Land degradation through the lens of climate change adaptation and mitigation: new impetus for dealing with an old problem?

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ECONOMICS & POLICY INNOVATIONS FOR CLIMATE-SMART AGRICULTURE

Value of Land Degradation?

- Land degradation widespread and recurring problem

- Often assumed that there is a net positive value of avoiding degradation higher to farmers but evidence is not so clear.

- Externality value of avoided degradation is often found to be higher than private values

Private and public costs of land degradation: a quick summary

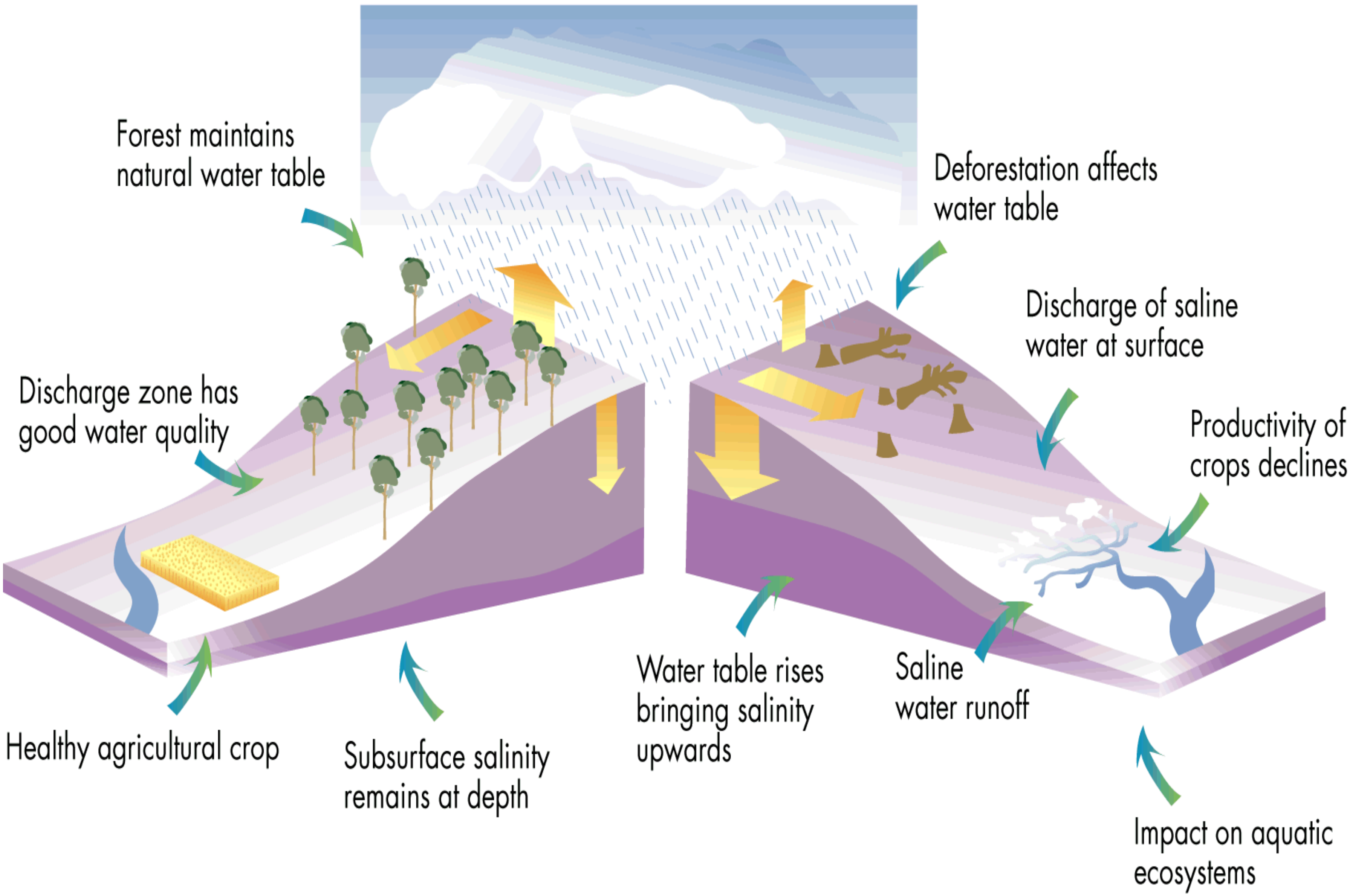
Private costs:

- Reduced productivity (.04-100% yield decline per annum) Yadav and Scherr 1995
- Reduced returns (.04-8 % of ag gross product) Bojo 1990
- Total factor productivity (Soil quality complementary to fertilizer) Walker & Young 1986
- Increased risk (higher yield variability in depleted soils Zimbabwe Moyo 1998)

Public costs:

- Water pollution (McConnell 1983)
- Siltation of waterways (Pagiola 2006; Muñoz 2007)
- Watershed functions (Branca et. al. 2005)
- Increased risk (landslides) (Holt-Gimenez 2001)

THE WATER CYCLE AND DRYLAND SALINITY



Land degradation and impacts on food security (Wiebe 2003)

- At global level, limited impact of degradation mainly due to:
  - limited impacts of degradation in temperate vs. tropical zones
  - more cost efficient practices to offset, in temperate zones vs. tropical zones

- At regional and national levels, impacts vary widely; significant evidence suggests strong negative impacts in Southeast Asia, Africa and parts of Latin America, particularly in countries with highly erodible soils (e.g. hilly/mountainous)

- Ambiguous evidence, and a lot of debate on ability to "substitute" external inputs for land quality, and on cost-effectiveness of halting and reversing degradation in tropical environments

Value of land management – w/out CC

- Major effort to build Payment for Environmental Service (PES) programs to support better land management

