



COMPETING FOR LAND OR ENERGIZING THE AGRICULTURAL SECTOR?

**A combined top-down bottom-up approach to
evaluating the bioenergy-food security nexus**

by

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Rural Development and the Role of Biomass

International workshop as part of the Development and Climate Project

14-16 November 2005, Dakar, Senegal





Different Forms of Bioenergy...

Liquid Fuels

Ethanol (e.g. from sugar)

Methanol

Biodiesel (e.g. from maize, rape seeds)

Vegetable oils

Solid Fuels

Charcoal

Briquettes

Agricultural Residues

Gaseous Fuels

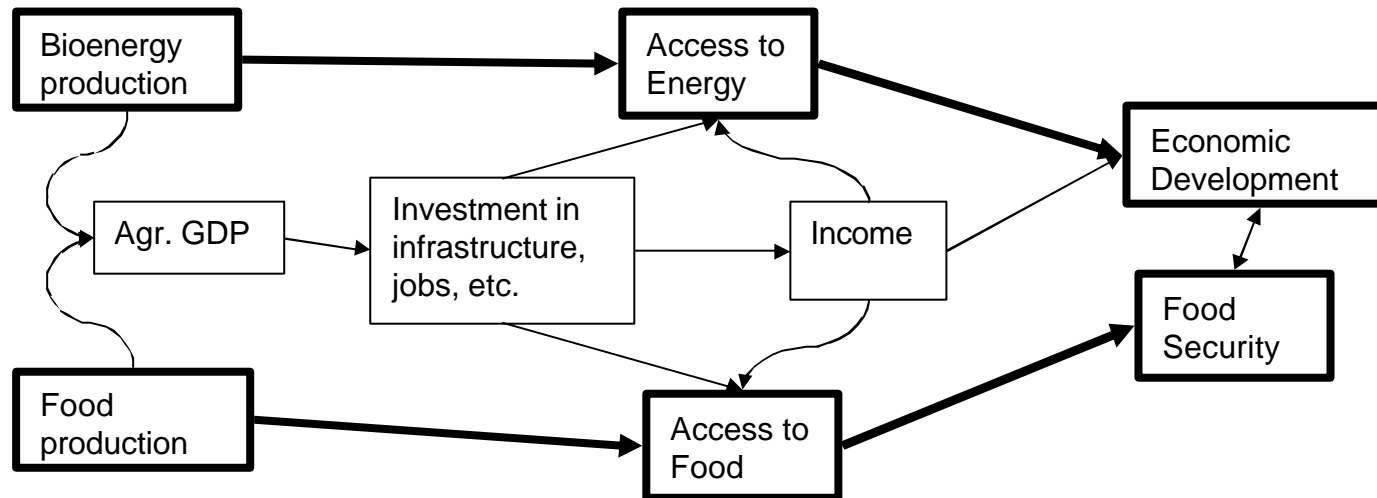
Hydrogen

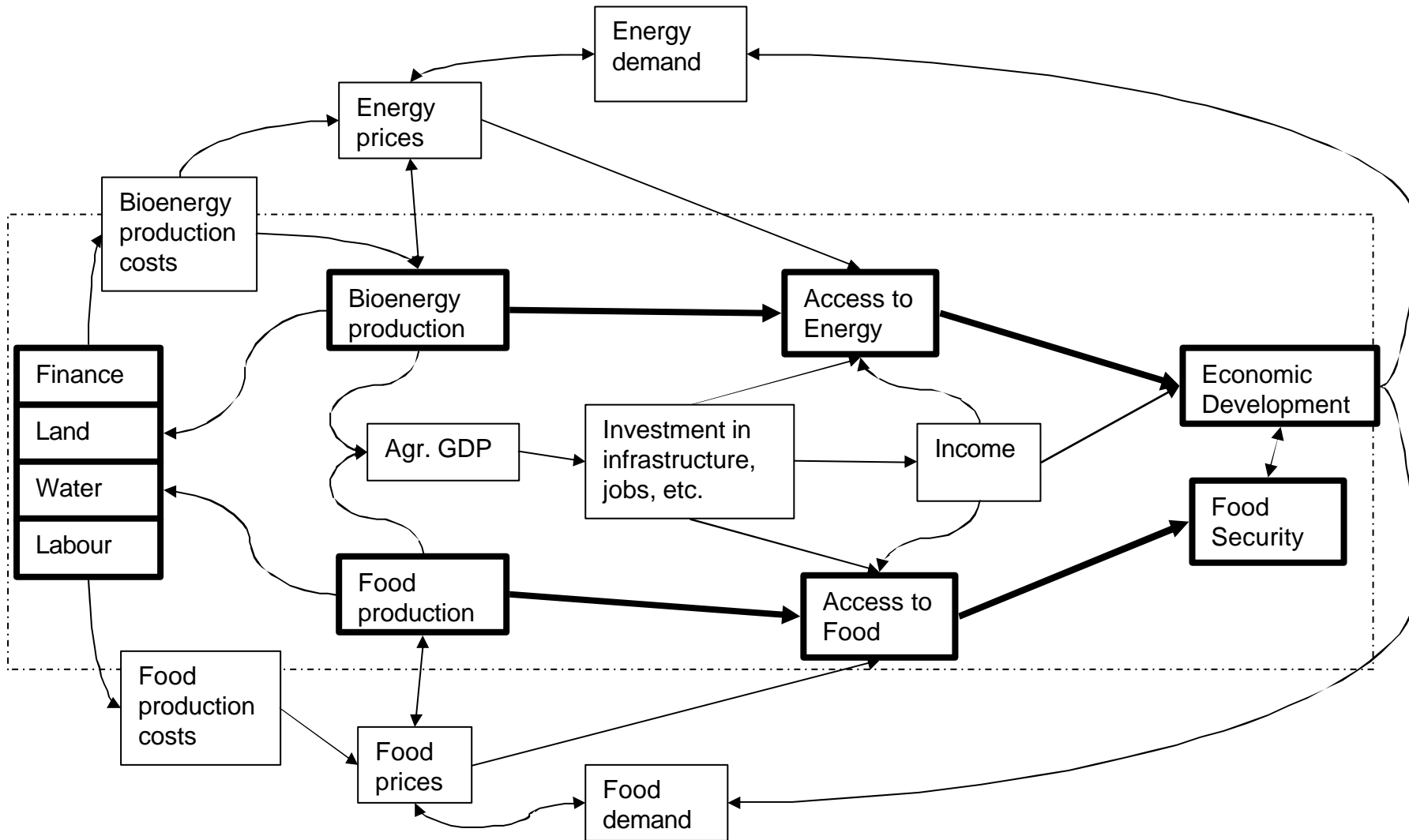
Methane (e.g. from animal manure)

Bioelectricity



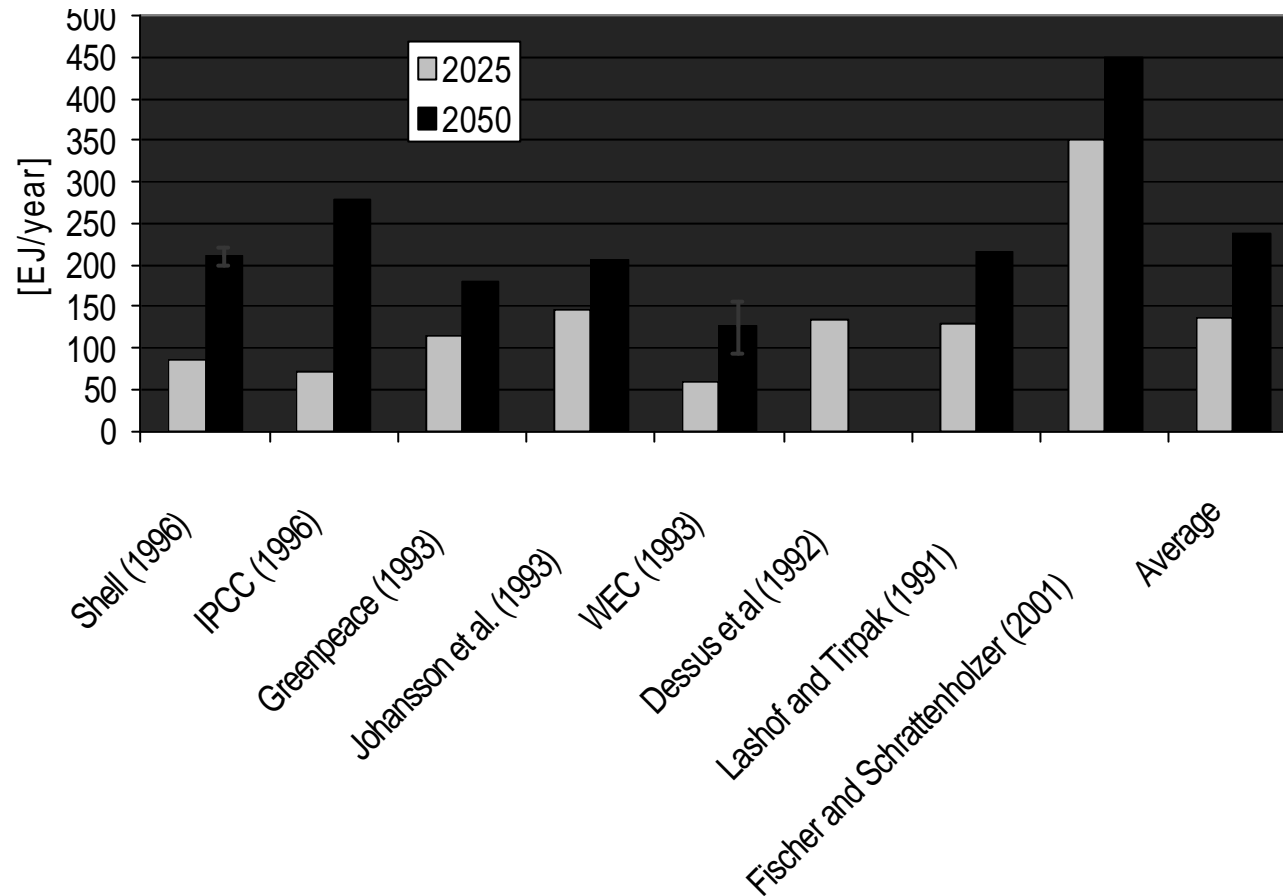
Bioenergy, Development and Food Security as a System





