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Global Impacts of Climate Change on Water, Agriculture and Food, and Implications for South Asia

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Outline

- Climate Change Impacts on South Asian Agriculture
- Pro-Poor Mitigation Potentials and Synergies with Adaptation
- Conclusions

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Impacts on Asian Agriculture

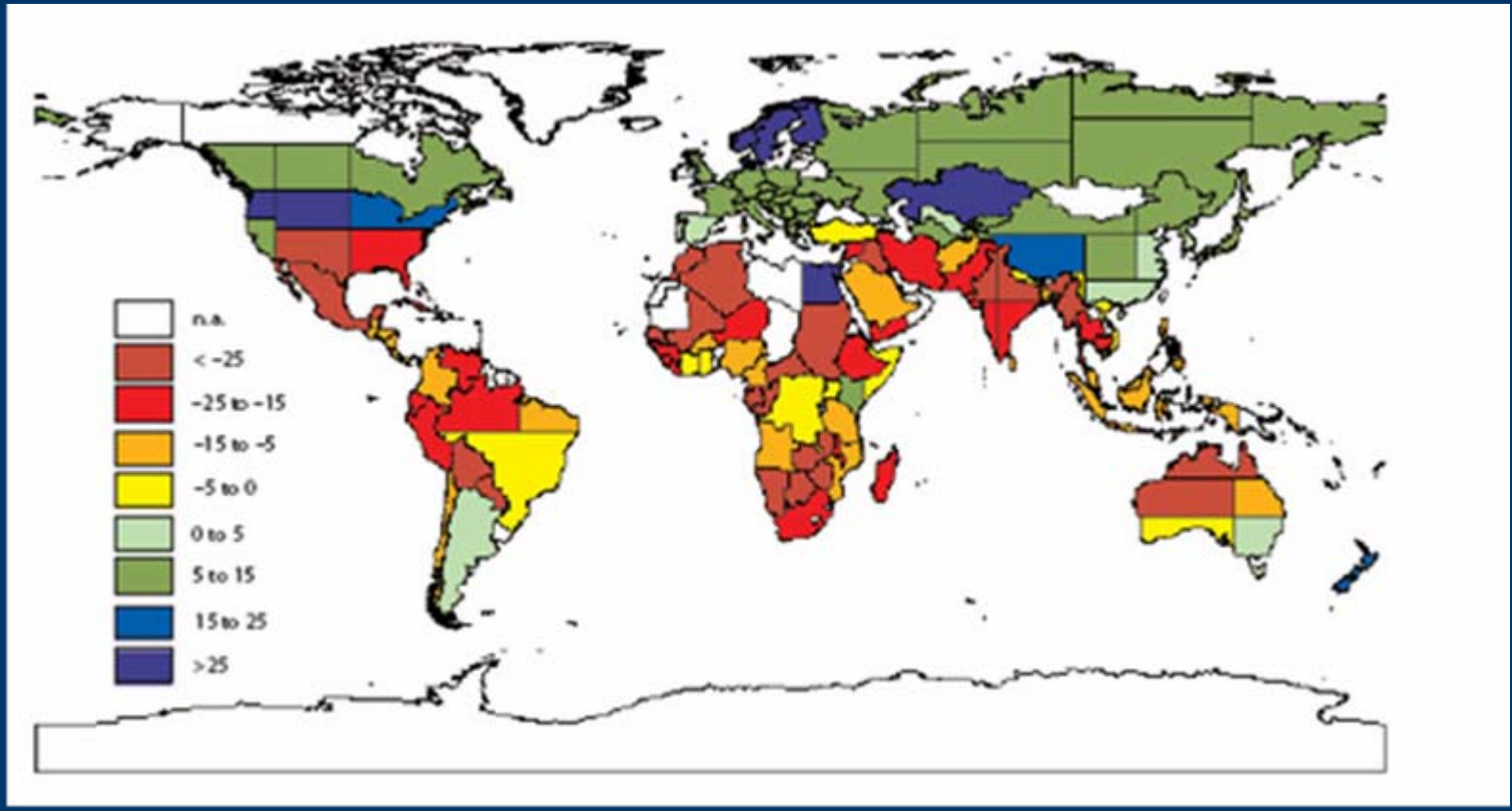
Impacts and Vulnerability

- Rich countries: majority of GHG emissions
- Poor countries: more vulnerable
  - Geography (hotter, less rain, more variation)
  - Greater dependence on agriculture and natural resources
  - Limited infrastructure and low-input agriculture
  - Low income, poverty and malnutrition
  - Limited adaptive capacity

Methodological Comparisons: IMPACT (2008) and Cline (2007)

	IMPACT (2008)	Cline (2007)
Scenario	SRES B2	SRES A2
Level of study	Sub-national level (river basin level)	Country
Projection year	2050	2080
Temperature and carbon fertilization effects on crop yield	√	√
Explicitly simulates water availability and irrigation under changed climatic conditions	Done	No
Explicitly simulates international trade and price effects on yield	Done	No
Explicitly projects food demand in future periods	Done	No

