% by 2050
   Country Group 2: medium productivity growth (India, Pakistan, Argentina,….)
   + 4 % by 2025 and + 10 % by 2050
   Group 3: no changes (developed countries)

3. **Land use restrictions** - Assume no deforestation

RESULTS Reference

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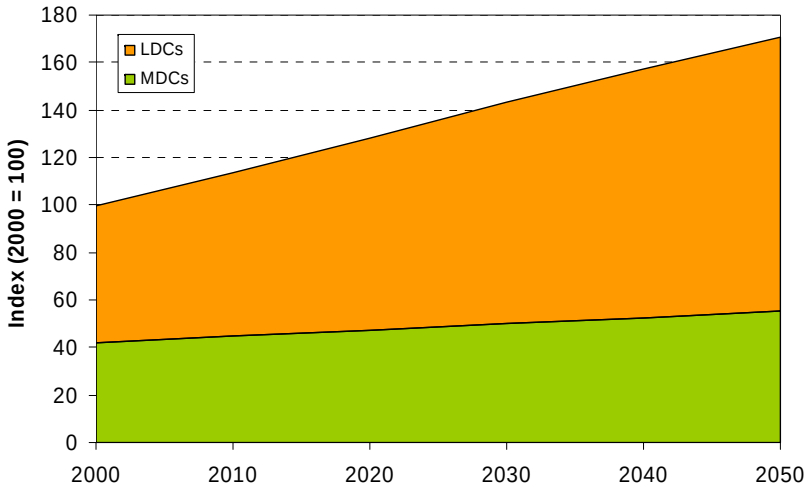
Food and agriculture outlook

Growth of:	2000-2050
Population	50%
Cereal production	60%
Ruminant meat	65%
Other meat	80%
Value added crop & livestock	75%
Harvested area	21%
Arable land	11% (+ 168 mio.ha)



Index of agricultural production (2000=100), 2000-2050

HUNGER: peaks in 2010 (951 million) by 2050 (530 million)

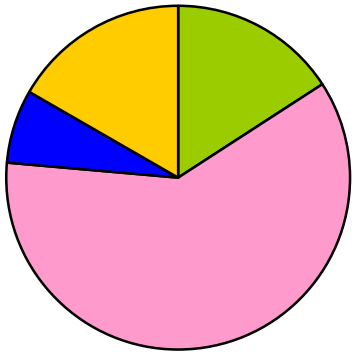
LAND USE:
Arable land expansion
+ urbanization (87 mio.ha)

→ Deforestation (99 mio.ha)

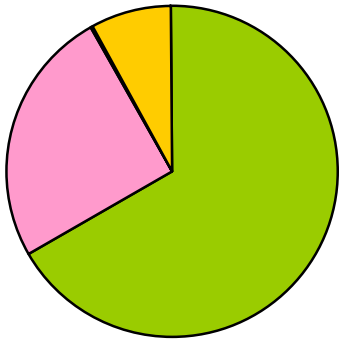
RESULTS Reference

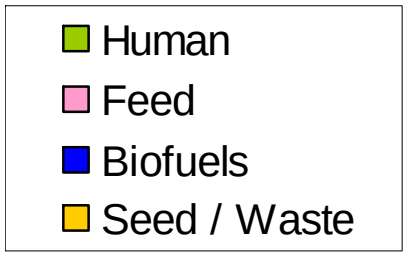
Composition of cereal consumption in 2030

Developed
Total = 1063 million tons



Developing
Total = 1798 million tons





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Impacts of biofuel expansion on FOOD SYSTEM