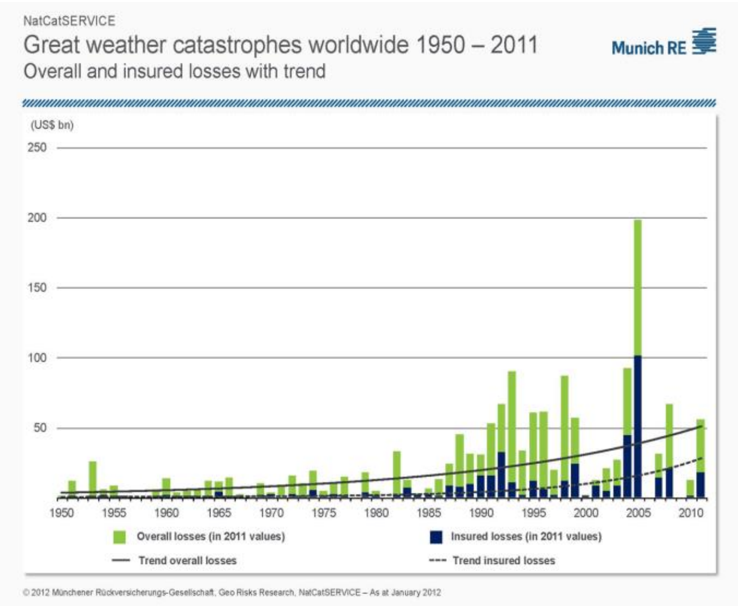
- Some successes (China sloping lands; Costa Rica; Tanzania) but problems with linking improved land management with quantified benefits.

And then came climate change…

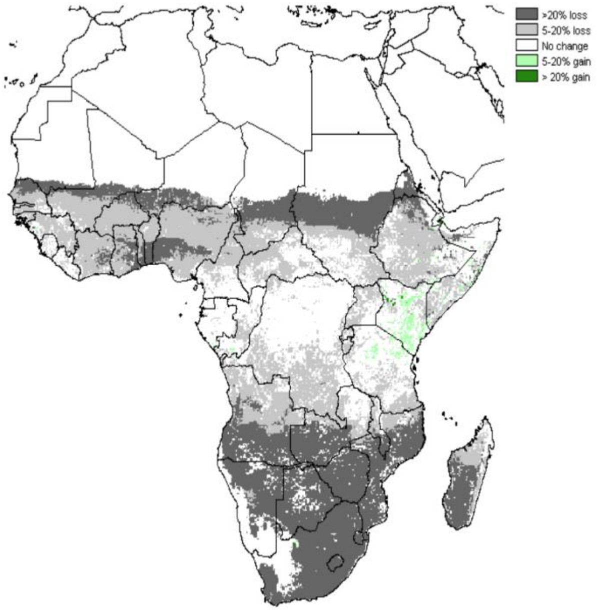
Climate change impacts on agriculture

- Increased variability and intensity of climate shocks in the near term (to 2050) in most areas, but particularly in Sub-Saharan Africa and S. Asia
  - Increased variability increases the value of resilience in agricultural production system
- Changes in temperature and precipitation generate lower yields over long term (with some possibility of local increases up to 2050)

Climate change impacts on agriculture



Change in African growing periods in a +4 °C world



Short run: increased intensity & frequency of shocks

Long run: major changes in temperature & rainfall patterns

Impacts of changes in climate variability on agriculture?

What's the evidence base?

Very thin from CC/AG models:

- IPCC (2007) – "effects of climate variability may be as great as changes in climate means"
- SREX (2012) – 1 page (in 600) on impacts of climate extremes on food systems and food security

But growing empirical, farm level evidence

Evidence that CC effects farmer adoption patterns (Malawi)

	Soil and Water Conservation Adoption	
	Coef.	p-value
Exposure to climate stress		
Coefficient of variation of rainfall (1983 -2011)	0.919*	0.09
Long-term mean rainfall (1983-2011)	0.001	0.11
Average delay in the onset of the rainy season (1983 -2011)	2.164***	0.00
Coefficient of variation of maximum temperature (1983 -2011)	71.597***	0.00
Long-term maximum temperature (1989-2010)	0.003	0.92
Bio-physical sensitivity		
log (land size (acre))	0.088***	0.00
Slope of plot (0=flat, 1=steep)	0.723***	0.00
Nutrient availability constraint (1-5 scale)	0.131***	0.00

Ethiopia – effect of CC variables on adoption of anti-erosion measures

	Anti-Erosion Measures	
	coef	se
Climatic variables		
Coefficient of variation of rainfall	2.656*	1.542
Long-term mean rainfall	-0.002***	0.000
Long-term average temperature	0.089**	0.045
# dekades av. max temp over 30 (1989-2010)	0.002	0.002
Potential Wetness Index	0.024	0.033
Plot and bio-physical characteristics		
Log (land size in hectares)	-0.855***	0.264
Land tenure (1=owner)	0.122	0.119
Nutrient availability	0.356***	0.096
Terrain Roughness	-0.017	0.023
Workability (constraining field management)	-0.244***	0.065

Emerging empirical evidence of adaptation benefits at farm level: Tanzania

Average maize yields & Soil and water c

	Average Maize Yield	
SWC	**2008/09**	**2010/11**
No	1371.0***	1441.9***
	(53.1)	(48.1)
Yes	1862.1***	2037.2***
	(141.3)	(159.6)
T-test		
Difference	491.1***	595.3***
	(127.3)	(136.1)
SD in parentheses		