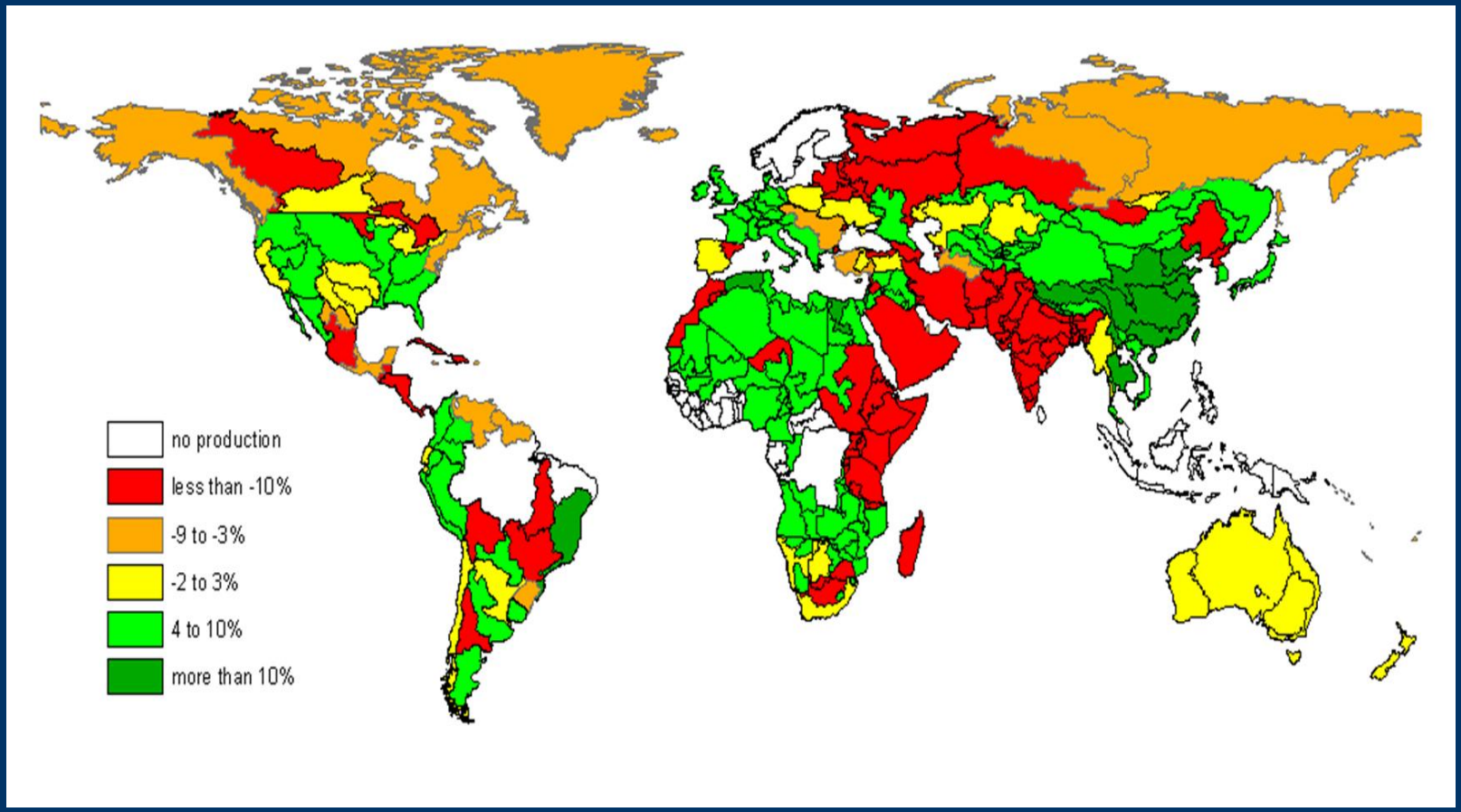
Impact on agricultural productivity with carbon fertilization (%)