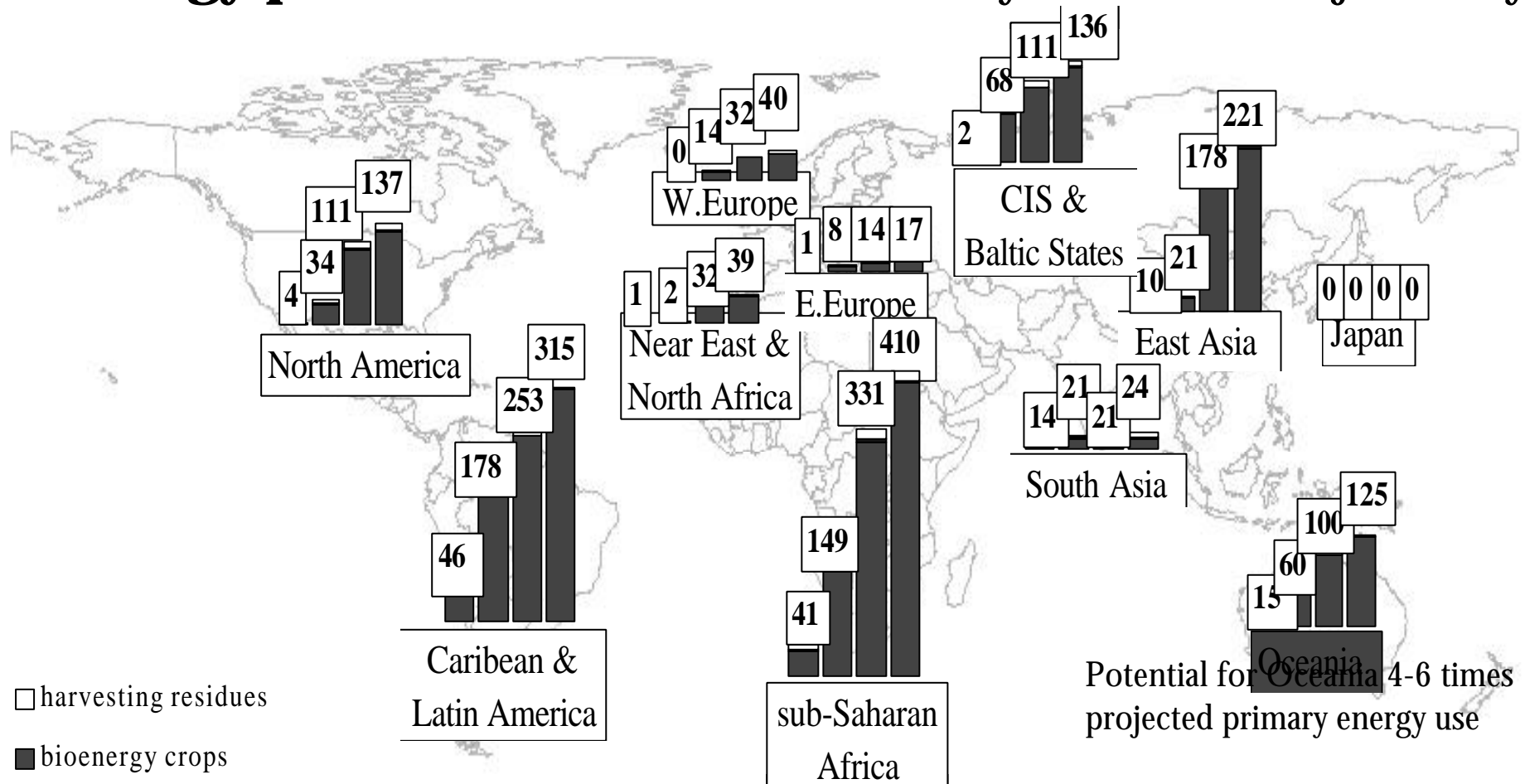


Bioenergy potential: different scenarios, years 2025 and 2050 Exajoules/yr





Bioenergy potential: different scenarios, year 2050 Exajoules/yr

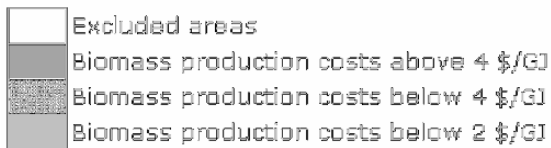
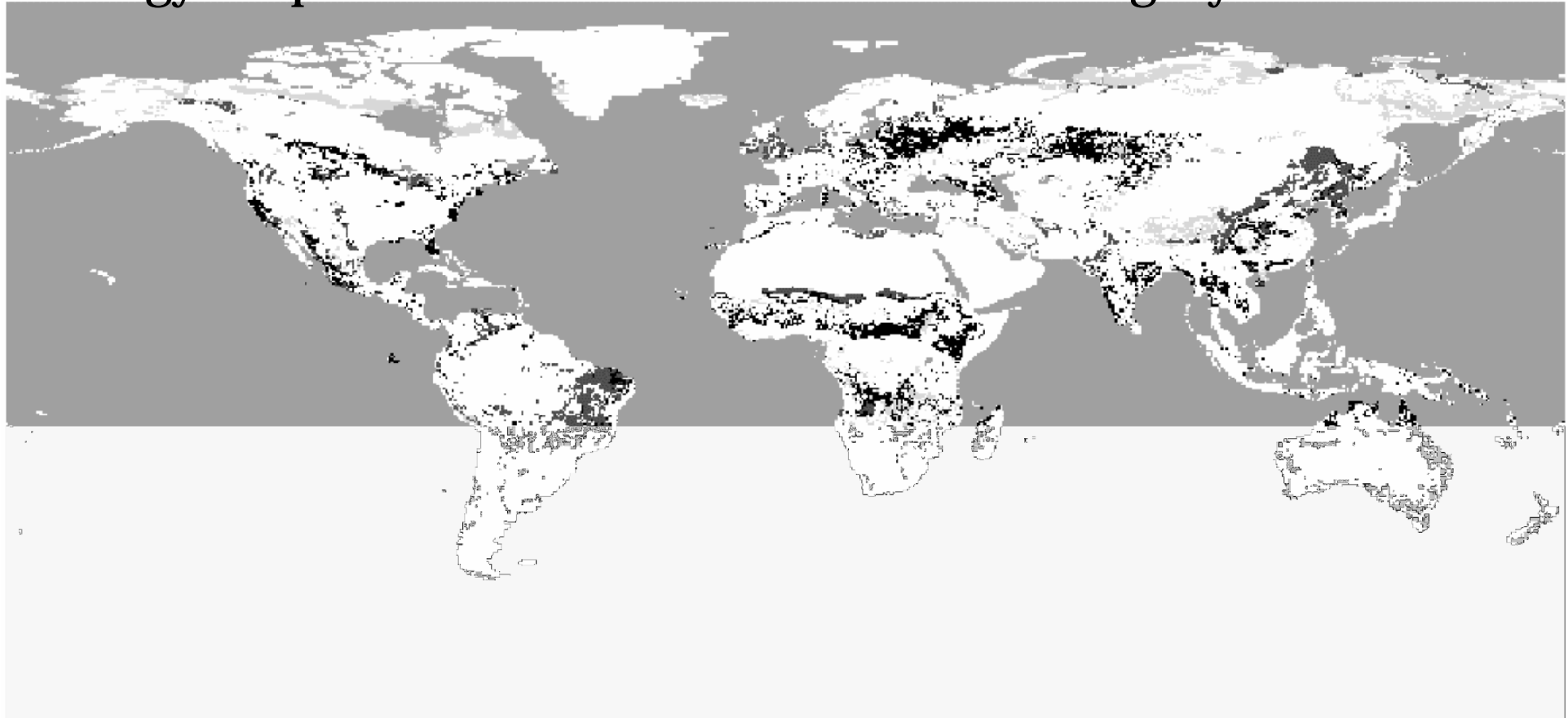


Potential for Oceania 4-6 times projected primary energy use

Source: E. Smeets, A. Faaij, I. Lewandowski, A (2004)



Bioenergy Potential: Spatial distribution of production cost of energy crops for abandoned and rest land category in 2050



Source: Hoogwijk et al. (2005)



What's Expected: e.g. IPCC TAR (2050)

Scenario / Biomass Energy Requirement	Bioenergy	% Primary	Land for Biomass
	EJ	%	Mha
Sørensen (1999) - bottom up assessment	178	74	-
IPCC (2001) - TAR - AIM - A1M	193	14	418
- TAR - A2 - ASF	71	27	
- TAR - B1 - Image	95	13	268
- TAR - B2 - Message	105	12	288
- TAR - A1F1 (A1G) - Minicam	52	4	68
- TAR - A1T - Message	183	71	418
IPCC (1996) - SAR	280		
	Average	31	292
	Max	74	418
	Min	4	68



Main Benefits of Bioenergy

Besides the diversification of the energy base and of rural economies, bioenergy...

...promotes additional employment and rural infrastructure

...stimulates the role of agriculture and forestry as energy producers

...contributes to domestic energy security

...helps mitigate climate change



Implications for Agriculture

- **livelihoods and employment**
- **species selection**
- **farming systems**
- **land use (rehabilitation of marginal/ degraded lands)**
- **biodiversity**
- **agroindustries**
- **local, national and international trade**
- **partnerships with other sectors**
 - ✍ energy – environment – industry - trade

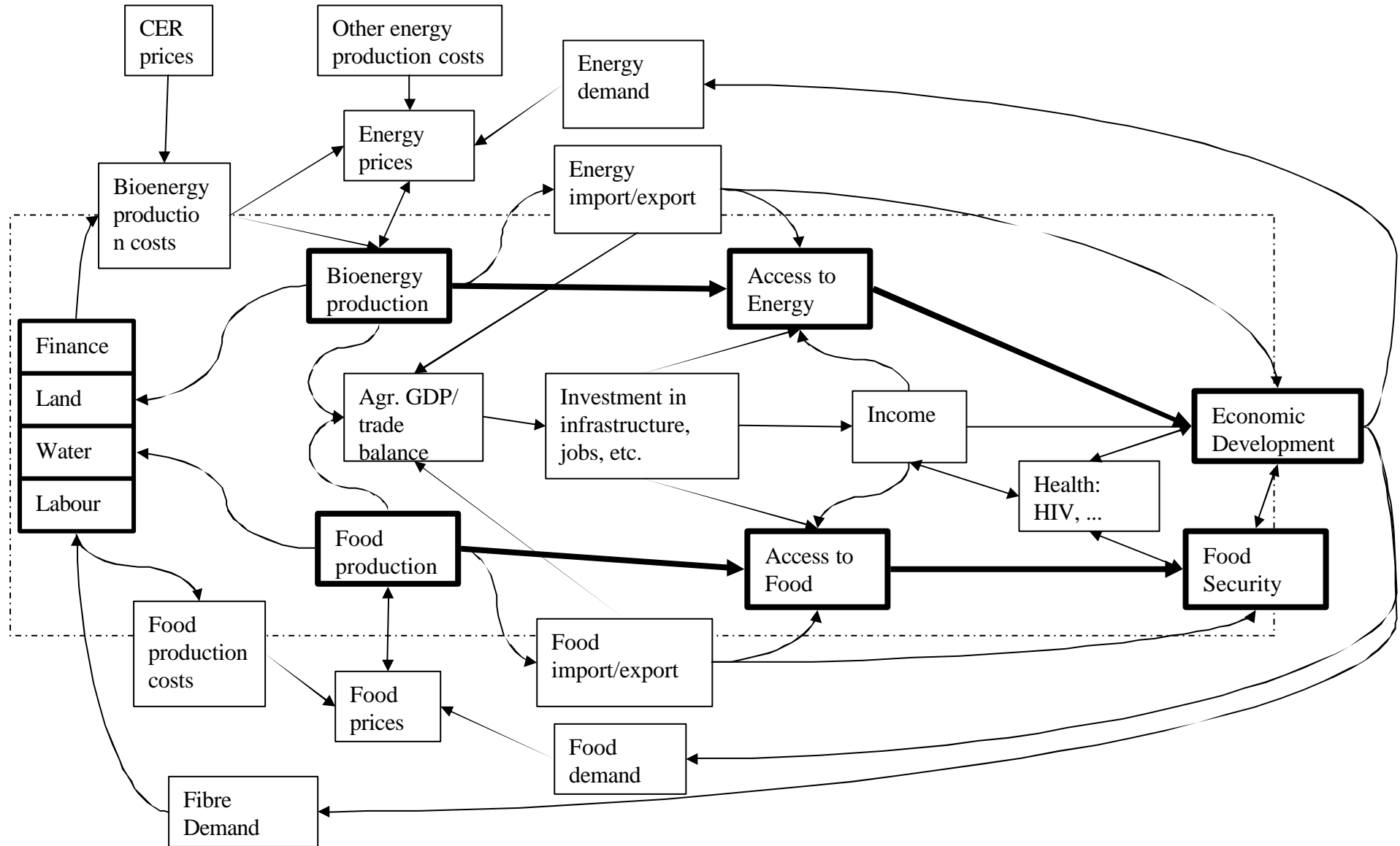


Determinants of Bioenergy Production

- **Population growth and economic development**
- **Energy prices**
- **Food consumption: per capita calorie intake and composition of diet**
- **Land use patterns (feasibility of marginal/degraded lands)**
- **Efficiency of food production: crop yields, livestock production**
- **Forest productivity and sustainable harvest levels.**
- **Competing demands for land: nature reserves, endangered/protected ecosystems, recreation, amenity**
- **Competing demands for wood and agriculture based bio-materials.**

Determinants of Food Security

- **Population growth**
- **GDP growth per person**
- **Agricultural GDP growth**
- **Health expenditure as a proportion of GDP**
- **Proportion of adults infected with HIV**
- **Number of food emergencies**
- **UNDP's Human Development Index**

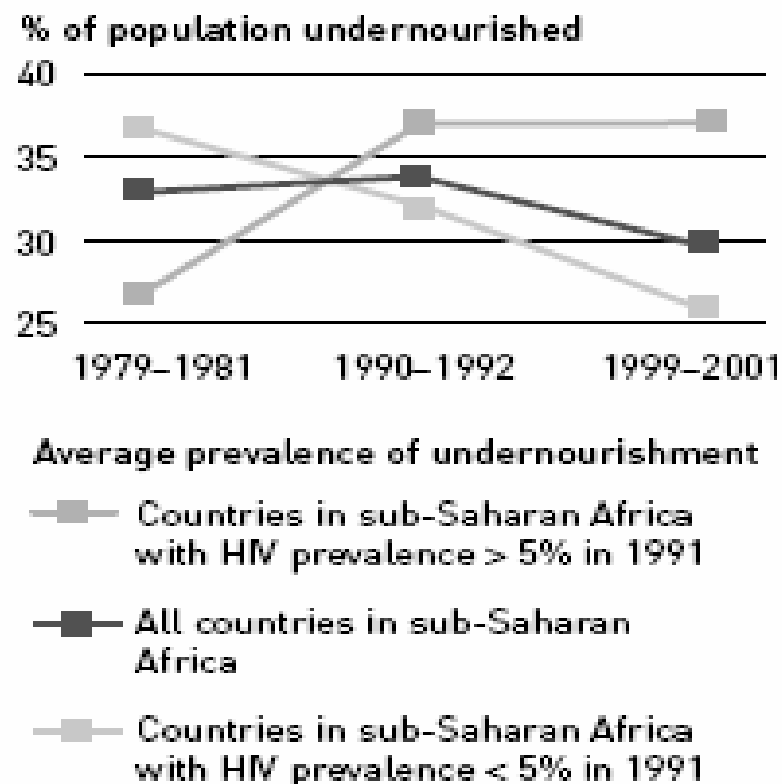




Possible Bioenergy Effects

- **Climate change mitigation**
- **Diversification of domestic energy supply (energy security, trade balance) & energy access**
- **Development of infrastructures and jobs in the agricultural sector, especially in rural areas**
- **Technological development through investment in new technologies**
- **Environmental benefits**
- **Diversification of agricultural production through energy crops**