Impacts of first-generation biofuels on agricultural prices

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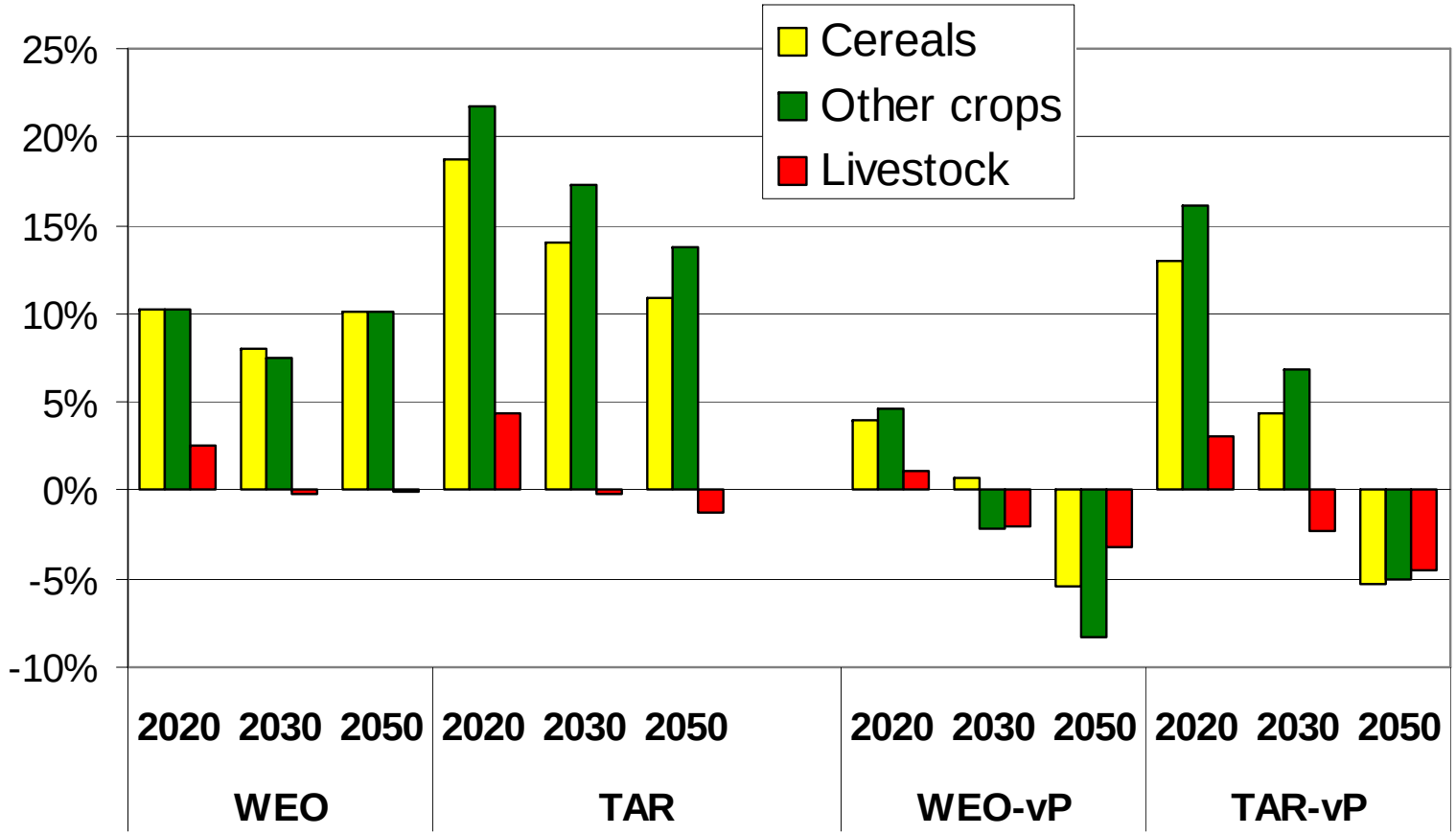
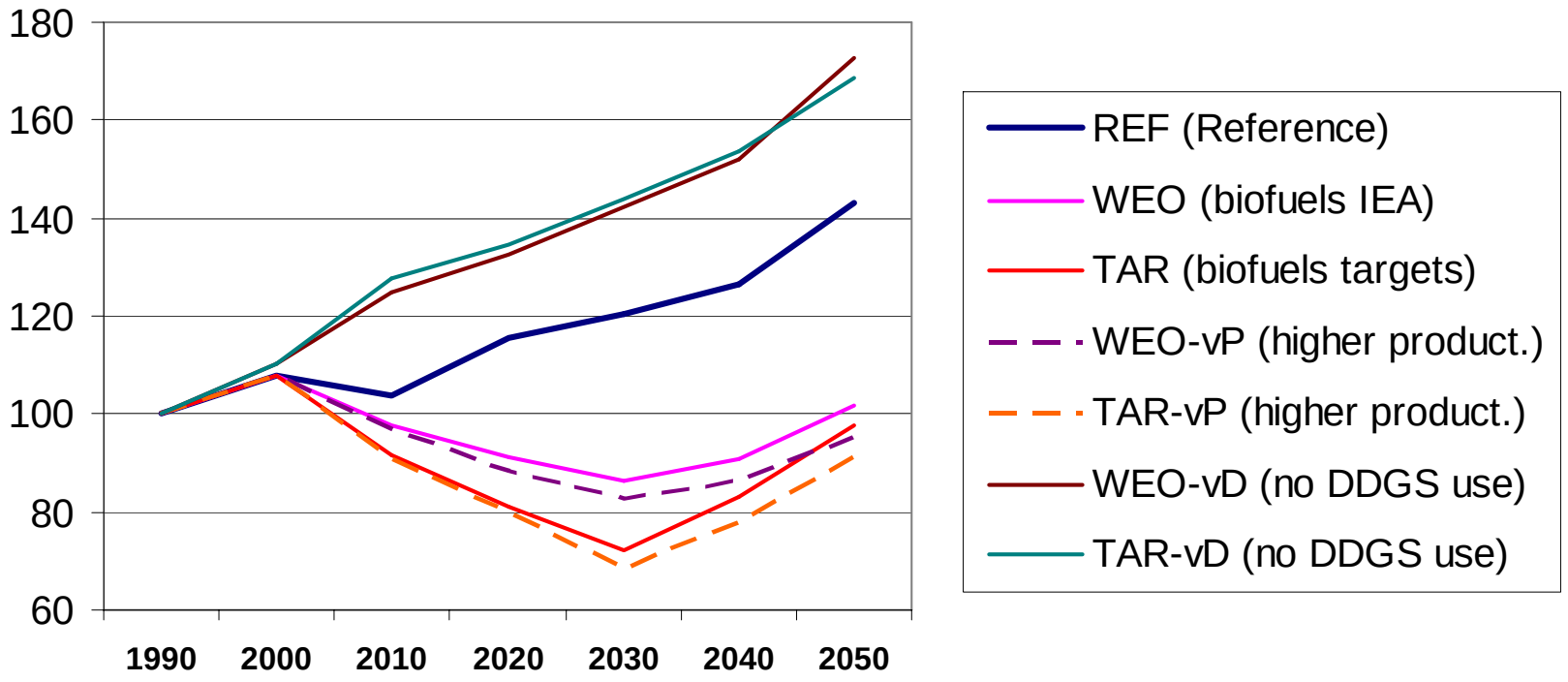
Percentage price changes, relative to REF