Changes in agricultural systems	Impacts on Food Production		Impacts on Yield Variability and Exposure to Extreme Weather Events	
	Positive	Negative	Positive	Negative
Cropland Management				
Improved crop/fallow rotations	Higher yields during crop rotation, due to increased soil fertility	Reduced cropping intensity may compromise household food security in short-run	Reduced variability due to increased soil fertility, water holding capacity	
Use of legumes in the crop rotation	Higher yields due to increased N in soil	Reduced cropping intensity may compromise household food security in short-run		
Use of Cover Crops	Higher yields due to reduced on-farm erosion and reduced nutrient leaching	May conflict with using cropland for grazing in mixed crop-livestock systems	Reduced variability due to increased soil fertility, water holding capacity	
Increased Efficiency of N Fertilizer/Manure Use	Higher yields through more efficient use of N fertilizer and/or manure		Lower variability more likely where good drainage and drought infrequent; experience can reduce farm-level variability over time	Potentially greater variability where drought frequent and inexperienced users
Incorporation of Residues	Higher yields through increased soil fertility, increased water holding capacity	Potential trade-off with use as animal feed	Reduced variability due to increased soil fertility, water holding capacity	
Reduced/Zero Tillage*	Higher yields over long run, particularly where increased soil moisture is valuable	May have limited impacts on yields in short-term; weed management becomes very important; potential waterlogging problems	Reduced variability due to reduced erosion and improved soil structure, increased soil fertility	
Live Barriers/Fences	Higher yields	Reduces arable land to some extent	Reduced variability	
Perennials/Agro-Forestry	Greater yields on adjacent croplands from reduced erosion in medium-long term, better rainwater management; and where tree cash crops improves food accessiblity	Potentially less food, at least in short-term, if displaces intensive cropping patterns	Reduced variability of agro-forestry and adjacent crops	
Water Management				
Bunds/Zai	Higher yields, particularly where increased soil moisture is key constraint	Potentially lower yields when extremely high rainfall	Reduced variability in dry areas with low likelihood of floods and/or good soil drainage	May increase damage due to heavy rains, when constructed primarily to increase soil moisture
Terraces	Higher yields due to reduced soil and water erosion, increased soil quality	May displace at least some cropland	Reduced variability due to improved soil quality and rainwater management	

Source: FAO 2009

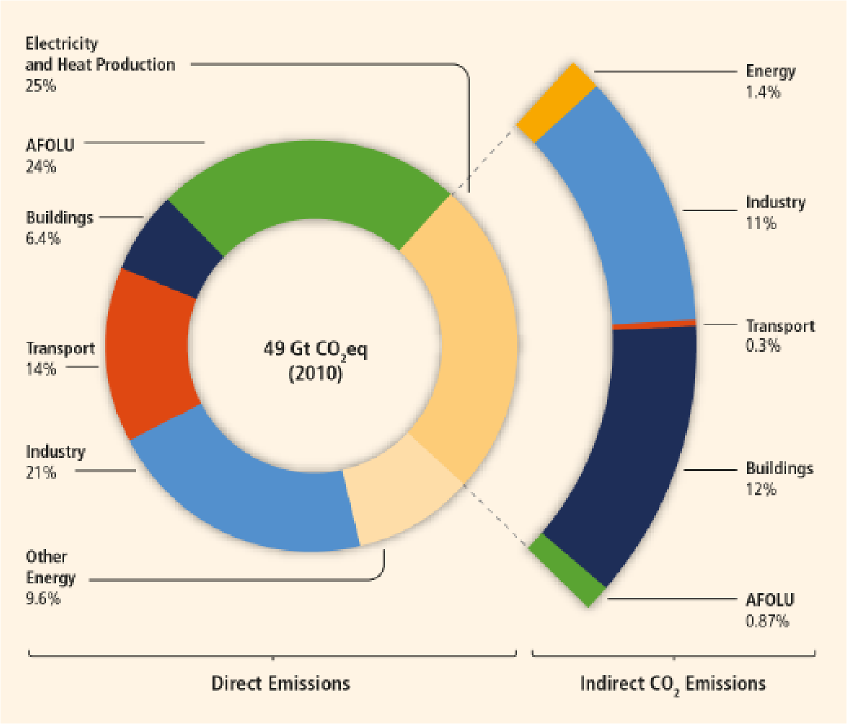
Climate Change Mitigation and Agriculture

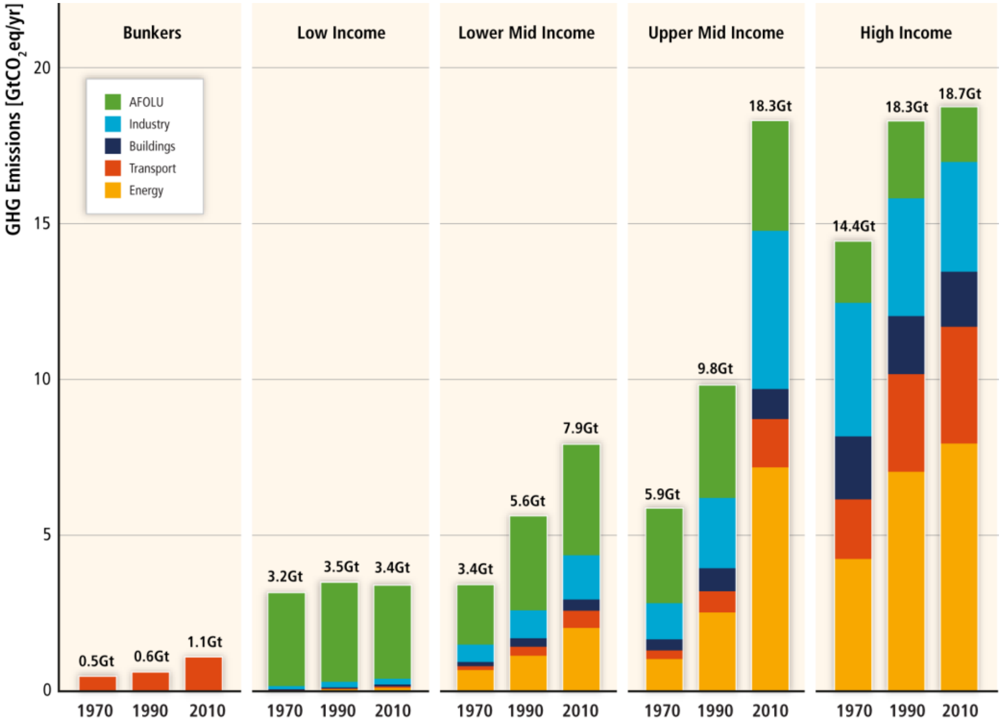
- Emissions from agriculture account for roughly 14% of global greenhouse gas emissions

- 74% of the emission from agriculture and most of the technical and economic mitigation potential from agriculture are in developing countries

- Degraded land restoration and cropland management are two categories with highest economic and technical potential for mitigation.