Undernourishment and HIV/AIDS, sub-Saharan Africa



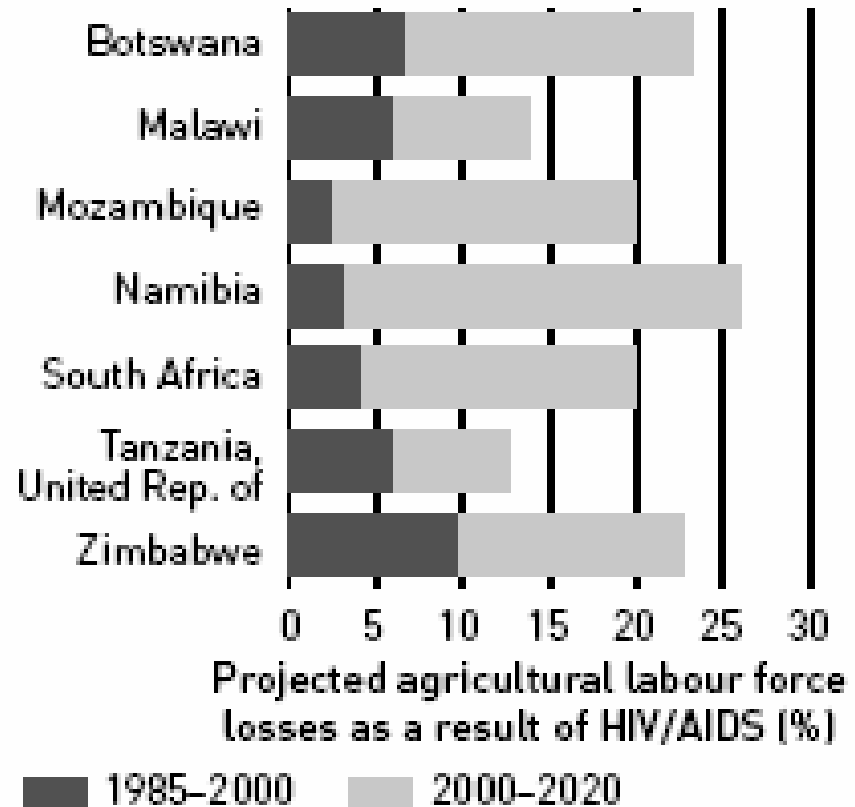
Source: WHO; FAO



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Projected labour losses due to HIV/AIDS, southern Africa



Source: FAO

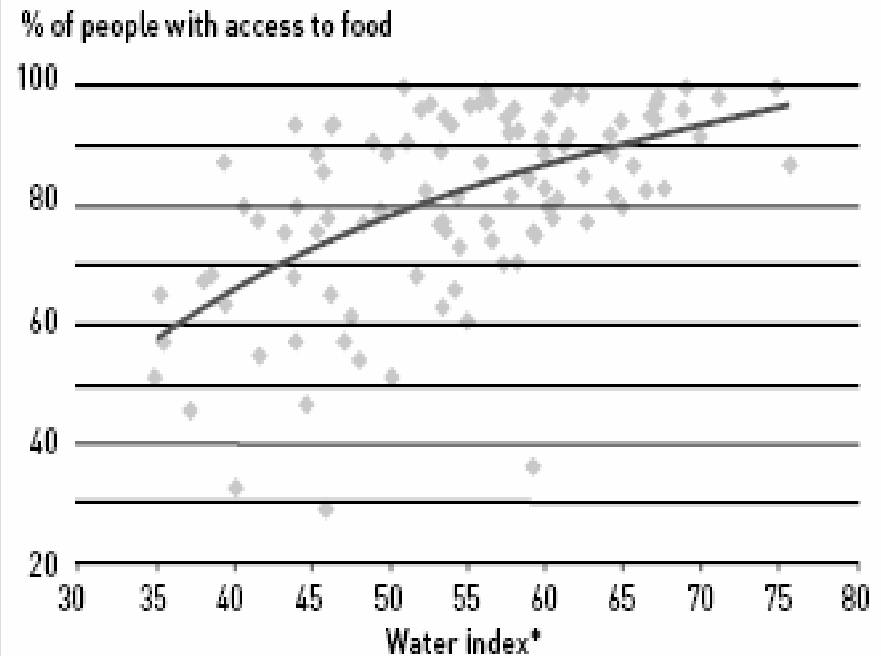


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Access to water and food security

(developing countries and countries in transition)



* A composite indicator that incorporates measures of water resources (from rainfall, river flows and aquifer recharge), access, environmental issues (water quality) and pressure on resources.

Source: FAO, CEH Wallingford

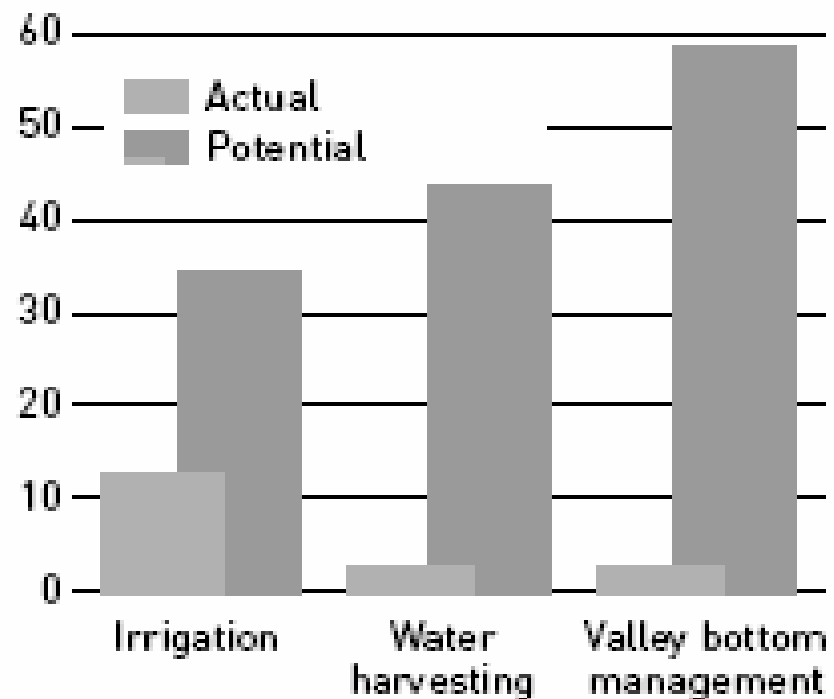


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Water management potential in Africa

Area (millions of hectares)

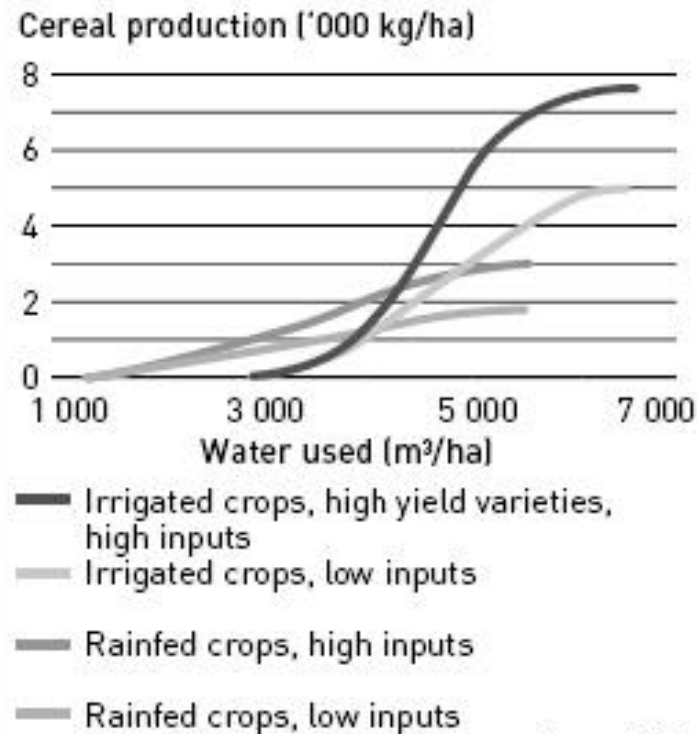


Source: FAO



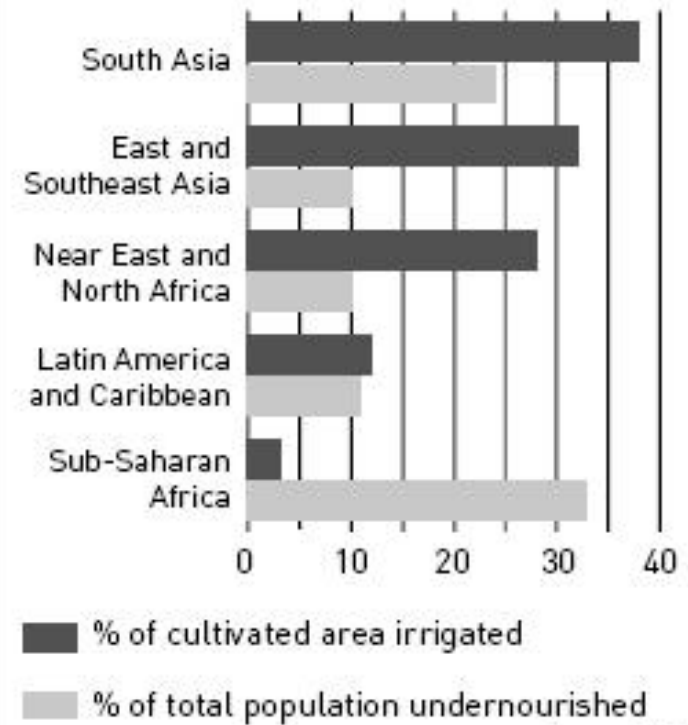
Water, yields, undernourishment

Yields and water requirements of irrigated and rainfed agriculture



Source: FAO

Irrigation and prevalence of undernourishment, 1998–2000



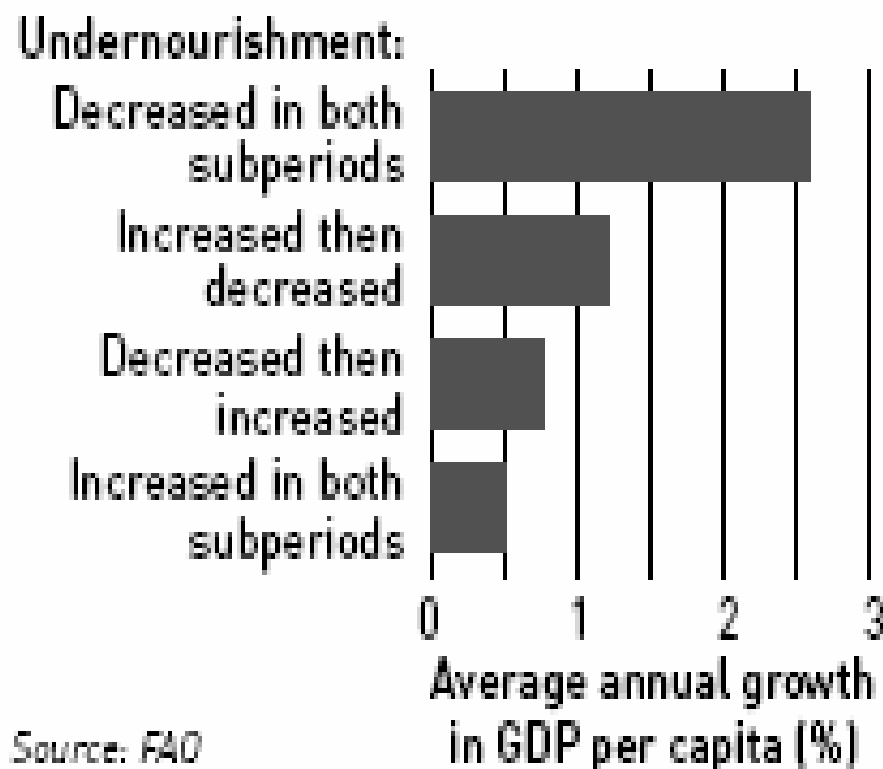
Source: FAO



Possible Bioenergy Effects

- **Climate change mitigation (CDM)**
- **Diversification of domestic energy supply (energy security, trade balance) & energy access**
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- **Technological development through investment in new technologies**
- **Environmental benefits (PES)**
- **Diversification of agricultural production through energy crops**

Trends in undernourishment and GDP, by country grouping

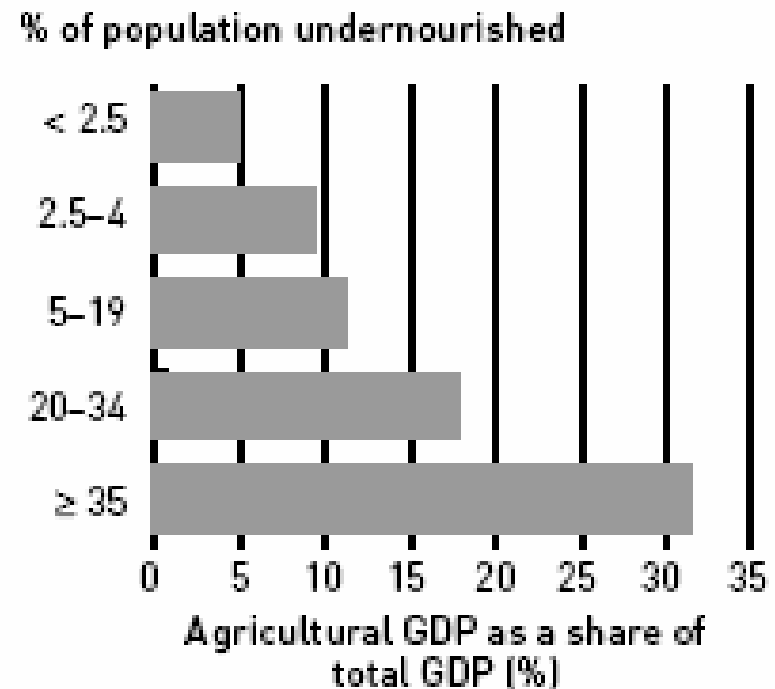




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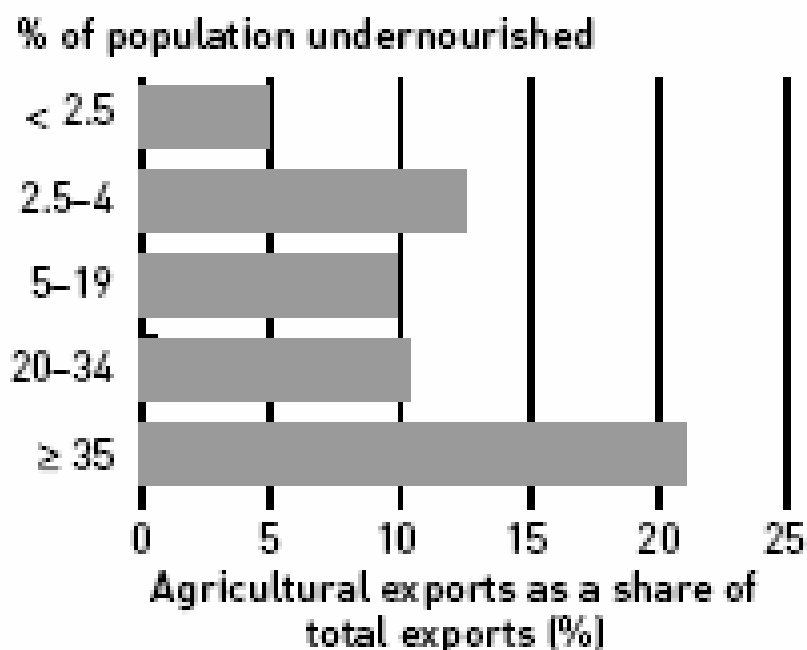
Agricultural GDP and undernourishment, 1996–2000