n.a. – not applicable for Alaska, Northern Canada and Antarctica

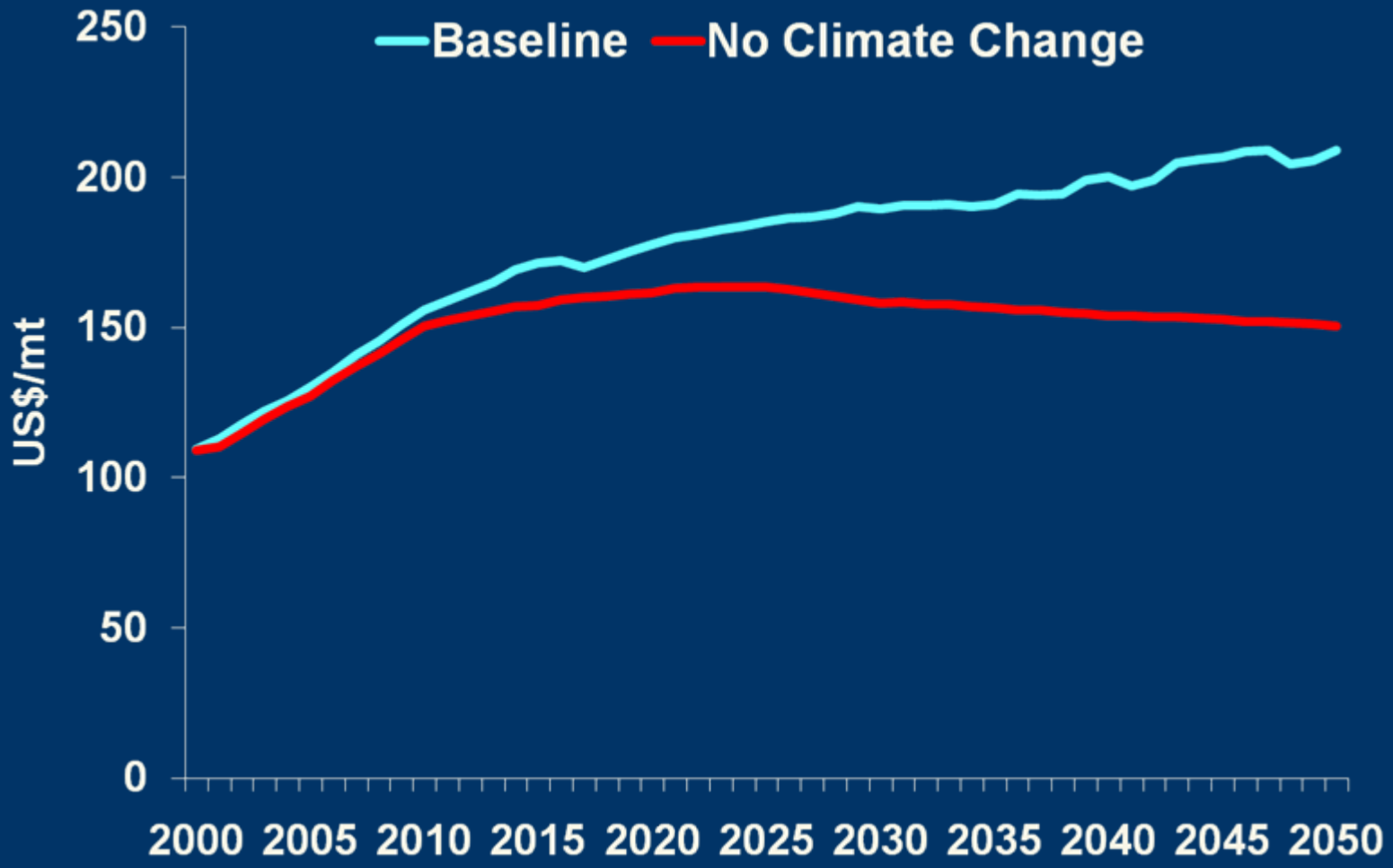
Source: Cline 2007

Change in Wheat yield (%) due to climate change with hydrologic effects, 2050



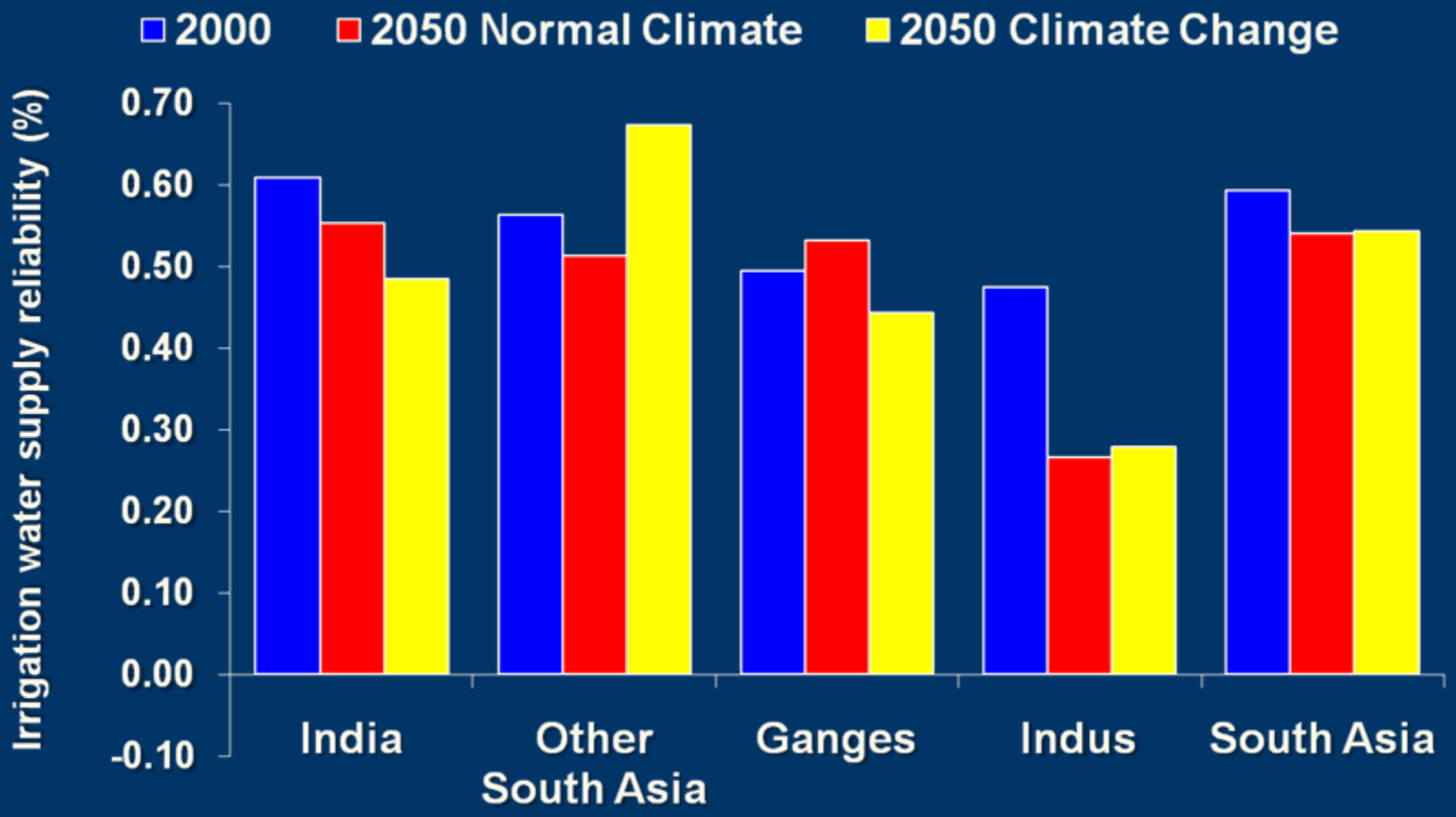
Source: IFPRI IMPACT simulations for HadCM3/SRESB2 scenario (with IMAGE temperature and CO2 fertilization effects), April 2008