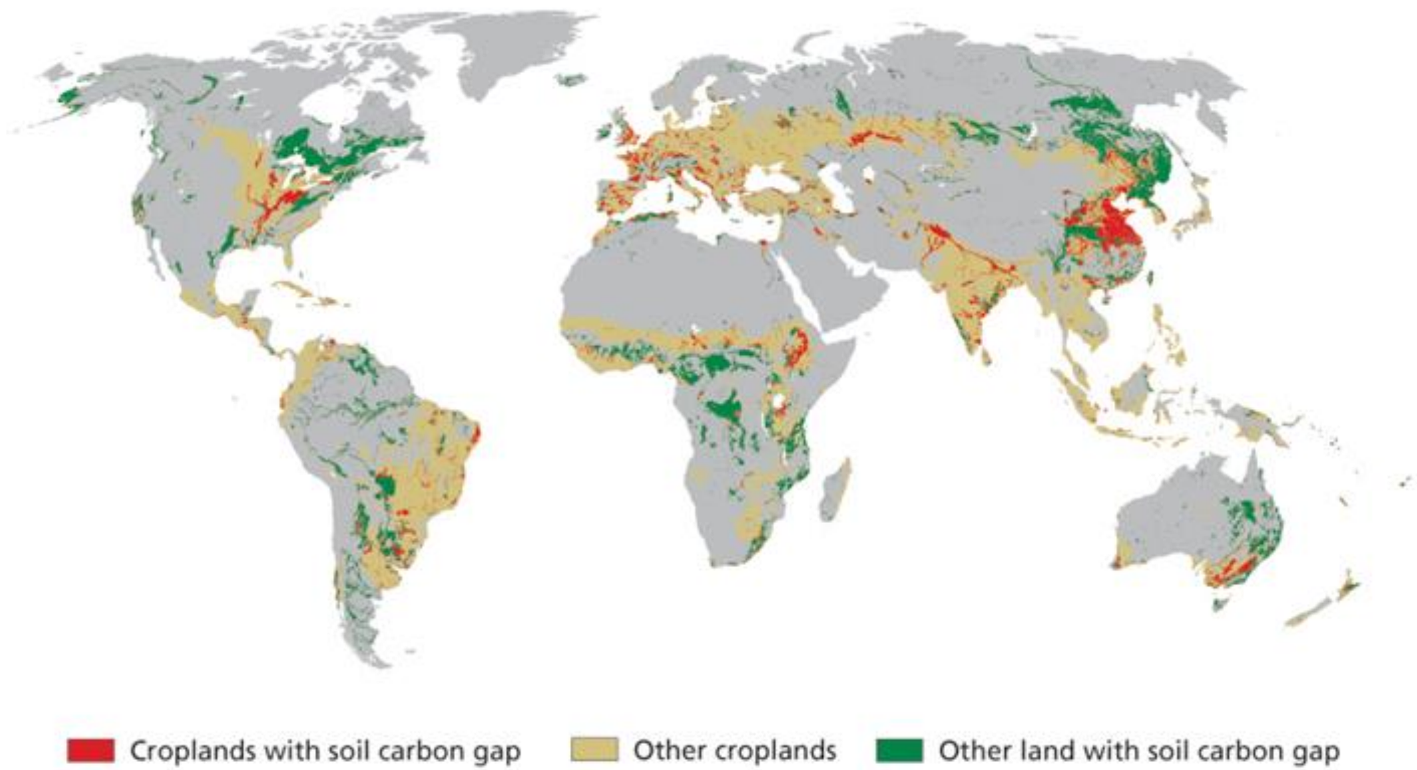
Agriculture – and Land Degradation a major source of GHG emissions…





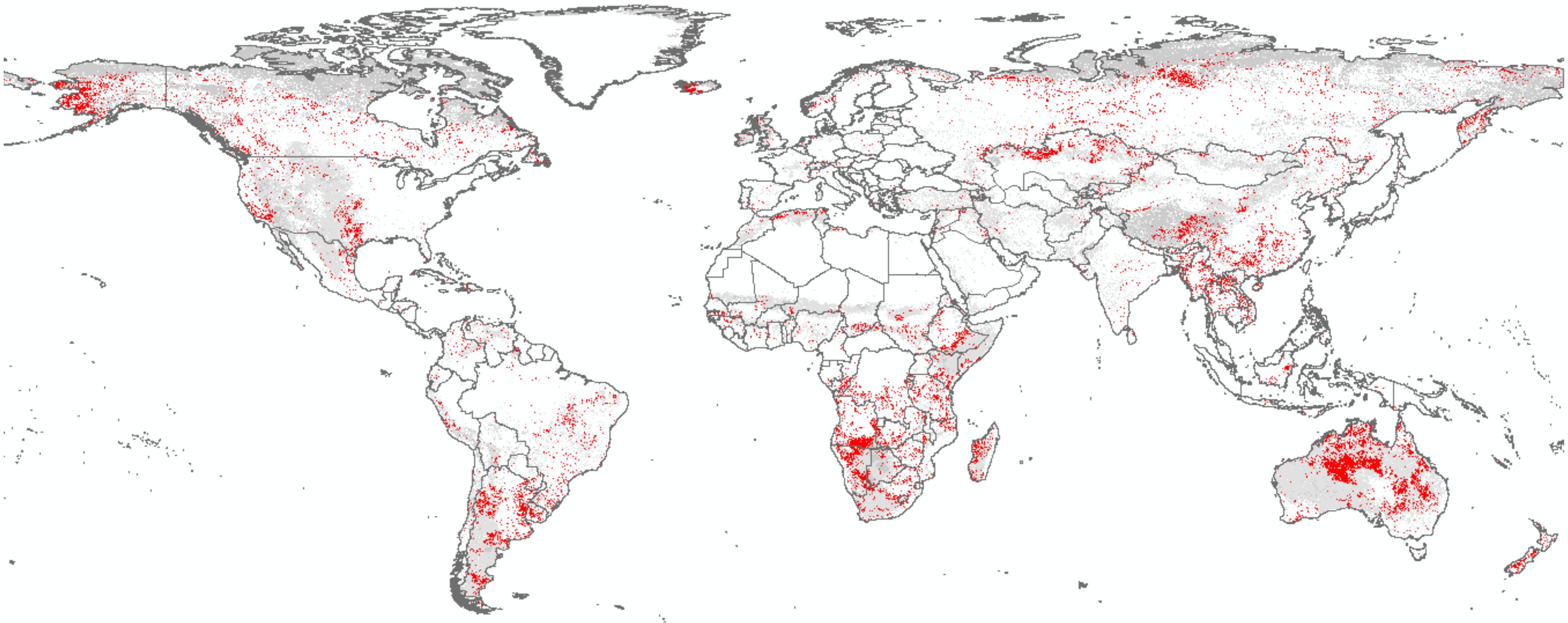
…but also a major potential source of mitigation Technical soil carbon sequestration in croplands