Scenarios: Higher agric. productivity

Price effects – protein feed

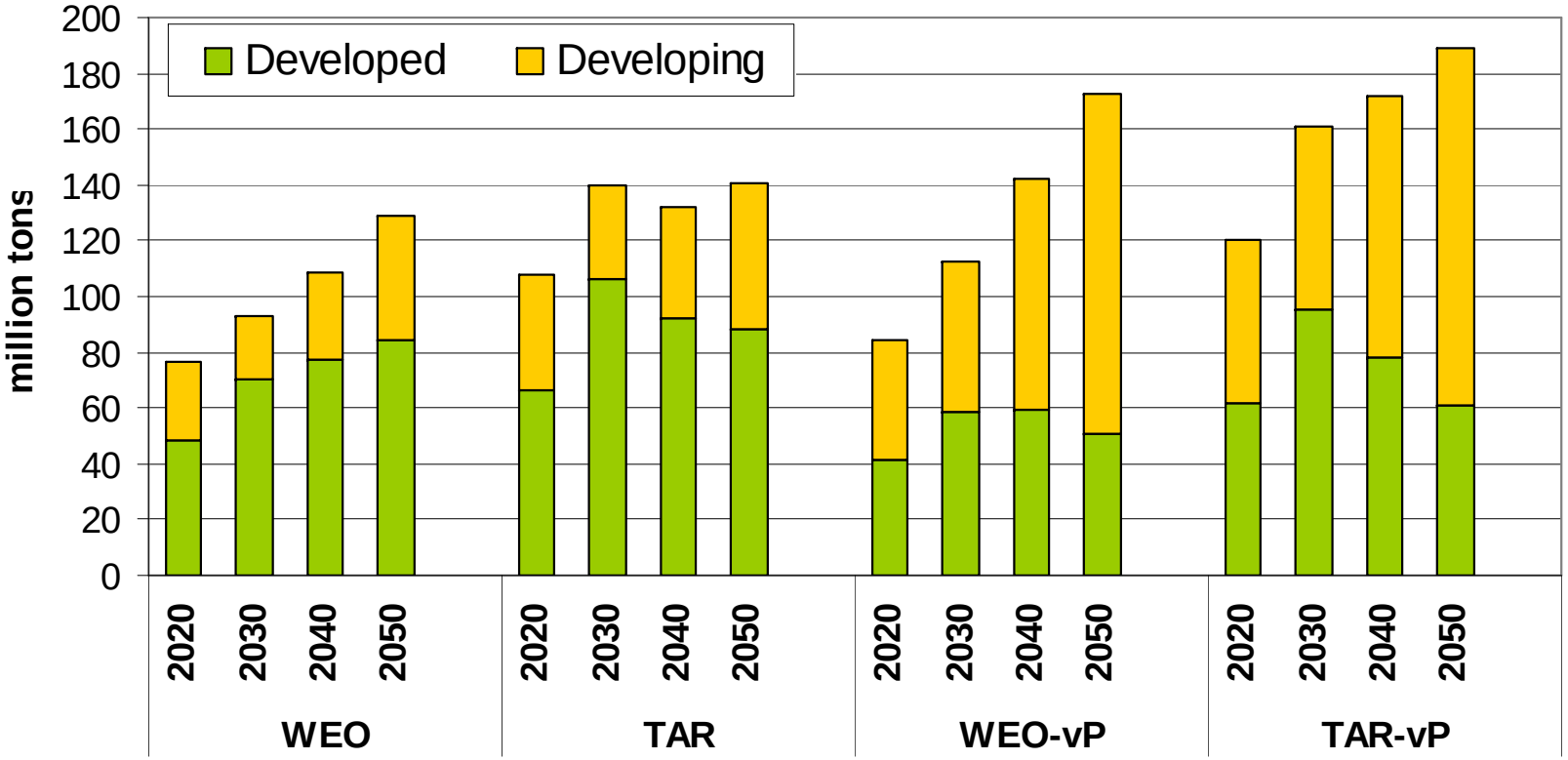
Development of price index for protein feed



Commodity effects

→ **More cereal production** due to biofuel demand

Additional cereal production, relative to REF



Scenarios: Higher agric. productivity

Where do additional cereals needed for ethanol production come from?