Global Price of Wheat: Baseline and Without climate change, 2000-2050



Source: IFPRI IMPACT simulations for HadCM3/SRESB2 scenario (with IMAGE temperature and CO2 fertilization effects), April 2008

Increasing Water Scarcity



Source: IFPRI IMPACT simulations, April 2008

Agricultural impacts with and without carbon fertilization, 2080

	Base Output ($ billion 2003)	Population (million)	Change in Agricultural Potential (%)	
			Without carbon fertilization	With carbon fertilization
Asia	500	3,362	-19.3	-7.2
China	213	1,288	-7.2	6.8
India	132	1,604	-38.1	-28.8
Indonesia	35	215	-17.9	-5.6

Source: Warren 2006

Varying and Unpredictable Impacts on Agricultural Production in Asia

- Estimated impacts depend on
  - Crop, degree of warming, degree of carbon fertilization and adaptation, modeling approach taken
- Evidence indicates the following likely impacts
  - Most negative in South Asia and Central and Western Asia
  - Other regions in Asia will likely face declines in wheat, rice, and maize yields - smaller than in South Asia
  - Parts of China and East Asia with slight increases in production for some crops
- Globally, decline in agricultural production due to climate change
  - Results in higher food prices
  - Poor consumers will face reductions in food security and well-being

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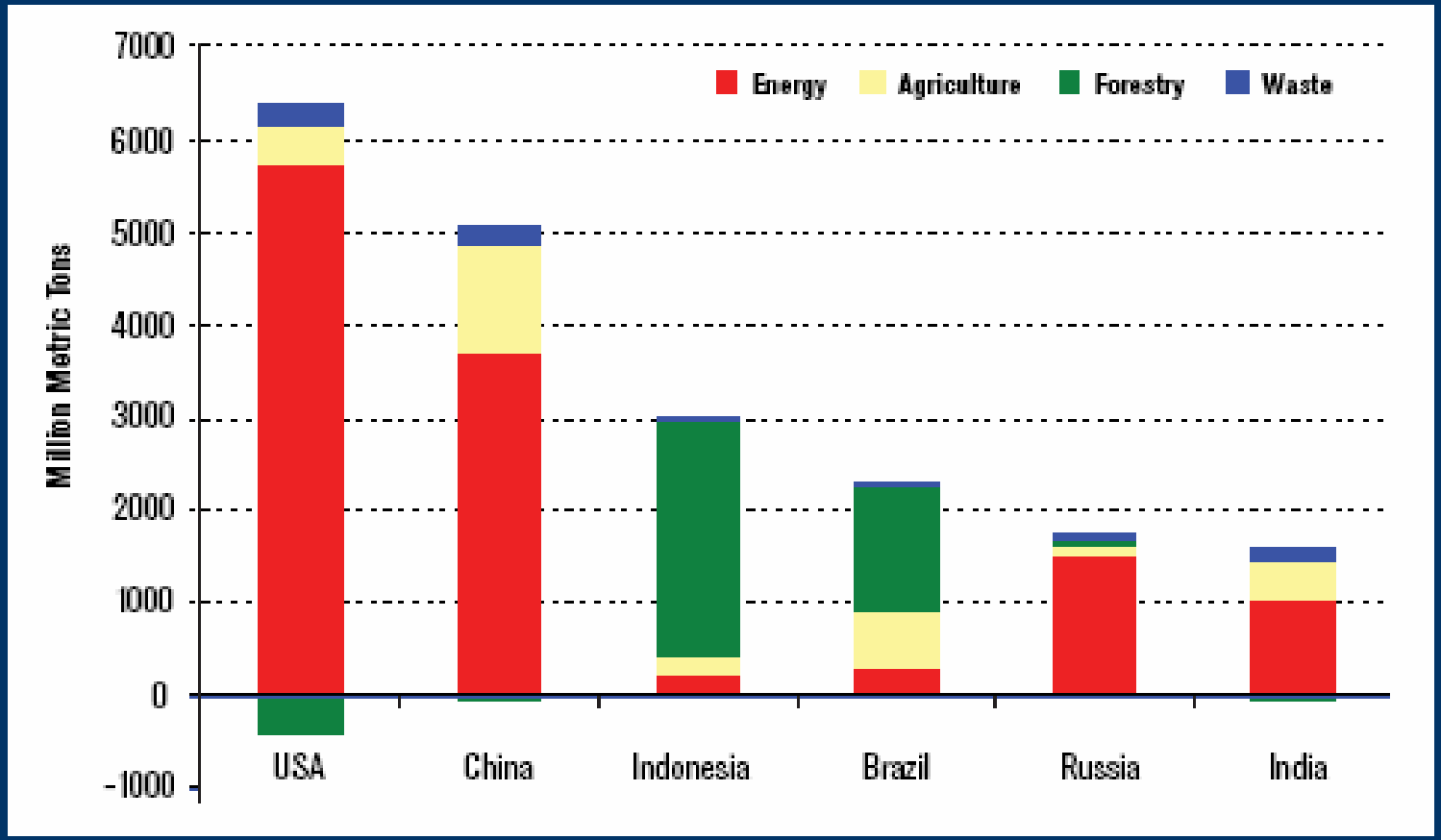
Pro-Poor Mitigation and Synergies with Adaptation in Agriculture

Why Mitigation?