Potential to sequester additional carbon in soils on croplands



Note: available at
http://www.fao.org/geonetwork/srv/en/google.kml?id=31152&layers=potential_sequester_carbon_cropland
Source: FAO.

Degraded grasslands



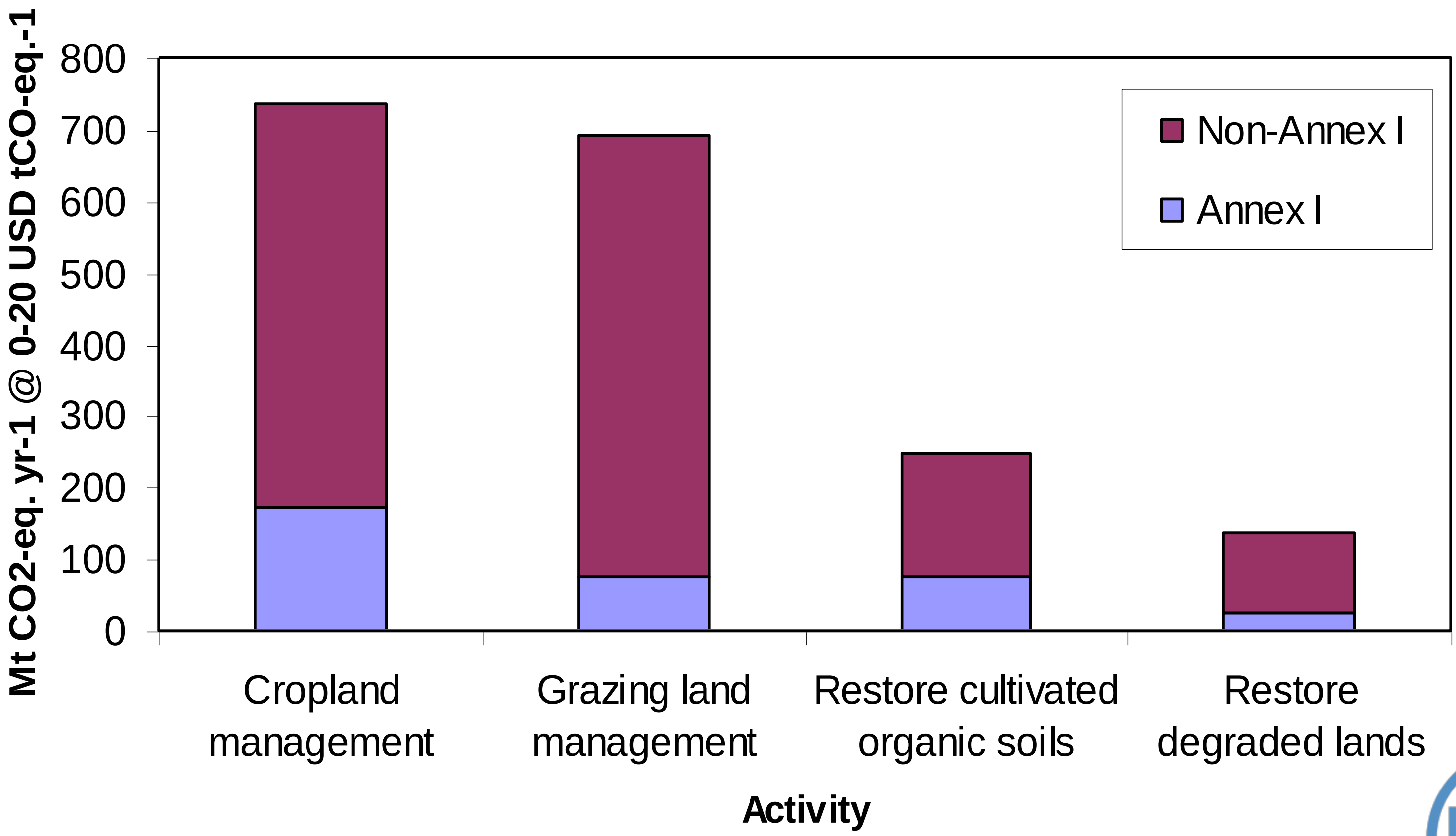
Satellite derived map using NDVI (Normalized Difference Vegetation Index) data from 1981 until 2003. Methods to obtain this map: NDVI is converted to NPP (net primary productivity) and corrected by Rain-Use Efficiency (correct the rainfall variability effect). the trend in time (1981-2003) defines improvements (higher NDVI) or decline of the vegetation

Data: Bai et al. , 2008. FAO / UNEP LADA project

High synergies with agricultural benefits translates into low opportunity costs of implementing

Ag Mitigation Potential @ 0-20USD/tCO2

Large Potential in Non-Annex I countries- possibly high co-benefits



(Smith et al 2008)