Source: FAO



Importance of agricultural exports and undernourishment, 1996–2000



Source: FAO

Trends in exports of commodity-dependent countries

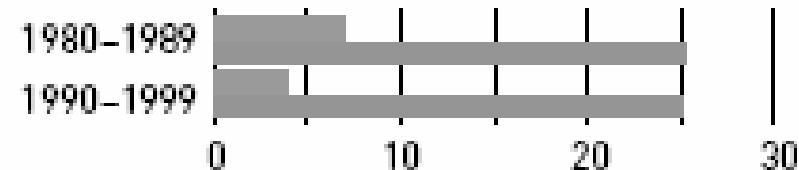
Average annual growth in total exports (%)



Average annual growth in agricultural exports (%)

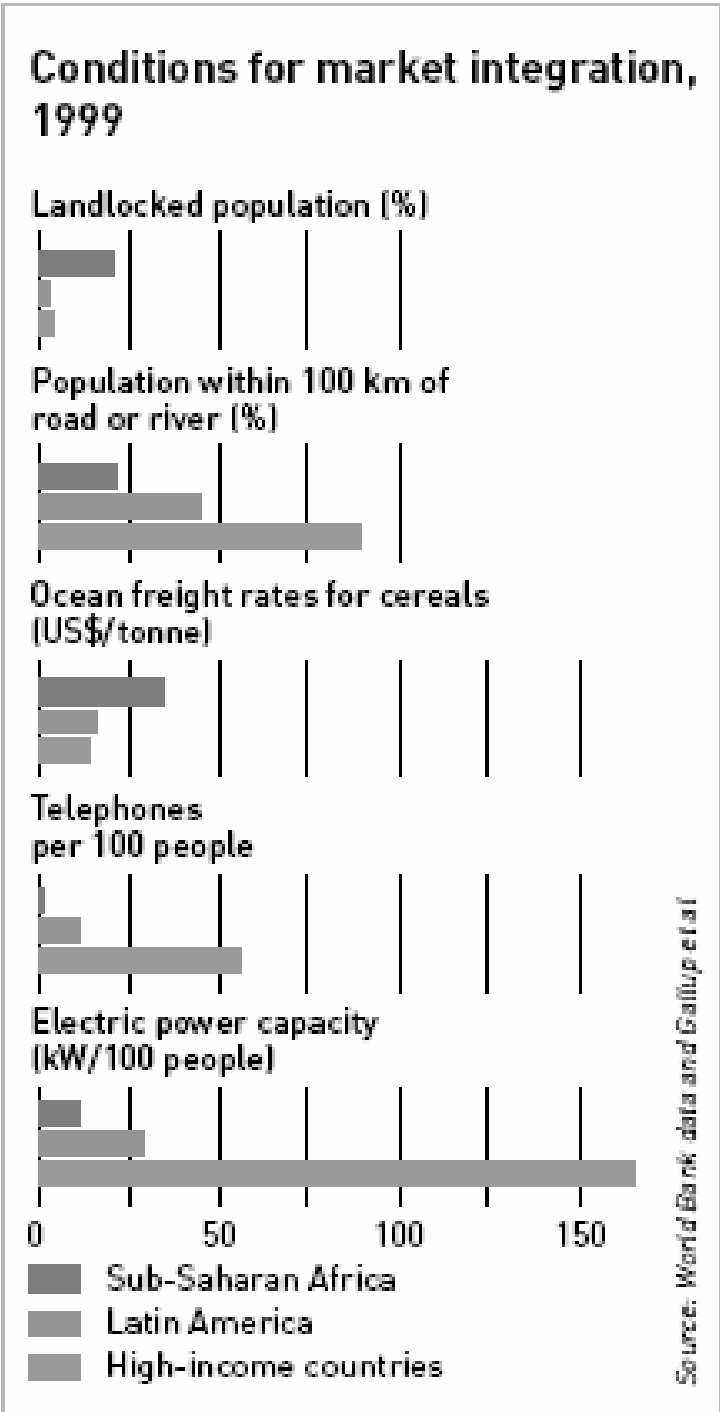
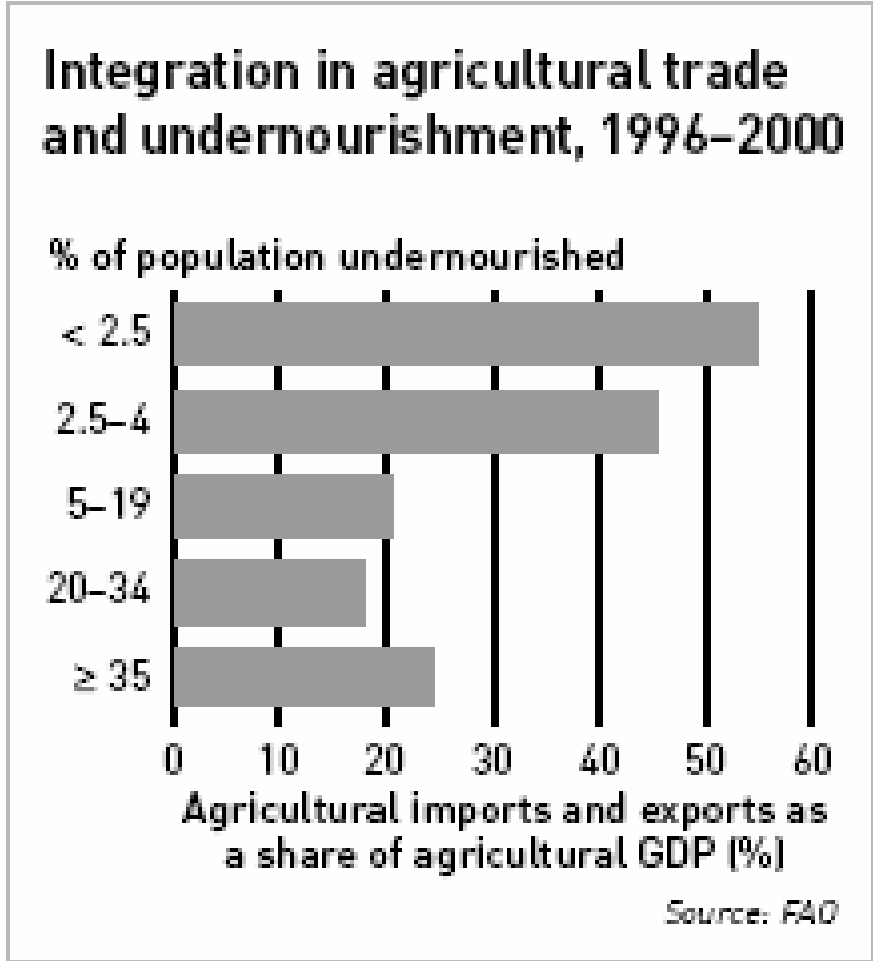


Share of world agricultural exports (%)



- 43 commodity-dependent countries
- Other developing countries

Source: FAO

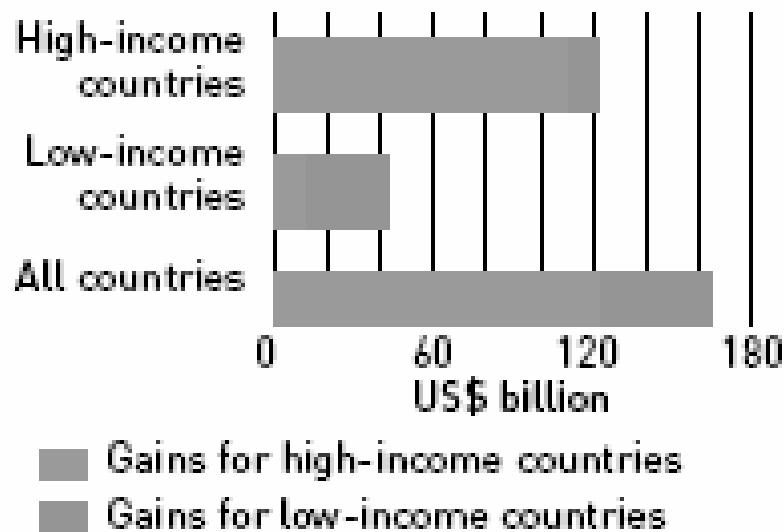




Ethanol and value added – or simply sugar for European refineries?

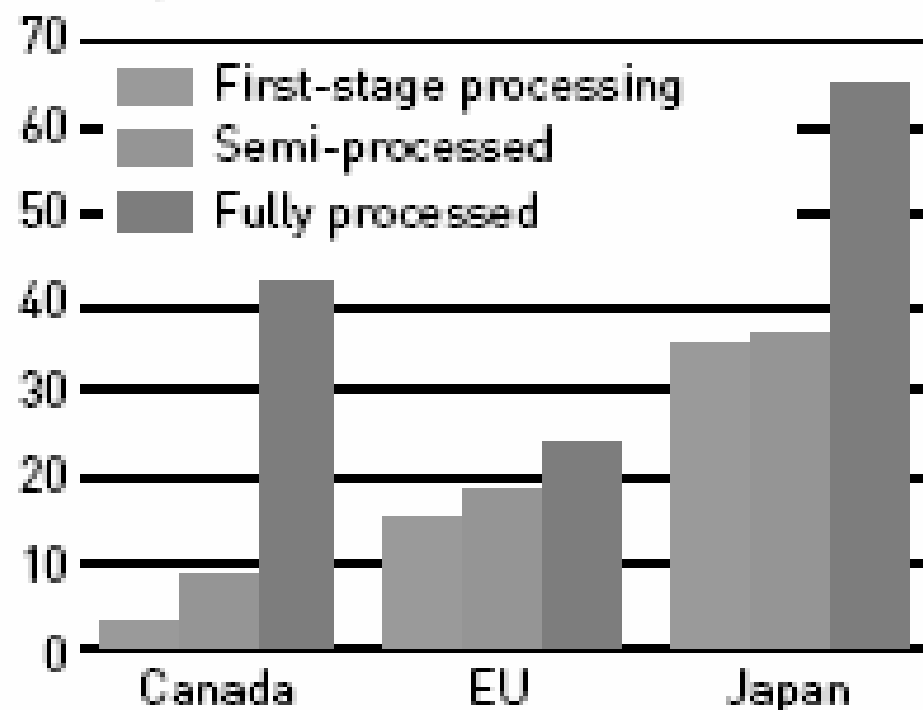
Potential annual welfare gains from agricultural trade liberalization

With liberalization of:



Source: Anderson et al

Average tariffs (%)



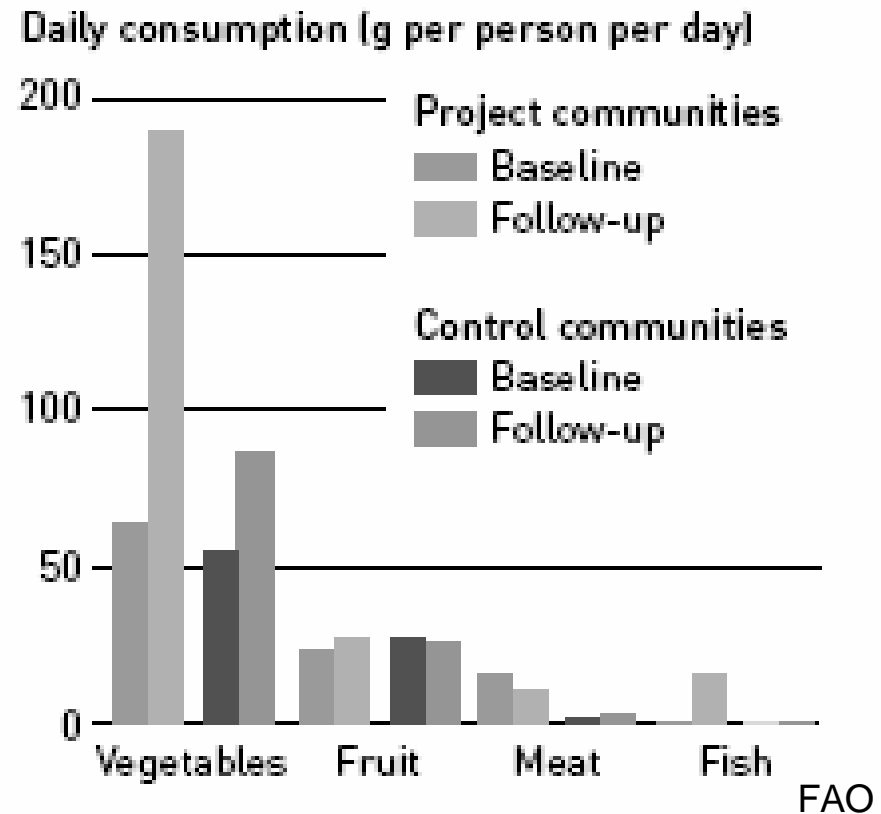
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Nutrition: the case of Vietnam