Mitigation and adaptation are both essential

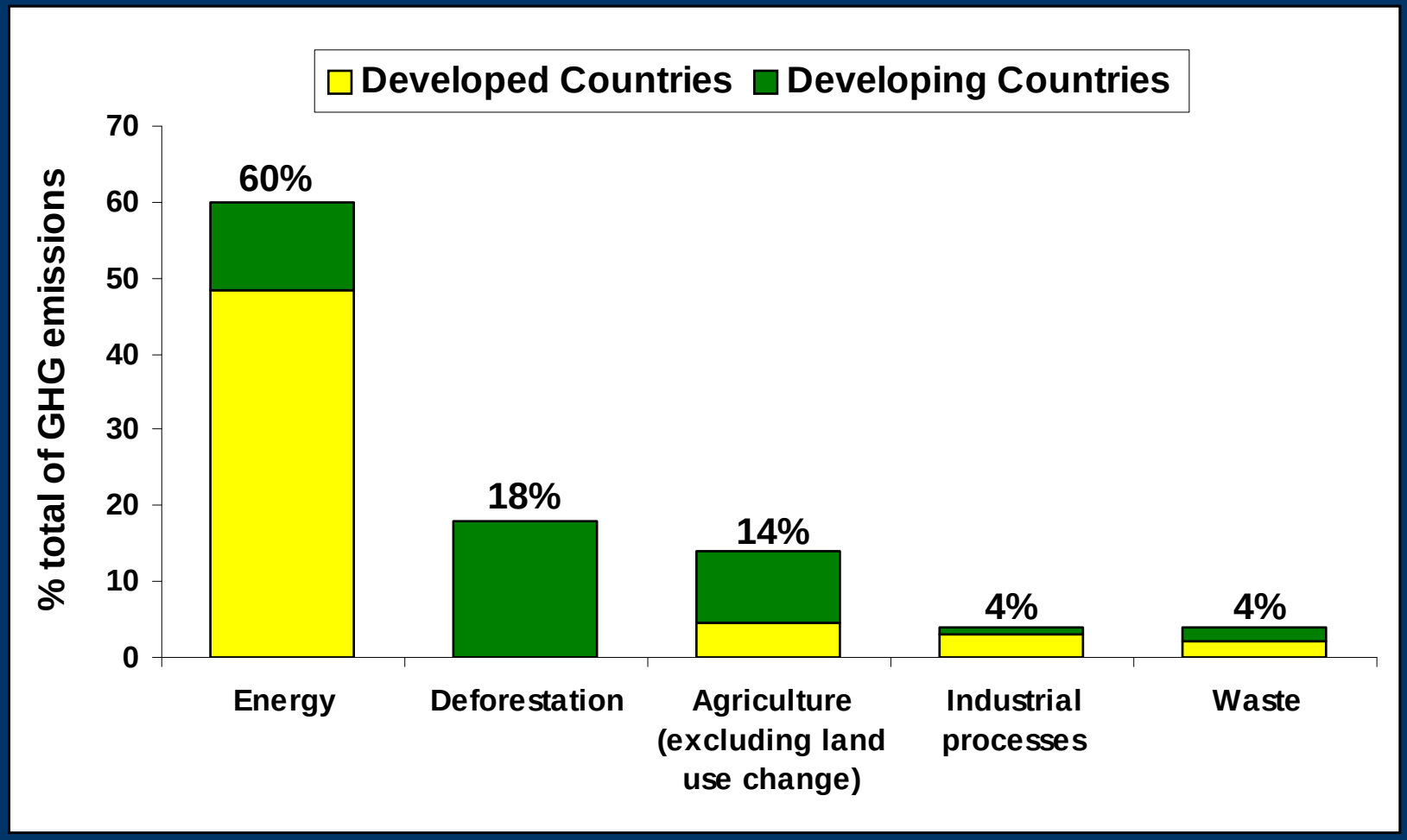
- **Human-caused climate change is already occurring**
- **Adaptation efforts are already taking place and must be expanded**
- **But adaptation becomes costlier and less effective as the magnitude of climate change grows**
- **The greater the amount of mitigation that can be achieved at affordable cost, the smaller the burden placed on adaptation and the smaller the suffering**
- **Effective mitigation generates incomes in rural areas, increasing adaptive capacity**