Summarizing:
Climate Change & Land Degradation

- Land management/restoration important for adaptation

  Non-degraded land

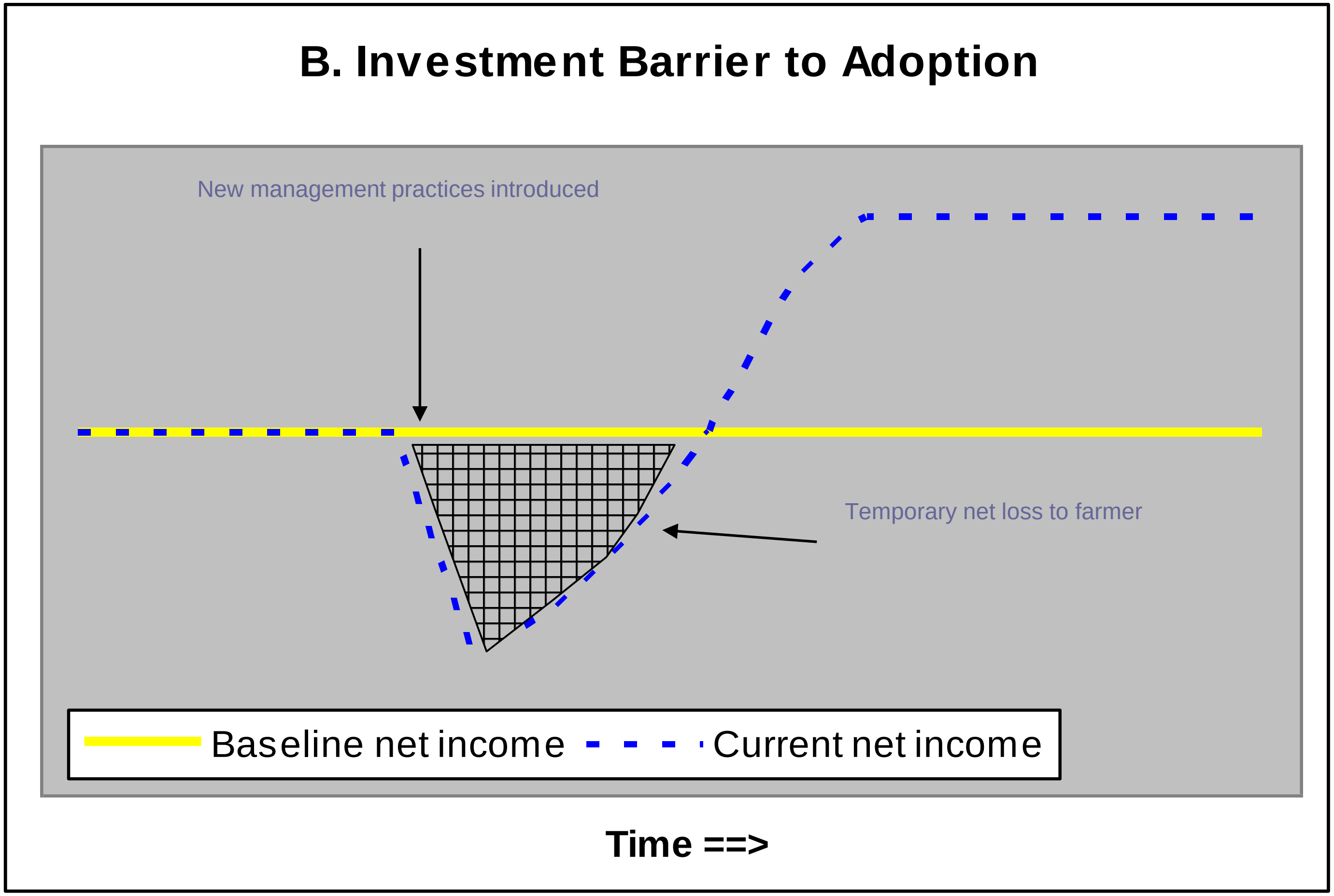
  – Reduces exposure & sensitivity of agricultural production to climate variability
  – Provides more stable and, on average (over long time periods), higher yields

- Land management/restoration important for mitigation
  – Economic potential for mitigation from agriculture highest
  – High synergies with adaptation/productivity

But barriers to adoption are numerous

- Tenure Security: lack of tenure security and limited property rights (limits on transfer), may hinder adoption of SLM
- Limited Access to Information, e.g. very low levels of investment/support for agriculture research and extension. CC adds uncertainty.
- Up-front financing costs can be high, whilst on-farm benefits not realized until medium-long term
  - Local credit markets very thin
  - Local insurance options very limited