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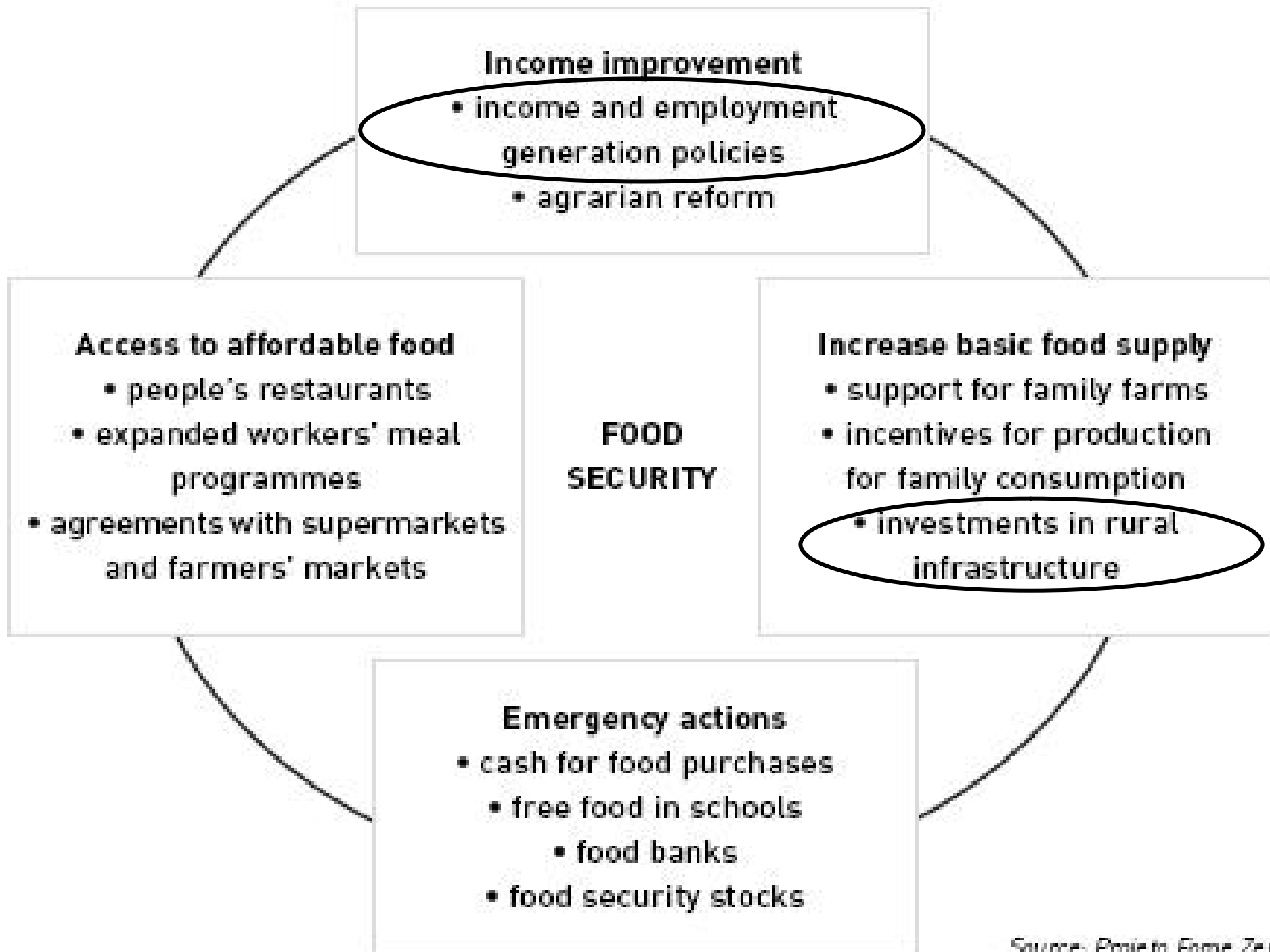


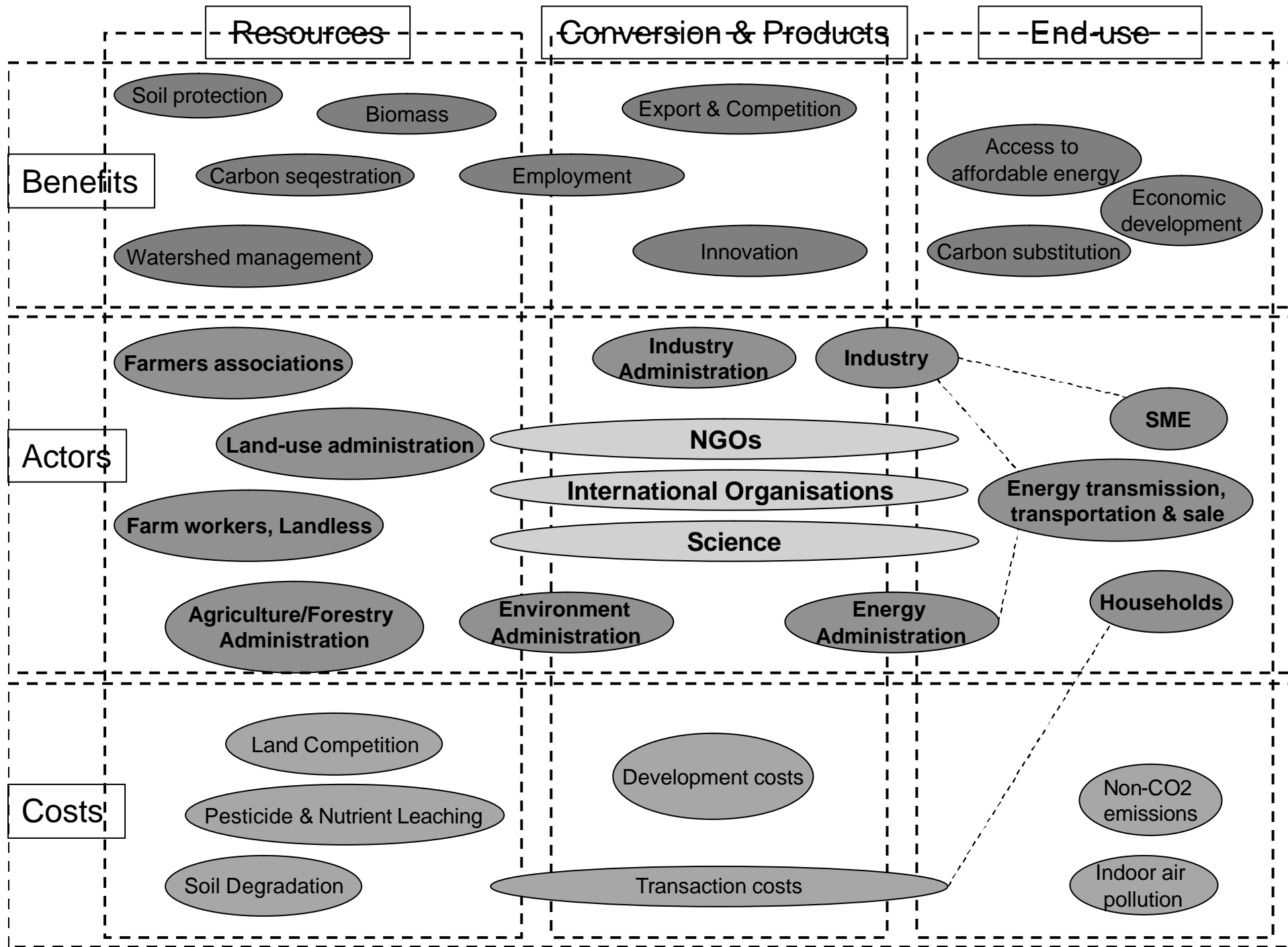


Food security and climate change

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 - **Forest productivity and sustainable harvest levels.**
 - **Competing demands for land: nature reserves, endangered/protected ecosystems, recreation, amenity**
 - **Competing demands for wood and agriculture based bio-materials.**
- **Minus 2-3% in African cereal production (2020) to raise numbers at risk from hunger by 10 million (Parry *et al.*1999)**
 - **Intensive farming systems: management flexibility ↗ buffer negative effects of climate change and benefit from the positive effects**
 - **More extensive farming systems operating close to the threshold management options are fewer and they are more vulnerable to CC**
 - **CC increase irrigation demand in the majority of world regions due to a combination of decreased rainfall and increased evaporation.**







Bioenergy effects vs. Determinants of Food Security

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Example: Employment

Measures for employment effects:

- **The direct employees' consumption of private goods and services.**
- **The direct employees' consumption of public goods and services.**
- **The directly involved companies' consumption of goods and services from companies connected to other sectors in the economy**

Different producers:

- **Upgraded fuel producer**
- **Local fuel supplier**
- **Local small-scale heat producer**
- **Local large-scale CHP producer**
- **Farmer**



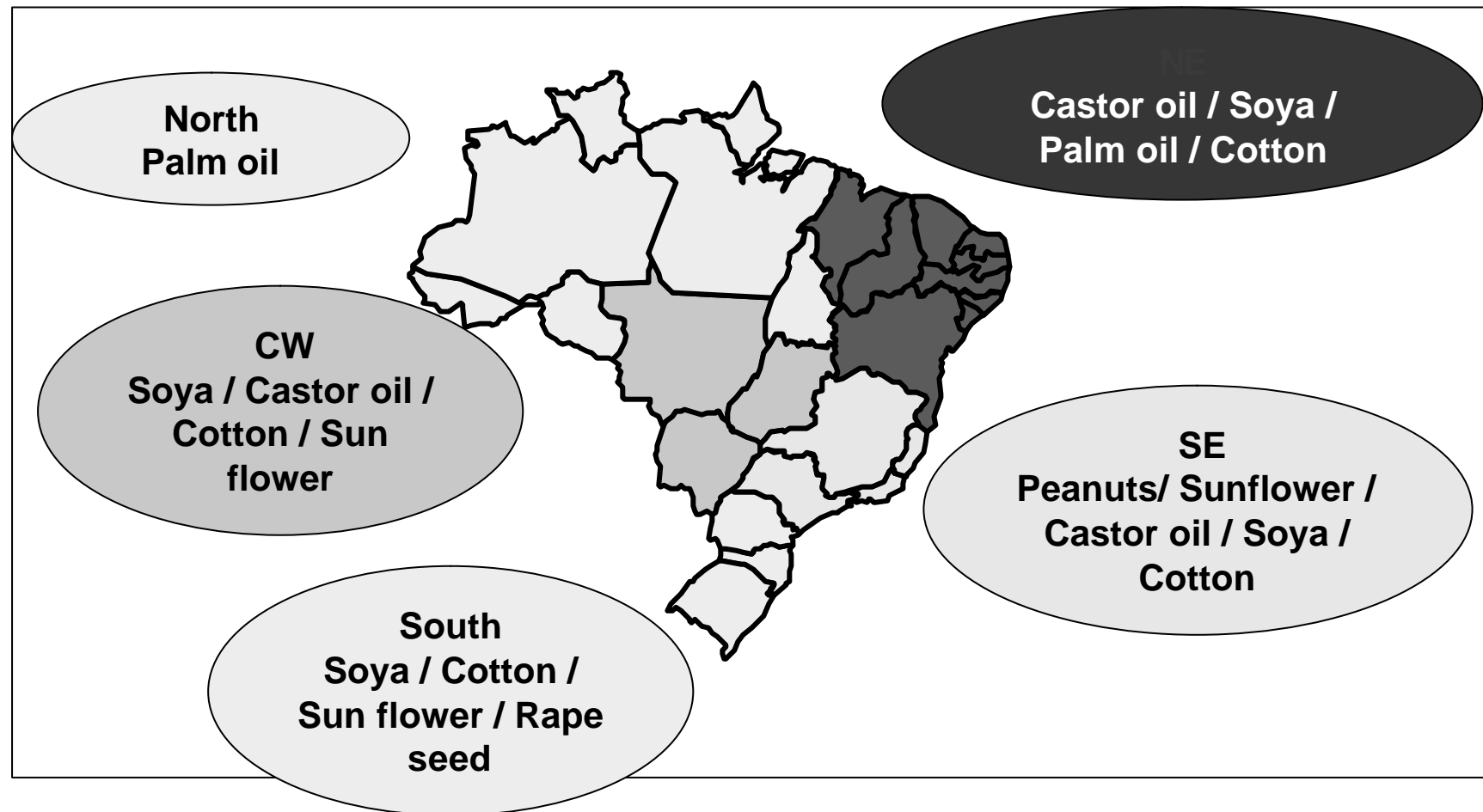
Different Implementation Modes

- **Bioenergy industry:** This implementation mode refers to an industrial scale bioenergy plant whose primary business is to procure feedstock and produce an energy commodity (such as biofuels or electricity).
- **Capital investments:** existing agro-processing facility or other biomass intensive industry such as a saw or paper mill invests in energy production from residues, either for its own consumption or for export, as an ancillary business activity.
- **Community infrastructure:** In this implementation mode, a village or cluster of villages could own and manage energy facilities with or without contracting to private operators
- **RESCOs:** Here, independent private Rural Energy Service Companies act as entrepreneurs providing energy services (rather than equipment) at a profit to villages, households or enterprises.
- **Retail appliances:** In this mode, several small entrepreneurs are engaged in manufacturing and marketing a bioenergy technology (for example, cook stoves, biogas digesters, biofuels), which is ultimately widely distributed through standard retail channels.