Largest Global CO_2 Emitters



Source: World Bank and IEA 2007; USEPA 2005; Houghton 2006

Sources of GHG Emissions

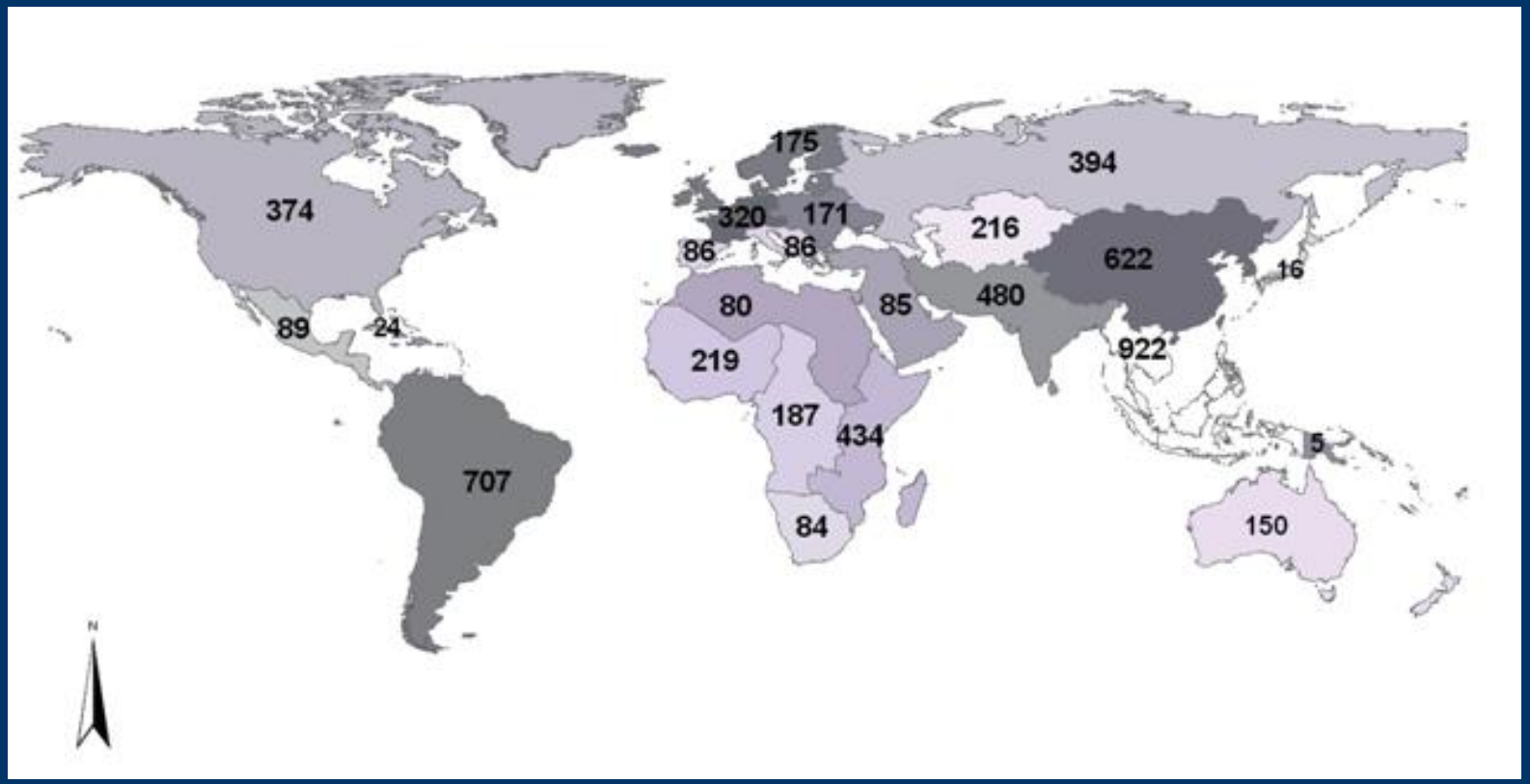


Sources: World Resources Institute 2007; World Development Report 2008

Strategies for GHG Mitigation in Agriculture

- On-farm GHG emissions reductions through
  - Farming systems management
  - Technology
- Carbon sequestration in soils
  - Enhancing the stock of soil
- Bioenergy production
  - Displaces GHG emissions from fossil fuel use