Adoption Barriers:
Short run trade-offs & long run win-win



Source: FAO 2007

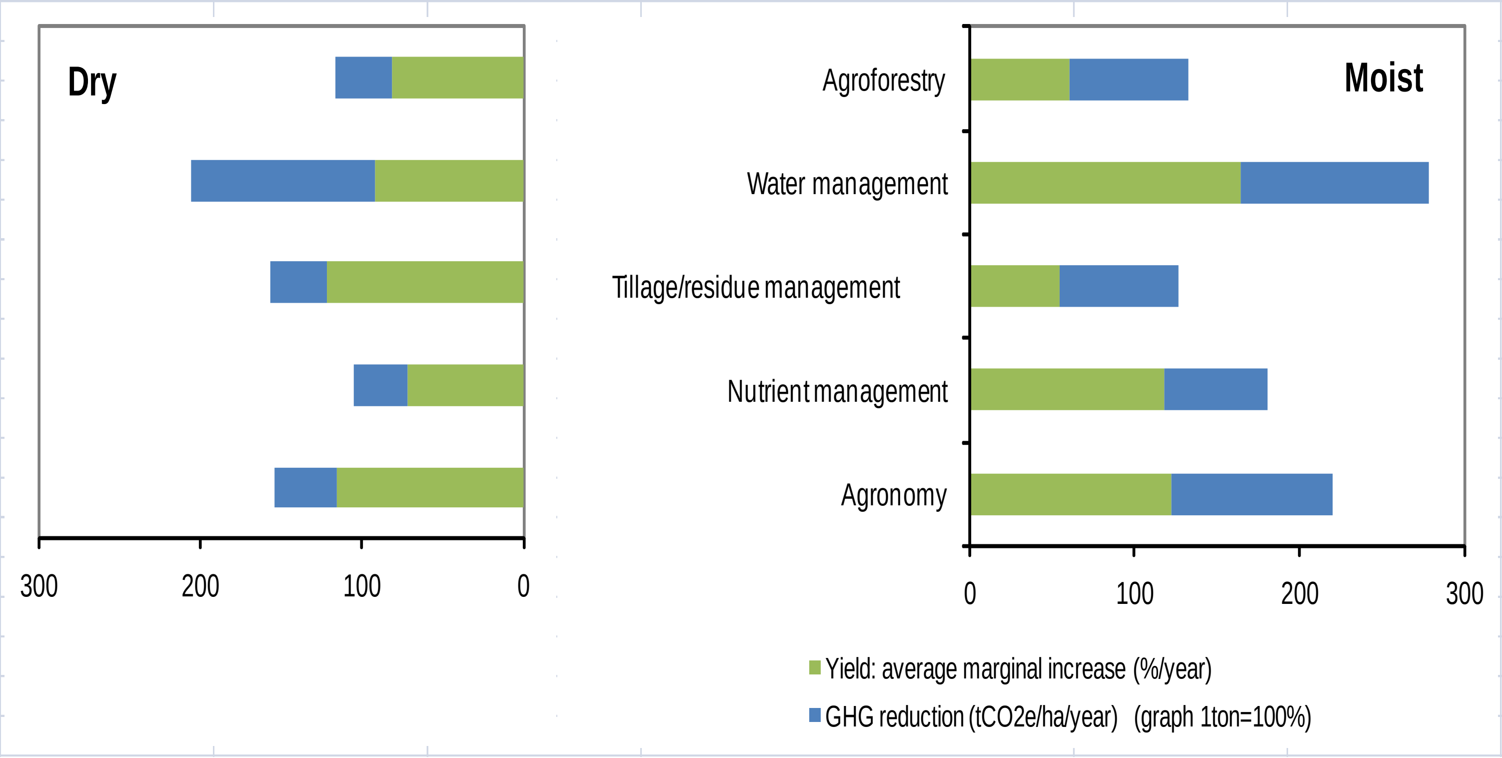
Short-run tradeoffs stronger for poorer farmers

NPV of restoring degraded grazing lands by herd size Qinghai China

Size of herd	Baseline net income	NPV/HA over 20 years	No years to positive cash flow	No of years to positive incremental net income compared to baseline net income
	($/ha/yr)	($/ha)	(number of years)	(number of years)
Small	14.42	118	5	10
Medium	25.21	191	1	4
Large	25.45	215	1	1
Source: Wilkes 2011				

Distribution of public/private benefits from land management vary across agro-ecology

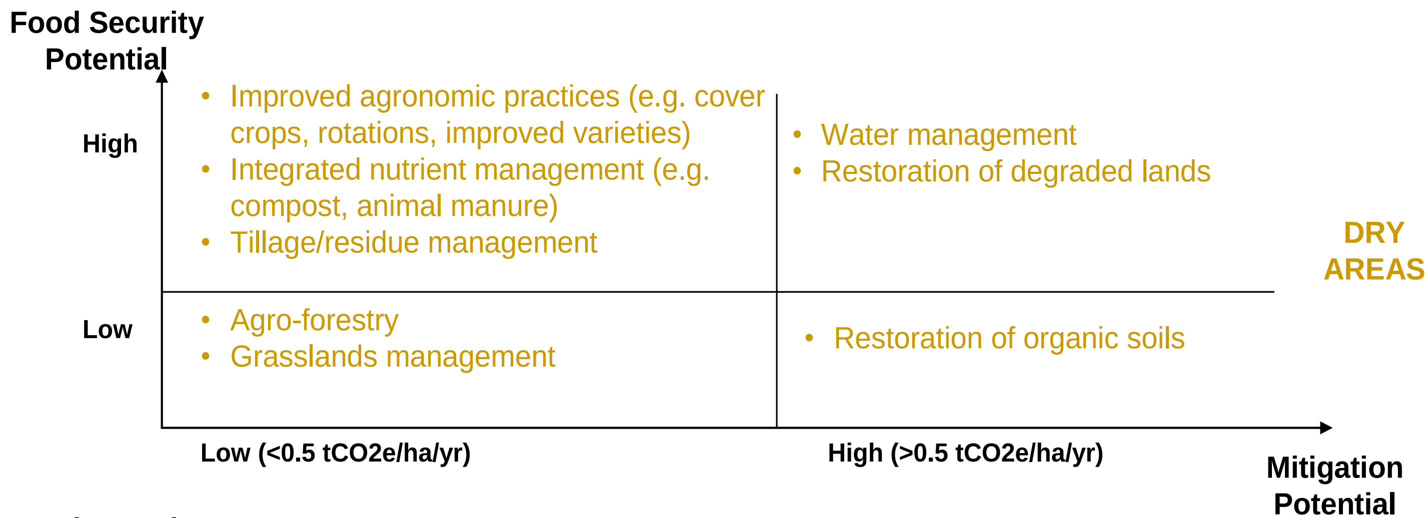
Synthesis of literature comparing yield and soil carbon sequestration effects of adopting sustainable land management practices in dry and moist areas