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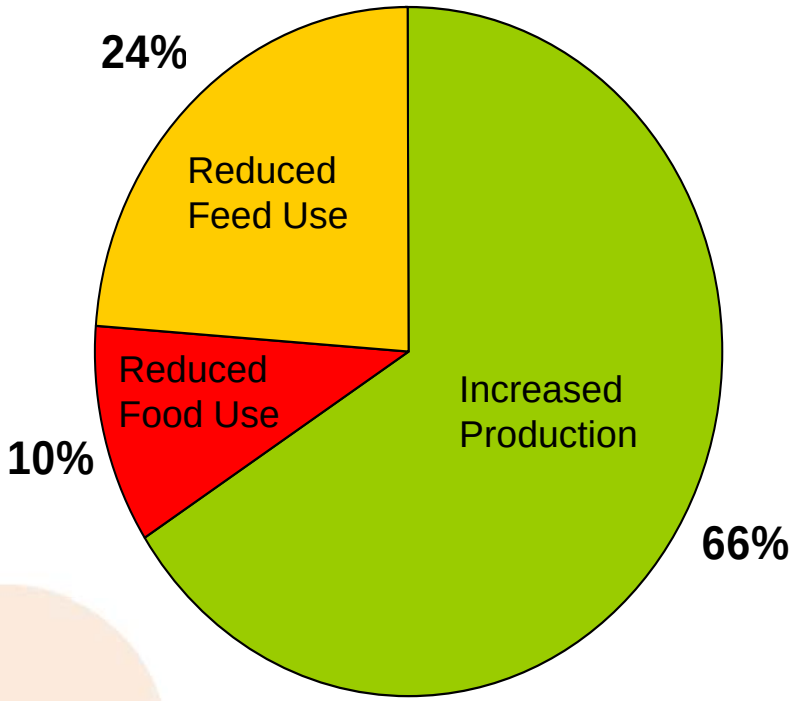
On average about two-thirds of the cereals used for ethanol production are obtained from additional crop production.

The remaining one-third comes from consumption changes. The reduction in direct cereal food consumption accounts for ten percent of the amount of cereals used for biofuel production, reduced feed use accounts for about a quarter.