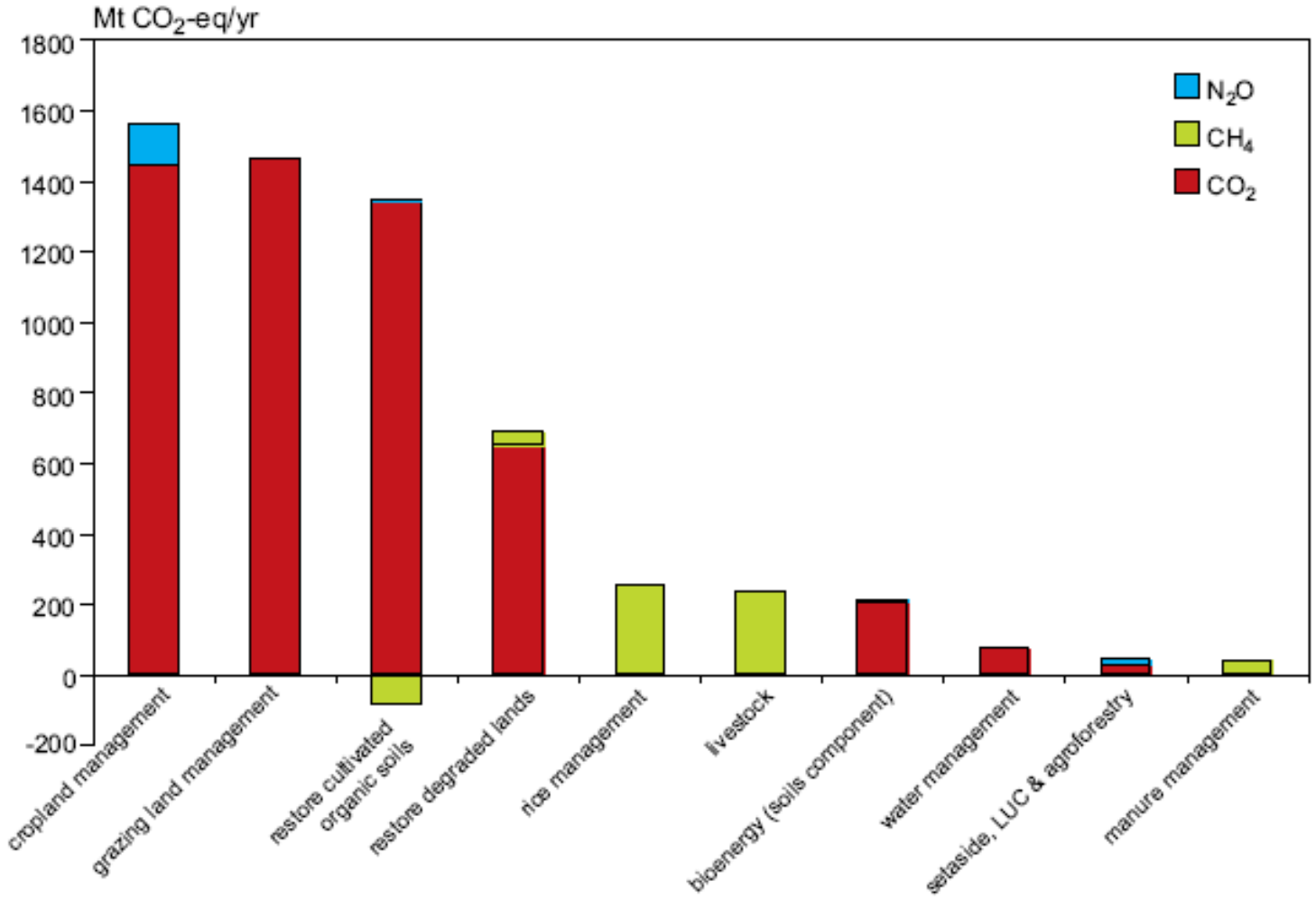
Total Technical Mitigation Potential by Region, 2030



Note: technical mitigation potential includes all practices, GHGs and Mt CO_2-eq/yr. The above figure is based on B2 scenario though the pattern is similar for all SRES scenarios