Source: ESMAP 2005



Regional distribution of biomass sources in Brazil (Amaral 2005)



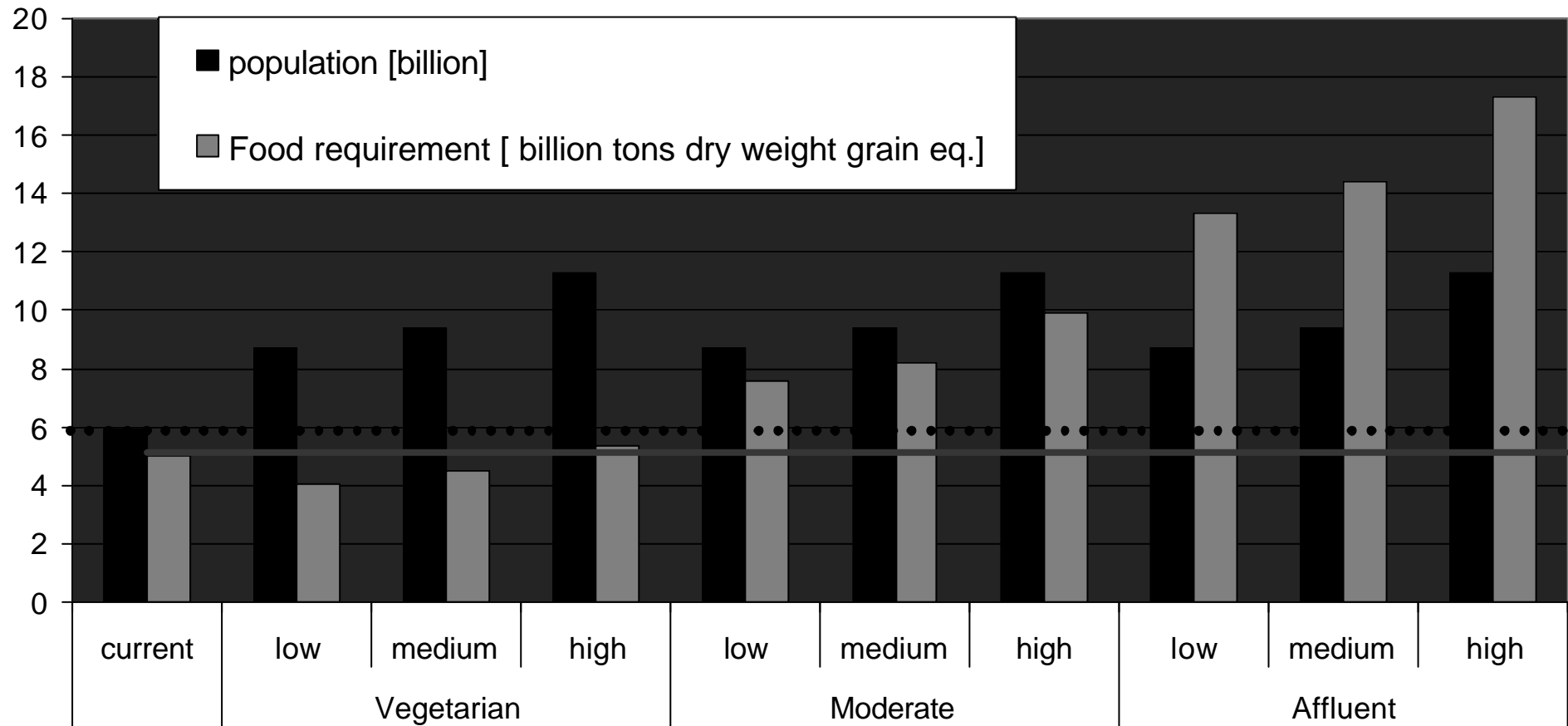


Competition

Resource	Alternative Use
Animal dung	Soil conditioner and fertilizer
Bagasse, sugar cane tops and leaves, molasses	Animal feed, paper and board industries, road cover
Cereal straw	Animal feed, soil conditioner, paper & board industries, roof thatching
Maize stalks	Cattle feed, soil conditioner
Rice husk	Cement and brick industries
Wood chips, bark, sawdust	Construction material
Wood logs, branches	Construction material, paper industry, handcraft

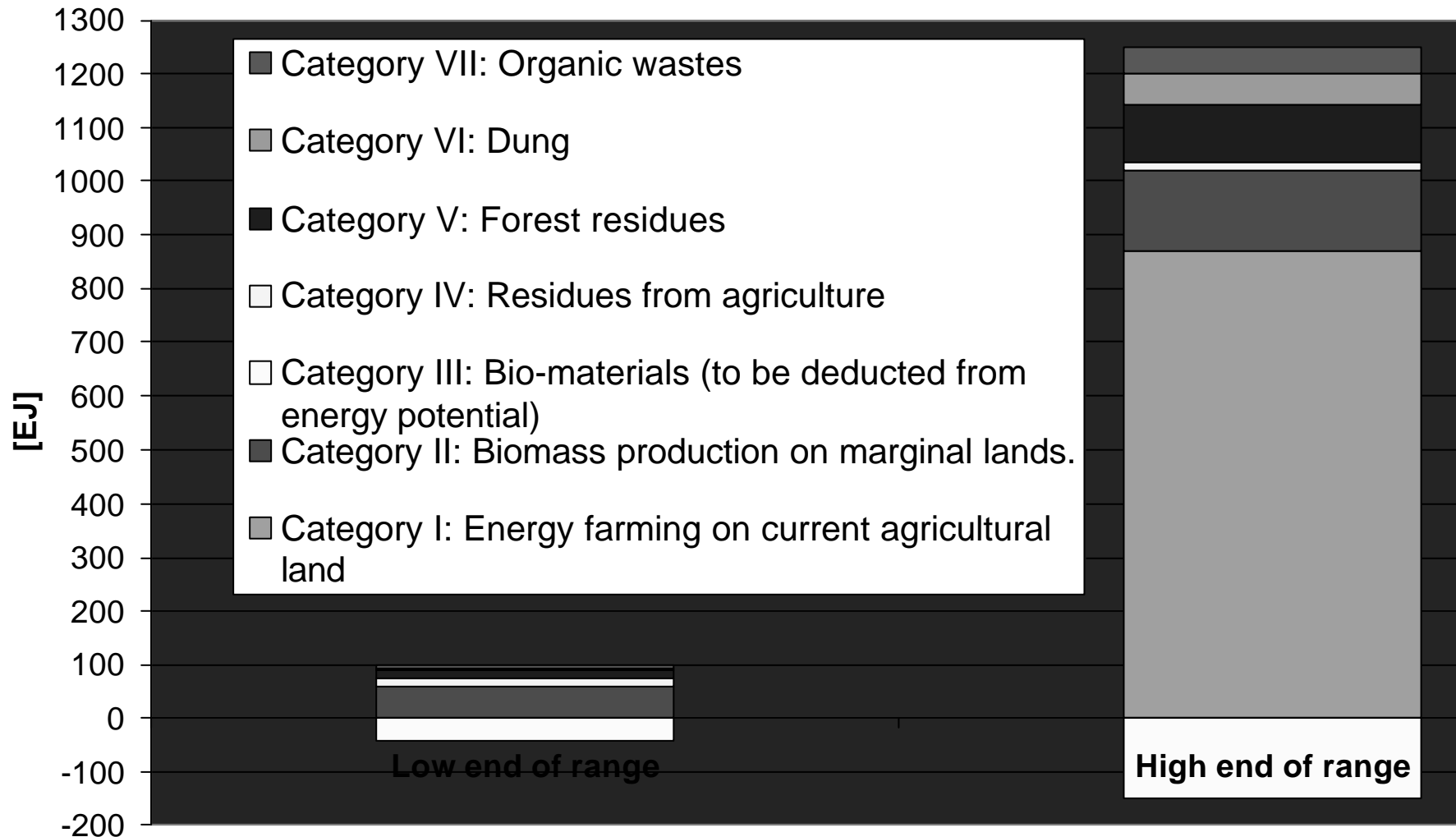


Food requirements: Population and Diet





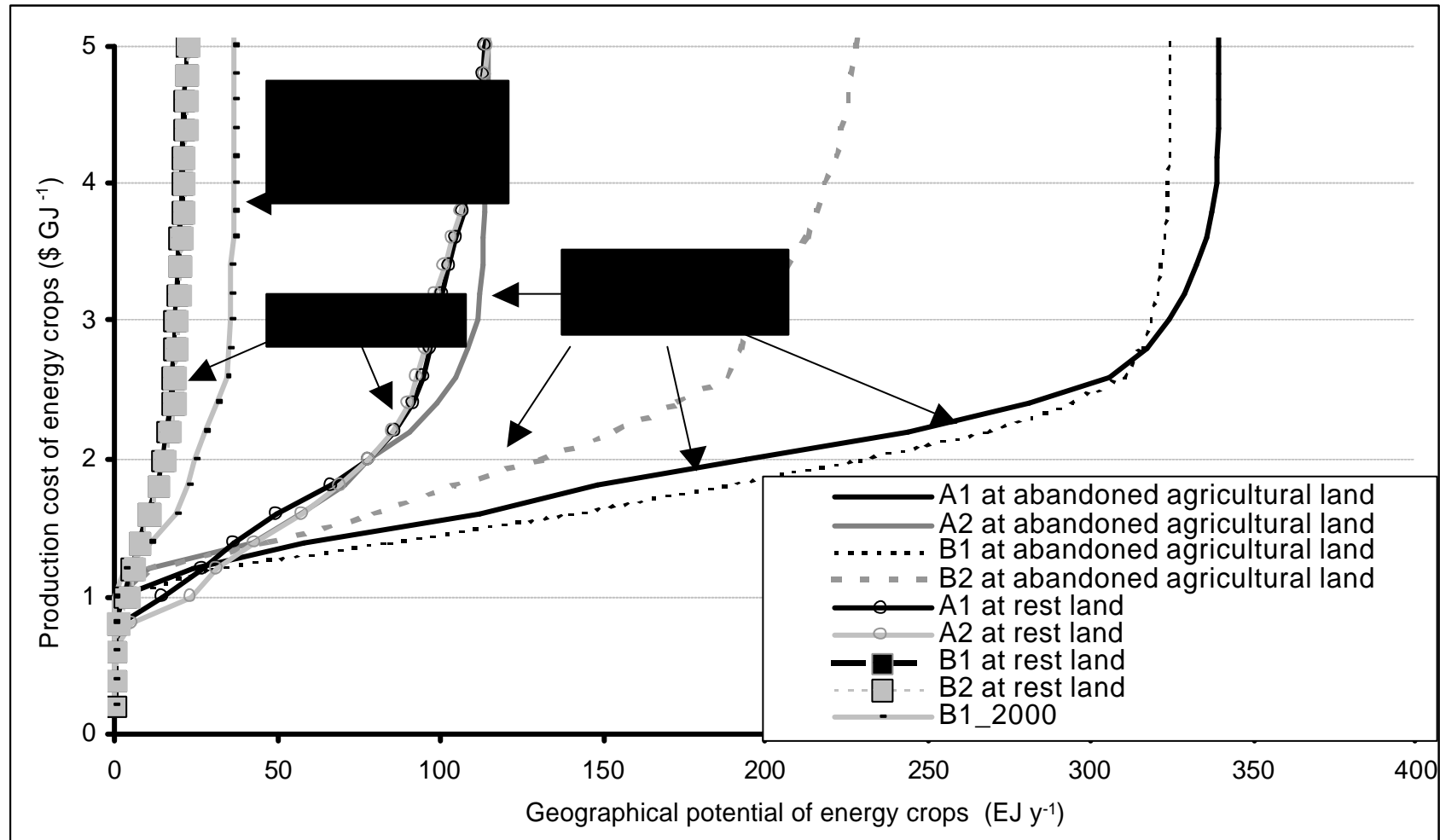
Different Bioenergy Sources with different land requirements