Note: values shown are approximate; simulated values vary with scenario.

Impacts of biofuel expansion on agricultural value added

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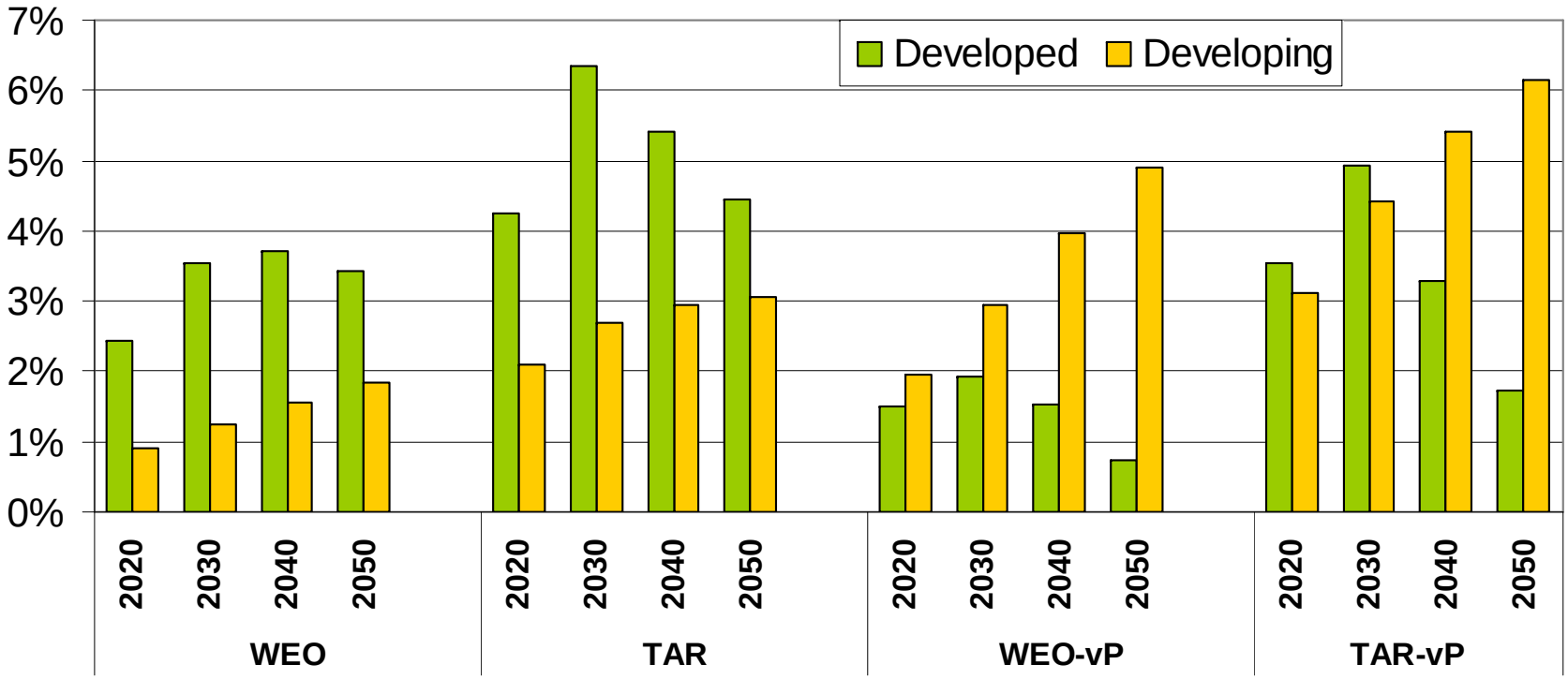
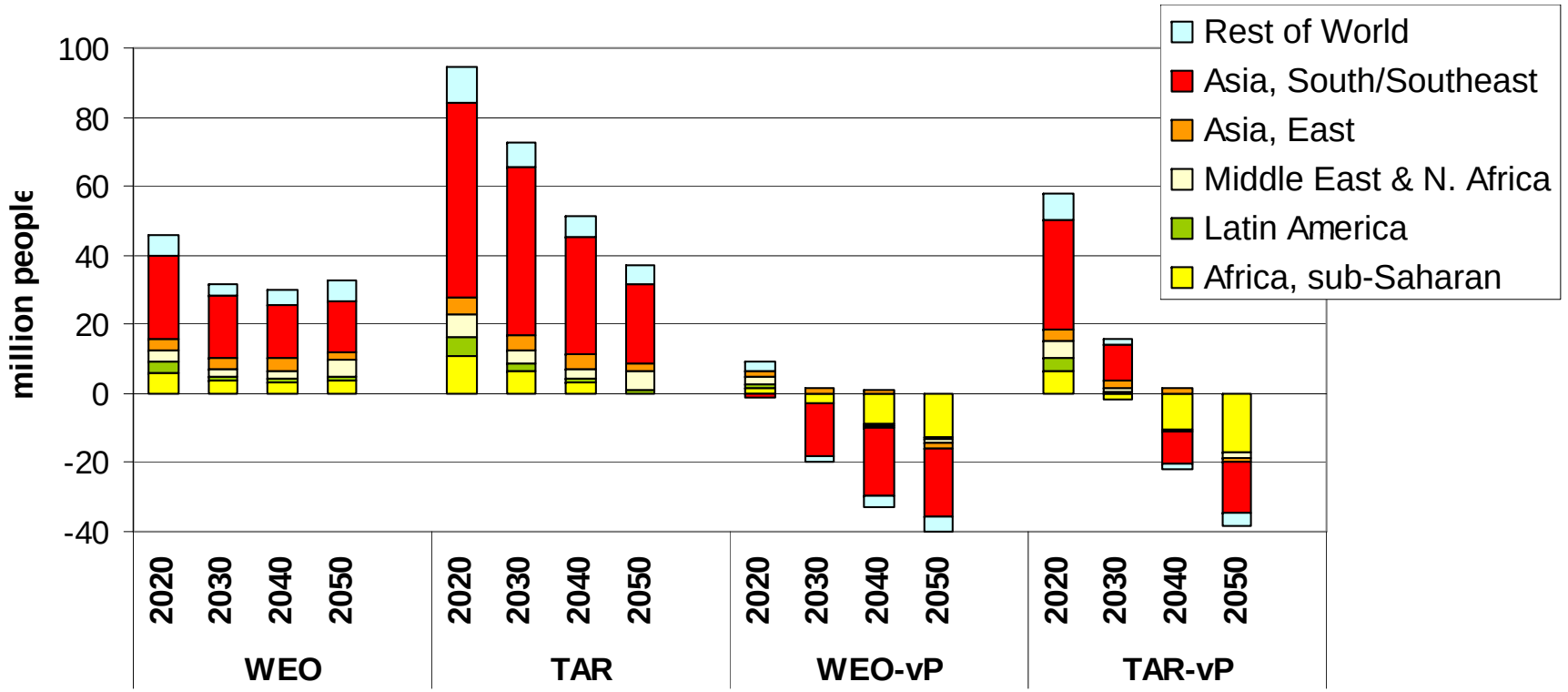
Gain in value added from crop & livestock sector, in relation to REF
(relative in percentage change)