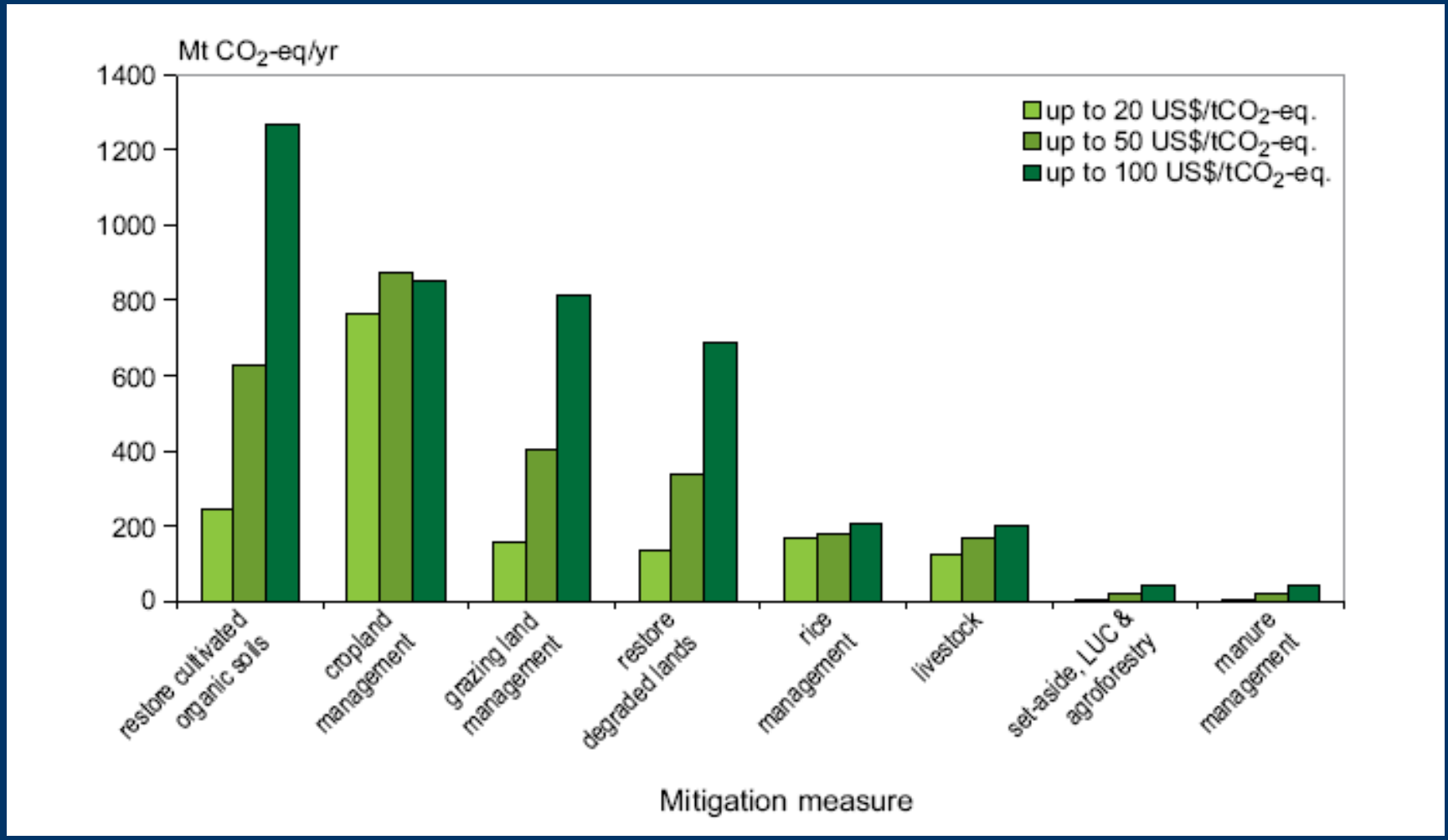
Source: Smith et al. 2007

Global technical mitigation potential in each agricultural management practice showing impacts of each practice on GHG, 2030



Source: Smith et al 2007

Economic potential for GHG agricultural mitigation at a range of prices of CO_2-eq, 2030



Source: Smith et al 2007

Pro-Poor Climate Mitigation Policy

- Agricultural mitigation policy
  - Can generate income for small farmers
  - Investment flows for rural communities
  - Co-benefits from improved soil fertility and long term productivity growth

- Required: Effective integration from global governance of carbon trading to sectoral and micro-level design of markets and contracts

Potential Emission Savings and Costs by Sector

Sector	2050 Annual Emissions Savings ($GtCO_2$)	Average Annual Cost($/tCO_2$) ~2025-2050
Deforestation	3.5-5.0	2-4
Afforestation and Reforestation	1.0-2.0	5-15
Land management practices	3.0-4.0	20-27
Agriculture (methane & nitrous oxide)	1.0	27
Bioenergy	2.0-3.0	25
Waste and fugitive emissions, industrial processes	4.1	3-5
Fossil fuel related, excluding bioenergy	40.0	22-33

Source: Adapted from various estimates, Stern Review, pp. 244-63

High Potential for Pro-Poor Mitigation

- Annual Official Development Assistance = $100 billion
- Foreign direct investment in developing countries = $150 billion
- Potential annual cost of GHG emissions reductions in developing countries = $150-250 billion
- *Or* a $150-250 billion *value* stream with appropriate policies

But . . . .minimal carbon trades in agriculture in developing countries

- Only 3-4% of carbon trading is sourced from agriculture, land use, land use change, agroforestry and forestry

Constraints to Pro-Poor Mitigation

1. High transaction costs of Clean Development Mechanism (CDM) Conditions for Offset Projects in Developing Countries
   - Additionality, measurability, permanence, leakage prevention, social benefits, environmental benefits
   - Information about
     - carbon benefits to potential buyers
     - project partners
     - project management
   - Transaction costs higher for projects involving many smallholders

Constraints to Pro-Poor Mitigation

2. Carbon sequestration from soil carbon and avoided deforestation are excluded from CDM

3. CDM-eligible assets from afforestation and reforestation excluded from European Union-Emissions Trading Scheme

Expanding Pro-Poor Mitigation

1. Inclusion of agriculture in post-Kyoto carbon trading arrangements
2. Institutional innovations linking communities to global markets - Establish regional centers for carbon trading, specialized business services and local intermediaries
3. Simplified standards (baseline and monitoring) for small-scale projects - simplified emission reduction credits calculated using standardized reference emission rates
4. Dealing with permanence issue in carbon sequestration – Allow short term contracts, payment for mass-time units of carbon

Synergies between Adaptation and Mitigation

- Practices that increase the resilience of production systems may also reduce emissions or sequester carbon
- Strategies to conserve soil and water resources also enhance ecosystem functioning, providing resilience against droughts, pests, and other climatic threats
  - Restoring degraded soils
  - Agro-forestry

Synergies between Adaptation and Mitigation

- Adaptation can also come at the expense of mitigation
  - Intensified use of nitrogen fertilizer to improve food production also increases nitrous oxide emissions
- To maximize synergies and reduce trade-offs, mitigation and adaptation strategies should be developed together, recognizing that in some cases *hard decisions will need to be made between competing goals*

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Conclusions

Improve Knowledge

- Better understanding of spatially-disaggregated impact of climate change
- Include international trade and economic effects in climate change impact analysis
- Spatial targeting of types, costs, benefits of adaptation
- Spatial targeting of potential benefits and costs of mitigation

Mitigation: Include Agriculture

- Reform global architecture on climate change policy
- Enhance global financial facilities and governance to increase and manage funding flows
- Simplify management of carbon trading
- Employ advanced ICT to streamline implementation, monitoring, and evaluation

Agricultural Research and Technology

- Re-invest in crop productivity: agricultural research, rural infrastructure and IT investment, water and soil management
  - Emphasis on crop breeding for both irrigated and rainfed agriculture
    - Targeted spatially and to abiotic and biotic stresses
  - Water harvesting, minimum tillage, integrated soil fertility management
  - Rural investment to improve access to markets, credit, inputs

Integrate Pro-poor Policies For Growth and Environmental Sustainability

- Establish economic incentives for water use
- Expand markets for environmental services (watershed management, biodiversity)
- Develop markets for agricultural and forest carbon, generating new value streams in rural areas through carbon mitigation
- Income generation with sustainable growth