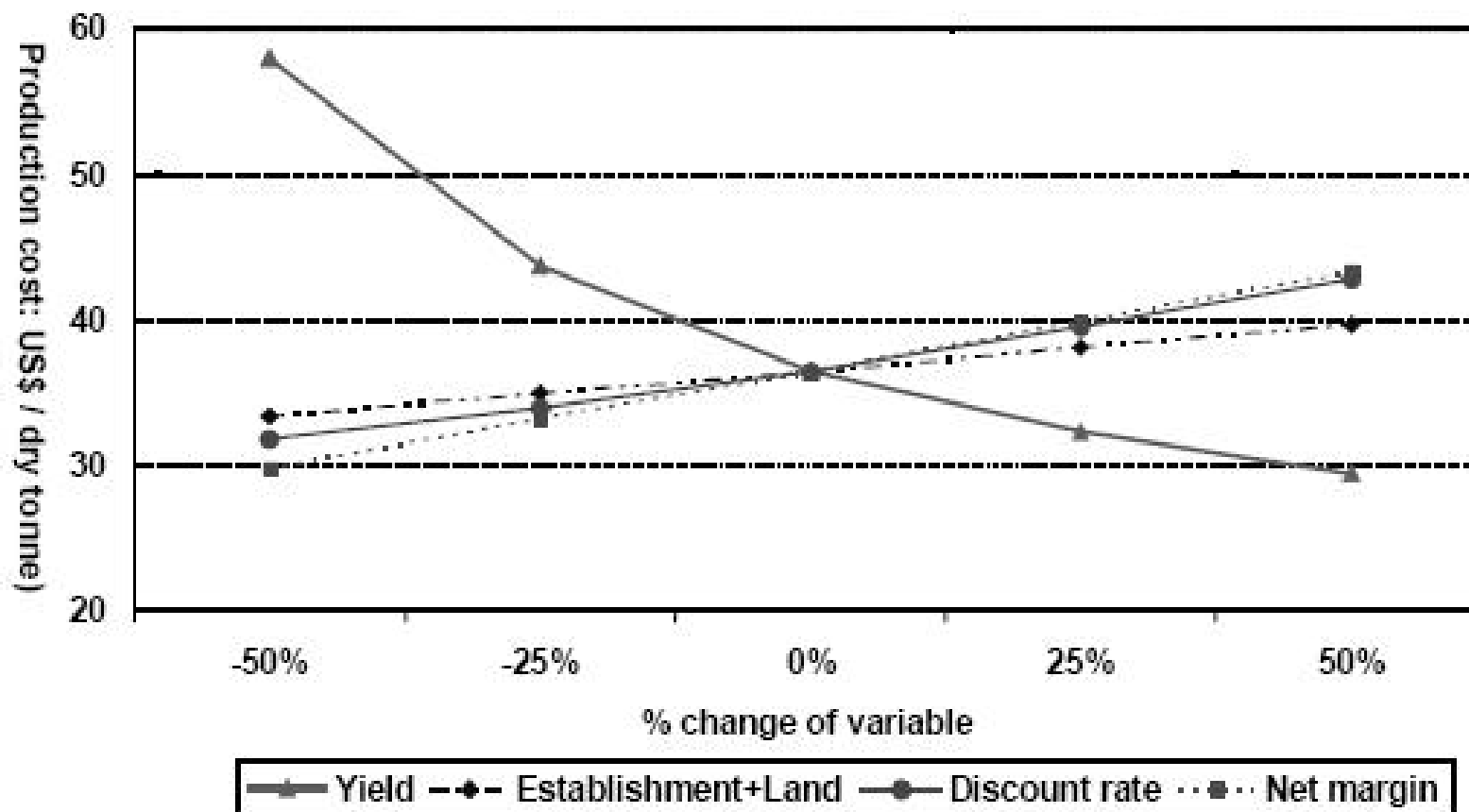
Global cost-supply curve for energy crops for four SRES scenarios for the year 2050

Source: Hoogwijk, Faaij, 2004



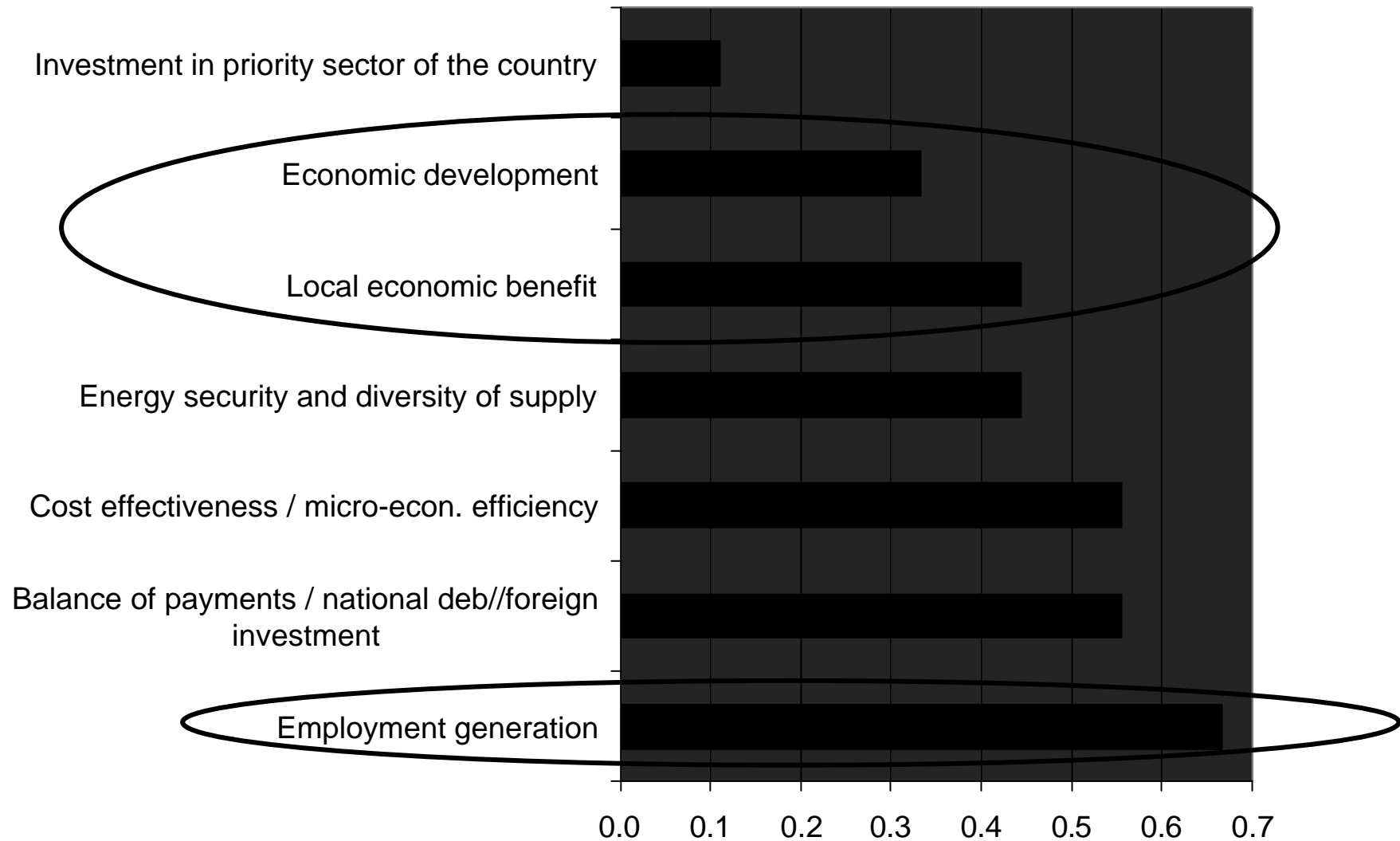


Data for small-scale tree plantations in China (Perlack 1996)