higher agric. productivity

Socio-economic effects - Hunger

Additional people at risk of hunger, relative to REF



higher agric. productivity

→ Strong impact of higher agric.productivity in LDCs

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Impacts of biofuel expansion on the ENVIRONMENT




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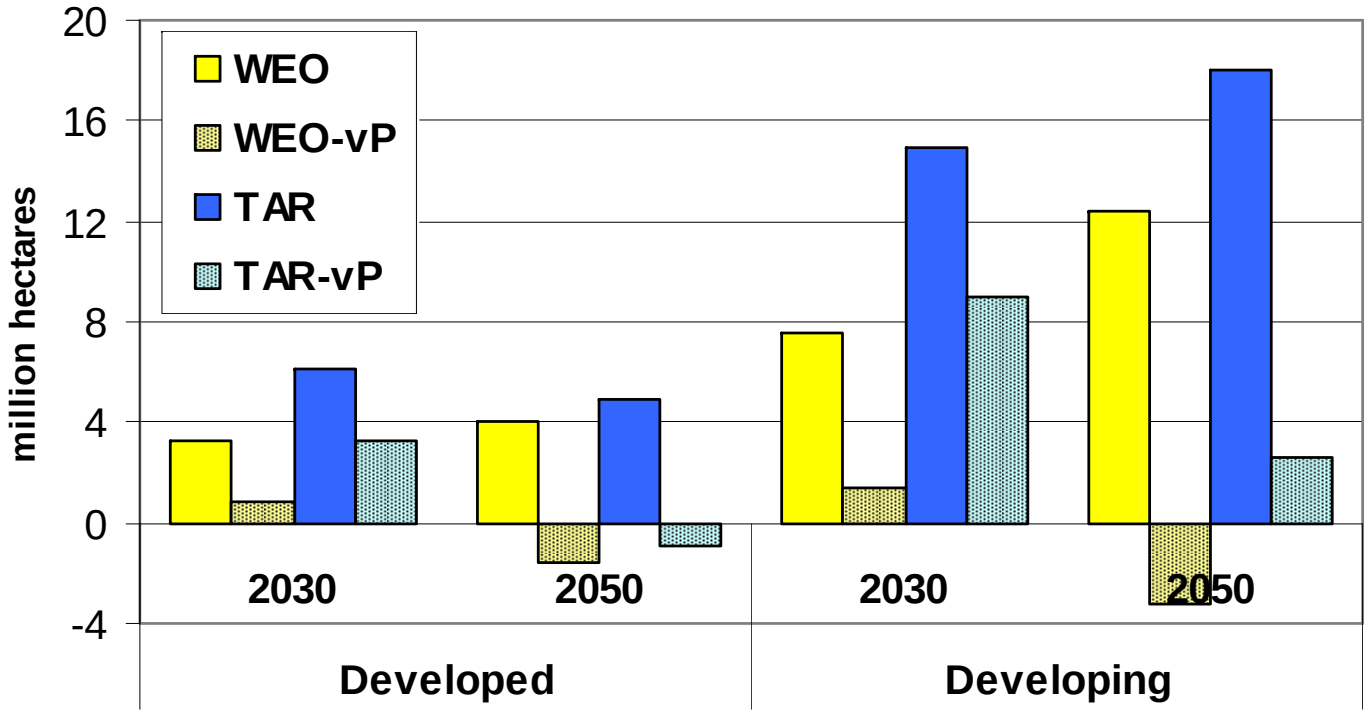
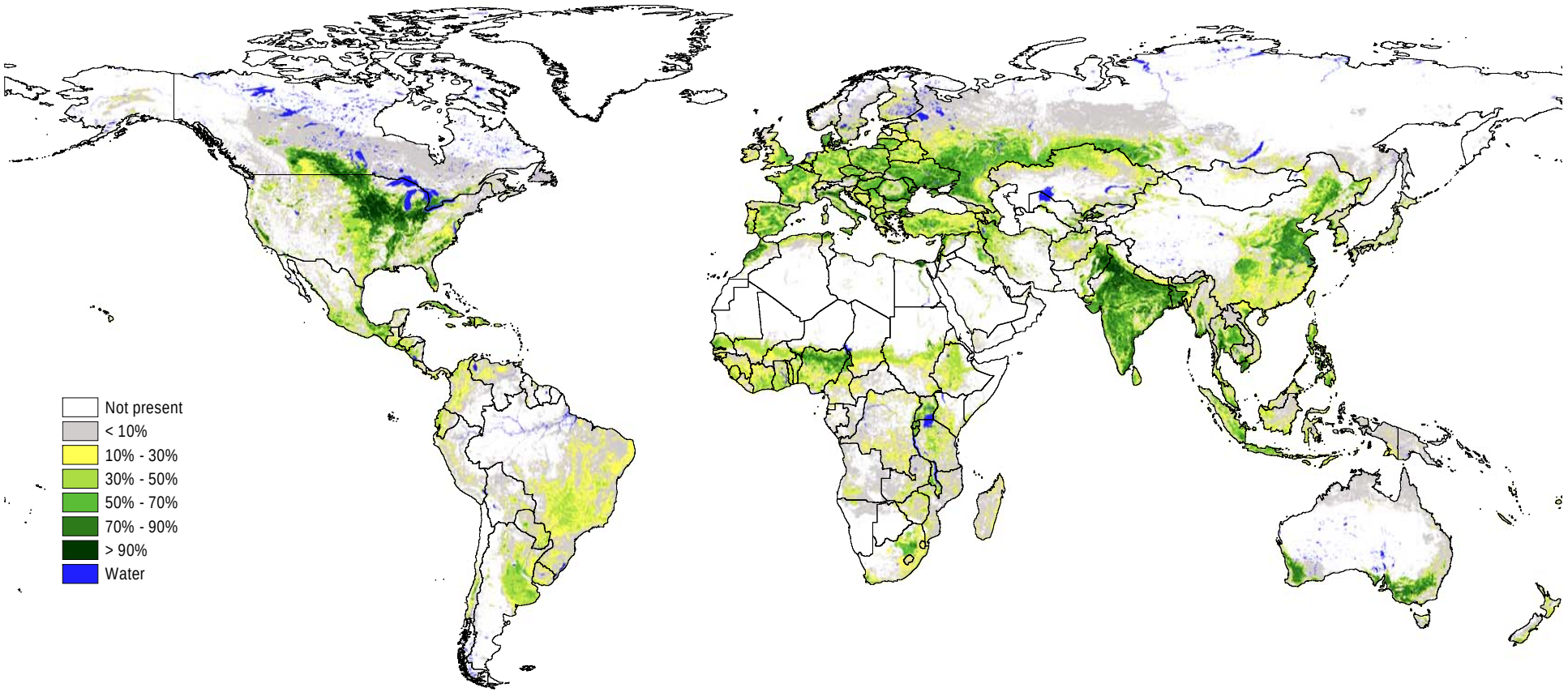
Land use changes – Agricultural expansion

Additional arable land use, relative to REF



Note: If DDGS were not used as animal feed an additional 5 to 8 million hectares arable land would be required globally

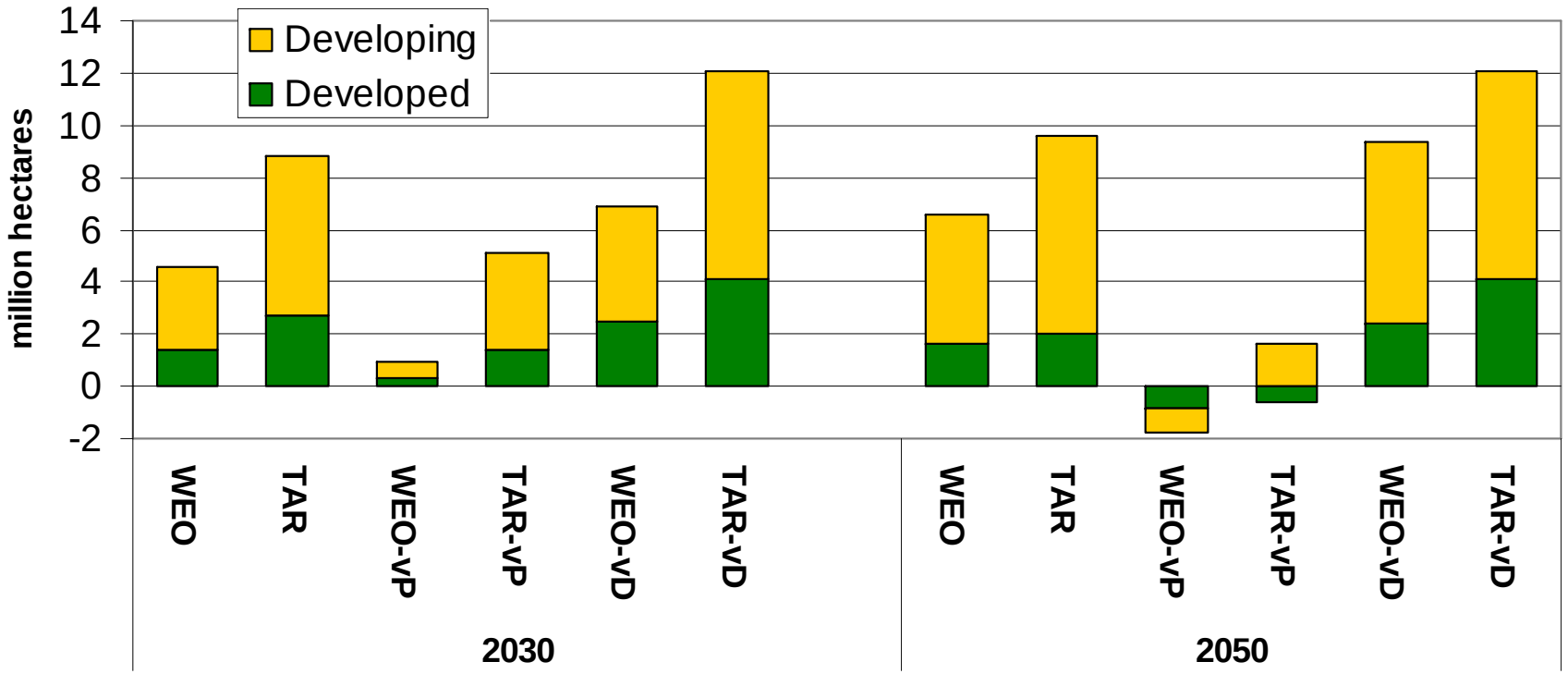
Spatial distribution and intensity (percent) of **cultivated land**, year 2000



Note: calibration of GLC2000 class weights starts from estimated reference weights and is based on an iterative scheme to match national / sub-national statistics of year 2000 (FAO AT2015/2030 adjusted cultivated land).

Land use changes – Deforestation

Additional deforestation, relative to REF



Variant **-vP**: higher agricultural productivity; **-vD**: no use of DDGS

Net greenhouse gas savings achieved in biofuels scenarios

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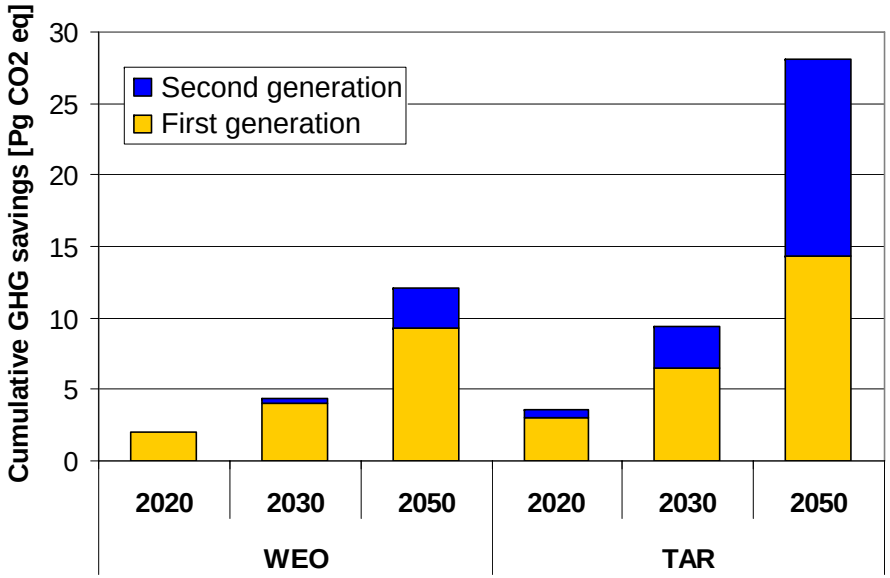
GHG savings due to biofuel use