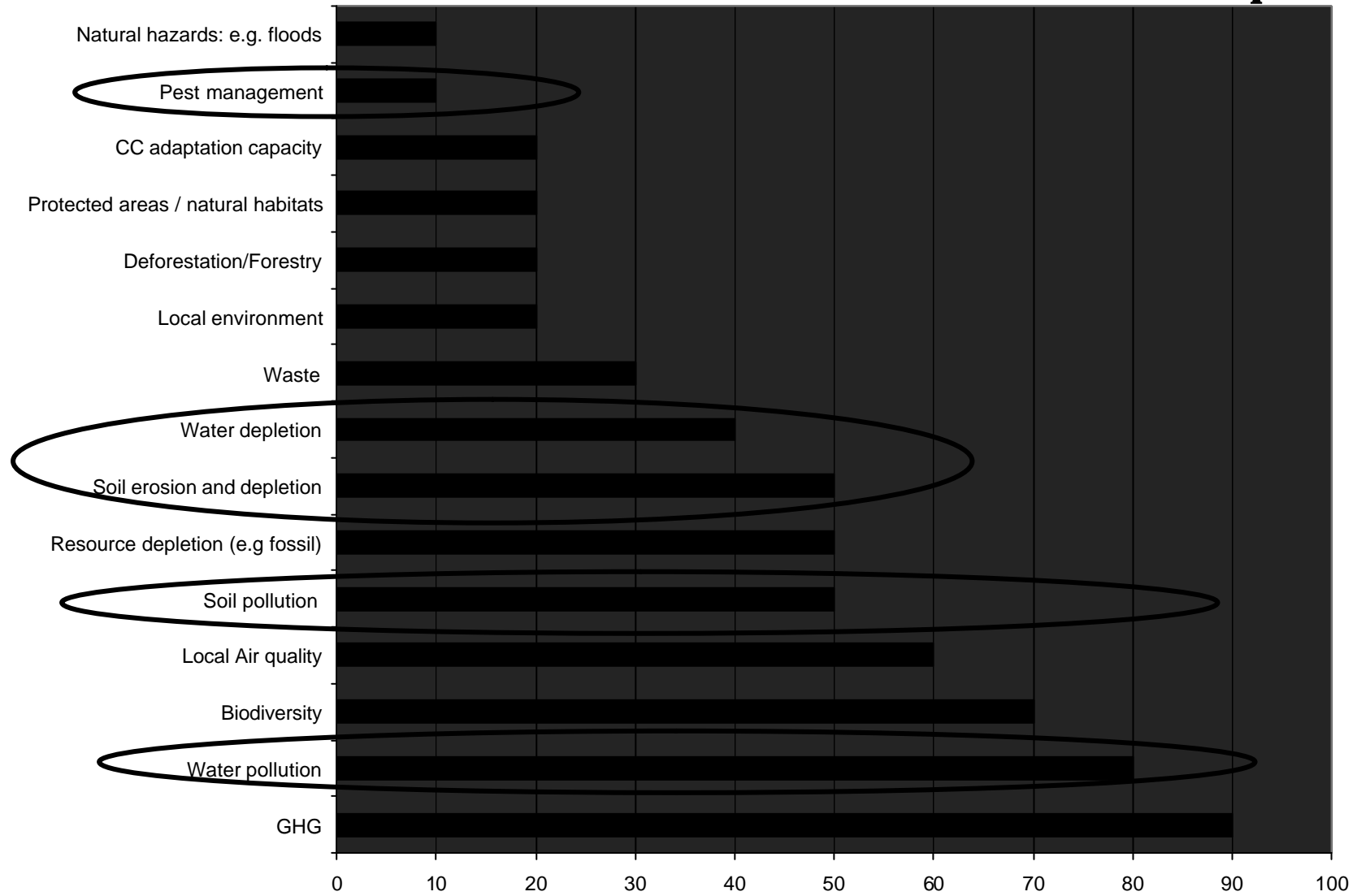


Reference to economic criteria in the 9 studies considered in percent



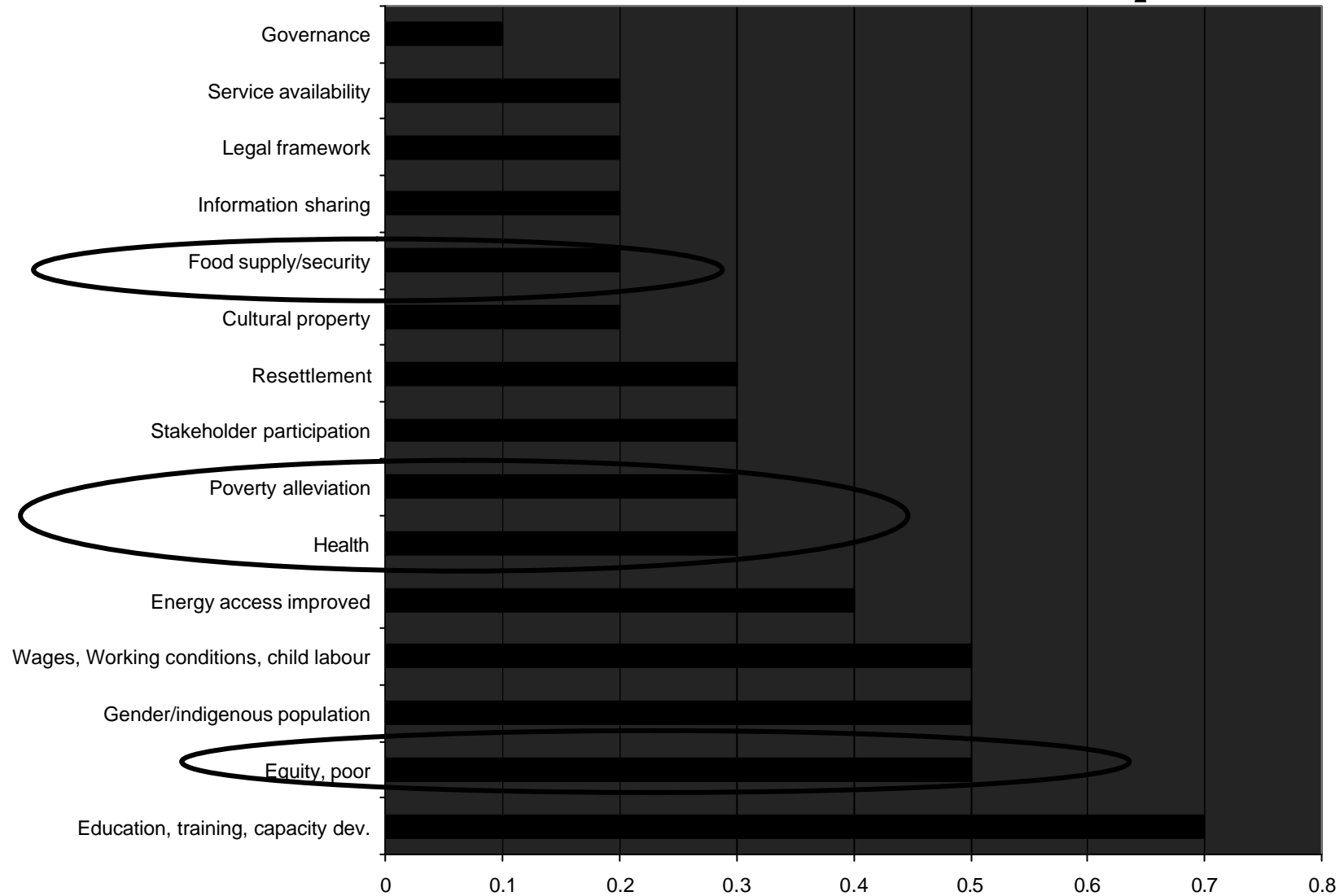


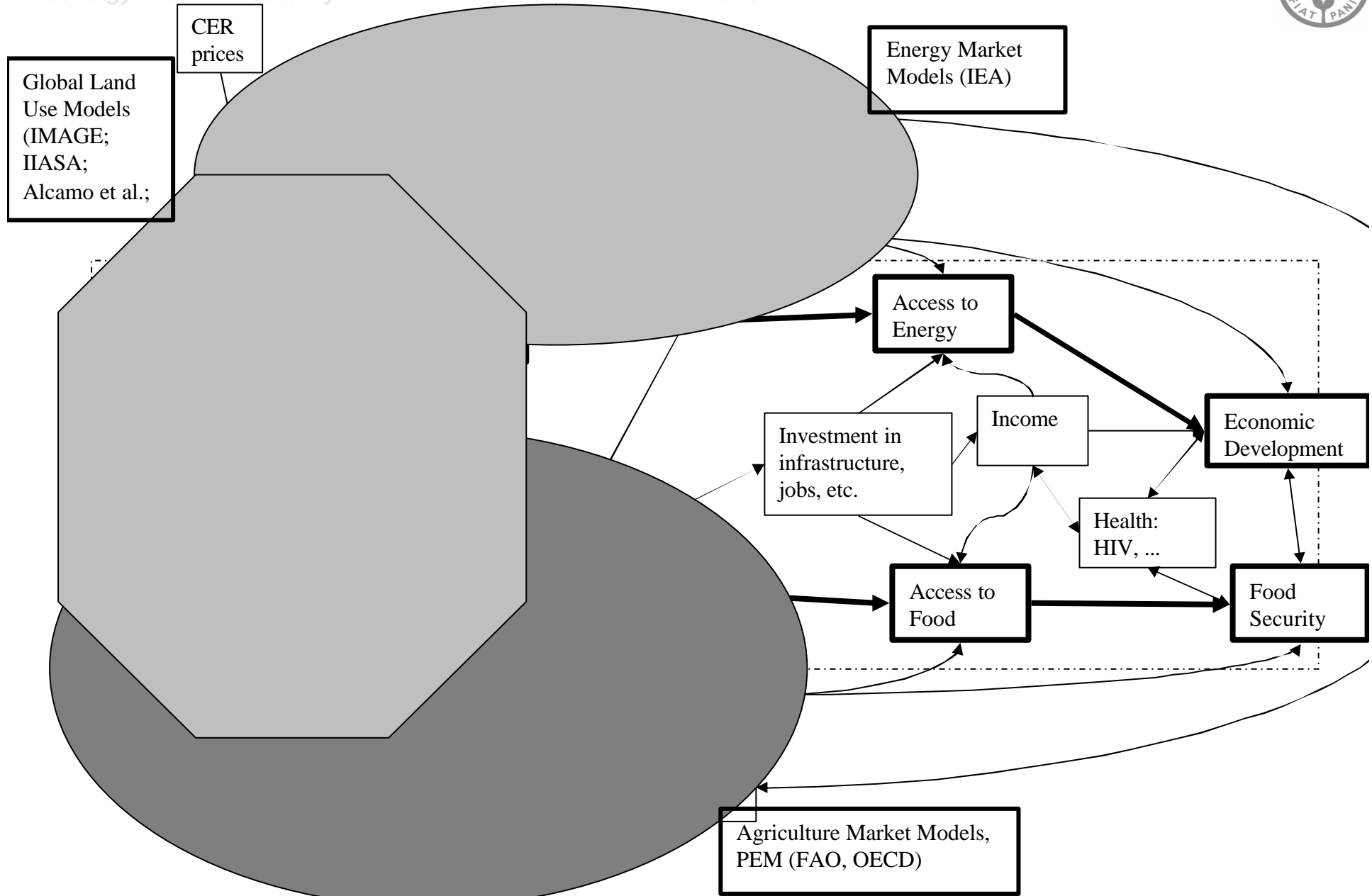
Reference to environmental criteria in the 10 studies considered in percent





Reference to social criteria in the 10 studies considered in percent

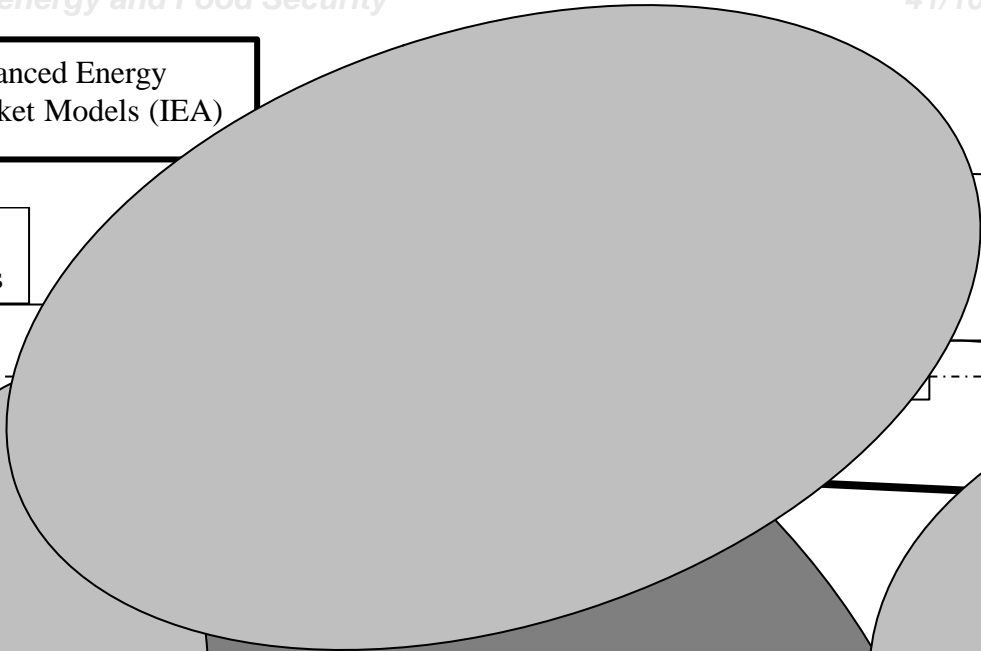




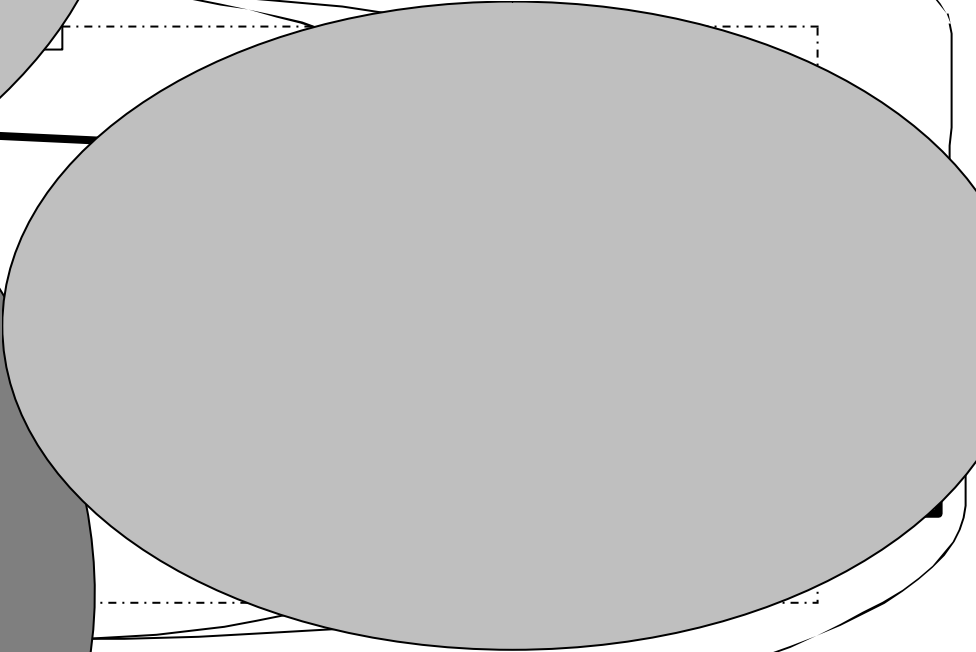
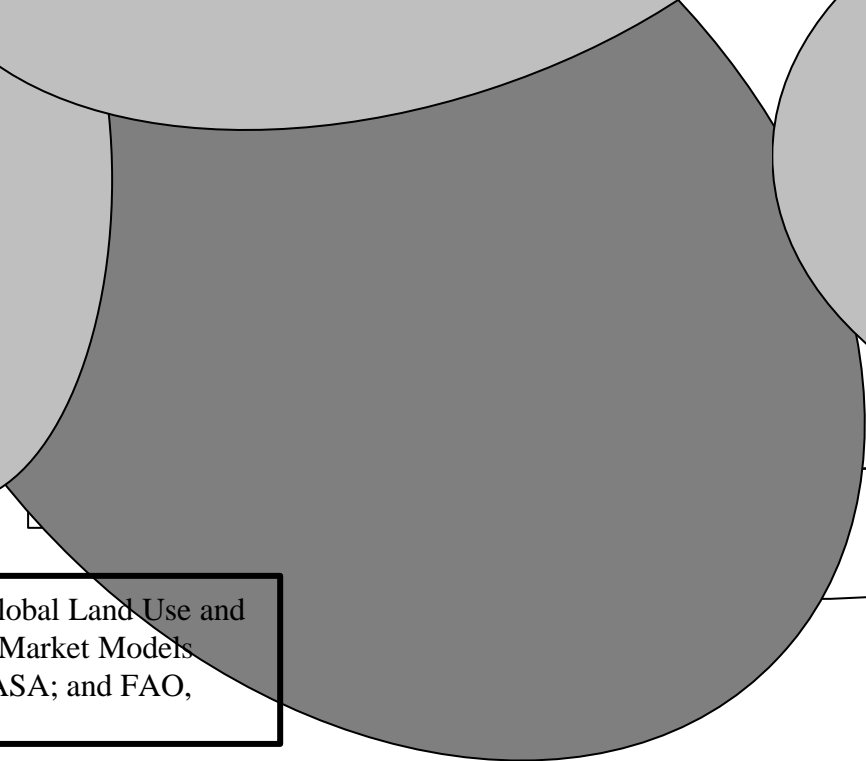


Enhanced Energy
Market Models (IEA)

CER
prices



Bottom-up Assessment of
the Bioenergy and Food
Security Nexus



Combined Global Land Use and
Agricultural Market Models
(IMAGE, IIASA; and FAO,
OECD)



Learning from the Carbon market?

- **Bioenergy projects do meet some of the sustainability criteria identified as relevant, by having to comply with the specific requirements of the funding arrangements under which they operate, i.e.:**
 - ✍ General requirements for World Bank projects, for example the environmental safeguard policies
 - ✍ Fund specific requirements, for example small-scale and community benefits under the CDCF
 - ✍ Simple limitation in size: small scale projects, as separate category of project types

- **Participation in voluntary certification schemes is a possibility**
 - ✍ The Gold Standard
 - ✍ The Community and Biodiversity (CCB) standards



Conclusions

- **The role of food production and thus competition for land might be overstated**
- **Food security and bioenergy systems are characterised by very complex interactions between the macro and micro level**
- **PEM (AG), Energy Models, and Global Land Use Models can be useful in determining the overall boundary conditions and some input variables for the evaluation of food security and bioenergy**
- **A careful, local/national analysis is required to qualify the different determinants of the food security and bioenergy nexus**



Conclusions II

- **The results of this bottom-up can feed back into the design of effective policies and the macro-models for LU, Energy and AG**
- **For synchronising and/or coordinating the global modeling efforts a coordinating mechanism, forum or meeting point and respective incentives for collaboration for the different modeling communities should be created**
- **For the country level analysis, FAO would like to stimulate the formation of national task forces, subject to the interest of bioenergy producing member countries**
- **FAO's International Bioenergy Programme, to be launched next year, will offer a reference and framework for a concerted analysis of sustainable bioenergy in general and the bioenergy and food security nexus in particular**



Further and general conclusions

- **Large potential for bioenergy in developing countries; as energy source, bioenergy is becoming increasingly competitive**
- **Externalities can be significant: large potential benefits but opportunity costs regarding land use of large scale projects are of concern**
- **Large climate change mitigation potential of bioenergy**
- **The delivery of SD co-benefits is not automatic. It would be strengthened by an institutionalization of externalities valuation in the Energy market.**
- **Other drivers might be more important in the future (ex.: oil prices)**



DANKE



Quantity

- **At least US\$ 10 Billion in ERs are expected until 2010**
- **The Worldbank Pipeline includes ER worth US\$ 544 Million ((as of November 2004), including 10% Bioenergy, and the commitment of funding by the CF of the Worldbank equals US\$ 845 Million.**
- **Foreign direct investment: US\$ 172 billion in 2004**
- **Official development aid: US\$ 47.4 billion in 2004 the estimated US\$1 billion per year of carbon payments (IISD 2005) is very low.**
- **Estimated expenditure in the energy sector:**
 - ✍ annual fossil subsidies in the OECD and 20 largest countries outside the OECD amounted to US\$ 58 billion (in 2001)
 - ✍ global subsidies to fossil fuels and nuclear energy in mid-1990s reached around US\$ 250-300 billion