For first-generation according to GHG saving coefficients based on EC (2008). For second-generation biofuels a GHG saving of 85 percent was used



- Carbon losses related to land use changes

IPCC Tier 1 approach; accumulated over time

→ Net GHG balance

Net greenhouse gas savings of biofuel scenarios

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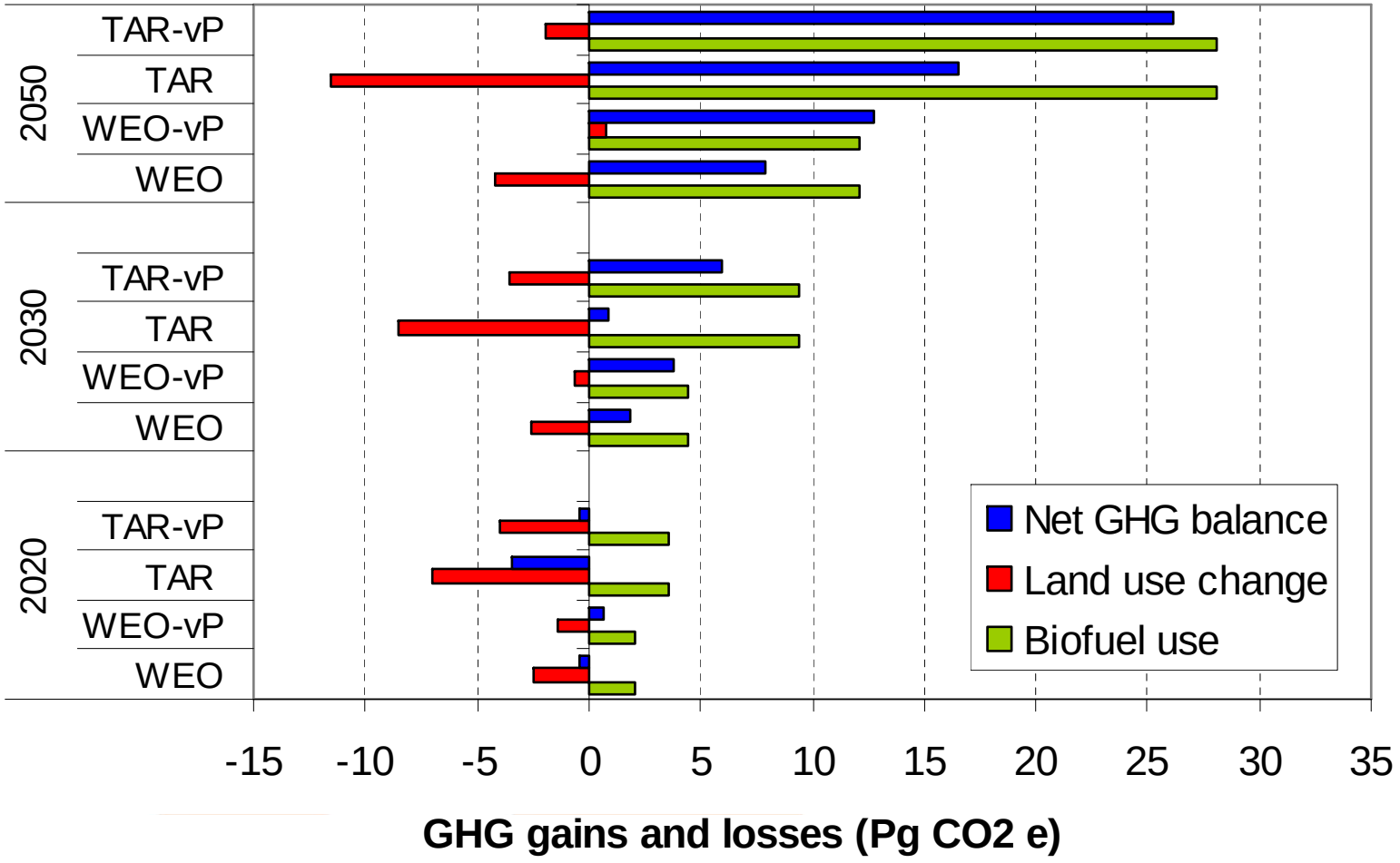
Scenario WEO, TAR, WEO-vP, TAR-vP



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In summary …

- Strong increases in global demand for agricultural products
- Expected increasing integration of agriculture, forestry and energy sectors through land competition for biomass

- Use of biofuel by-products contribute substantially to dampening price increases and reducing agricultural expansion
- High sensitivity of assumed growth in agricultural productivity

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Policy conclusions …

- ‘Low disturbing’ biofuel development requires agricultural productivity increases to exceed food demand growth.
- Focusing on LDC yield gaps could bring about rural income growth, improve food security and provide plenty feedstocks without carbon-intensive land conversion.
- Such a scenario clearly outperforms a baseline without biofuels; but creates more competition for MDC farmers.
- For GHG benefits to materialize, yield gap reduction, carefully monitored speed of biofuel expansion and regulation to avoid deforestation is important .

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Policy directions …

- Renew efforts to enhance agricultural productivity.
- Maintain high potential land in good conditions to facilitate sustainable production increases.
- Establish and promote sustainability criteria and “best practice guides” for land use.
- Protect the poor against impacts of rising and more volatile agricultural prices.
- Promote GHG-efficient and integrated technologies.

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http://www.iiasa.ac.at/Research/LUC