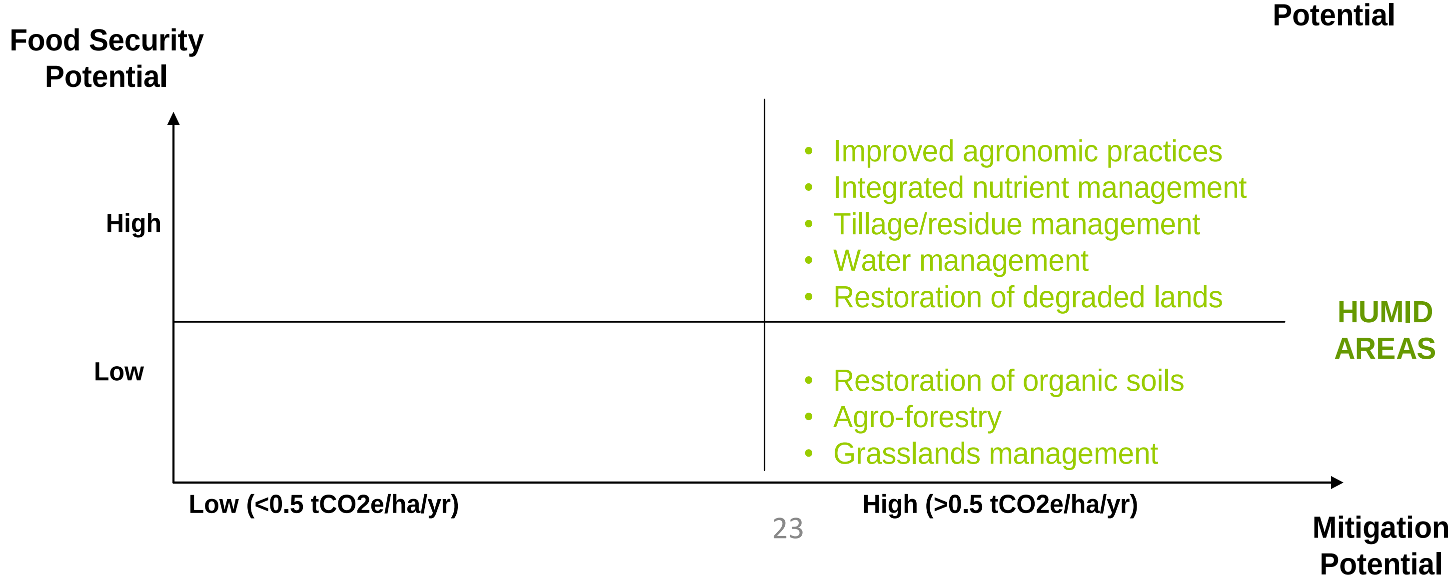


Heterogeneity in private/public benefits from land management

Implies the need for developing strategies for land management and restoration specific to agro-ecologies and socio-economic conditions – e.g. responding to relative distribution of private (agricultural adaptation) and public (mitigation) benefits.

SLM and food security/CC mitigation potential



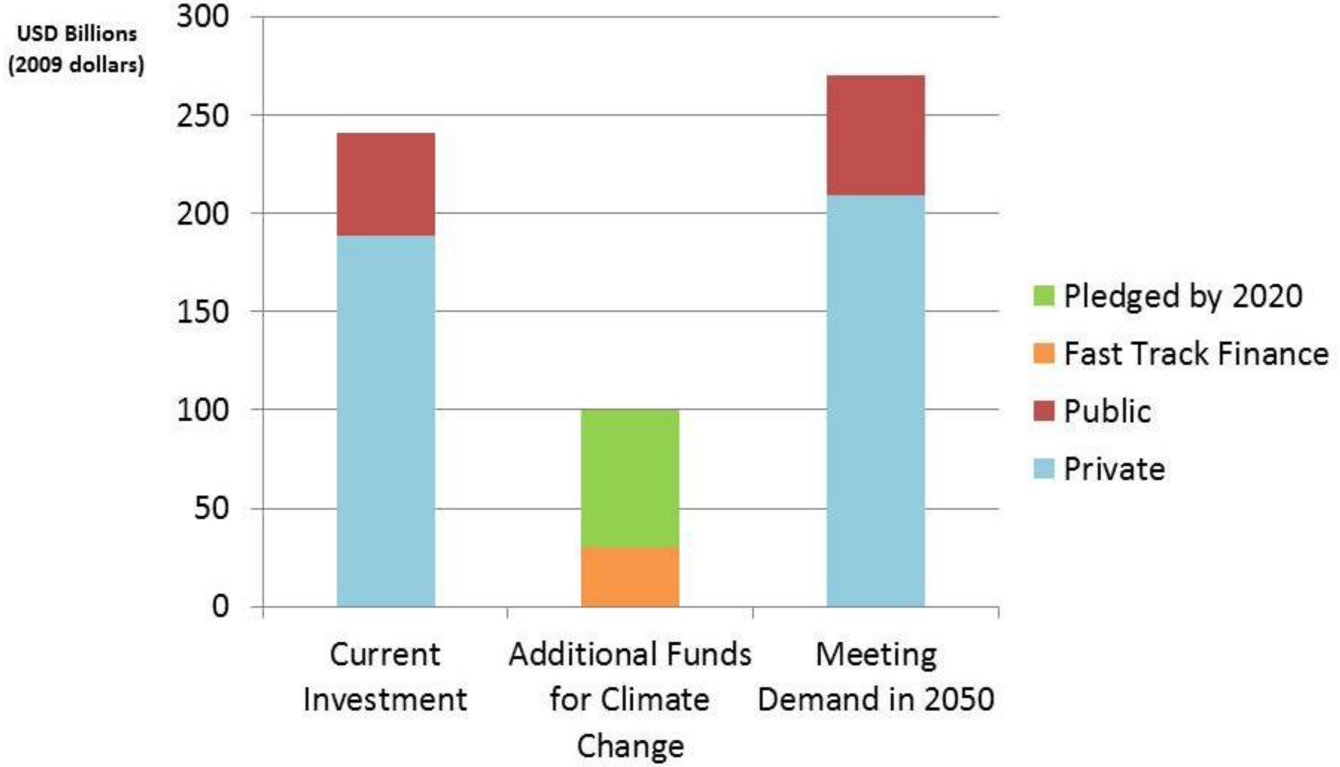


Addressing the barriers to adoption at scale requires major increase and retargeting of agricultural investment funds

Emerging climate financing mechanisms that may support land management

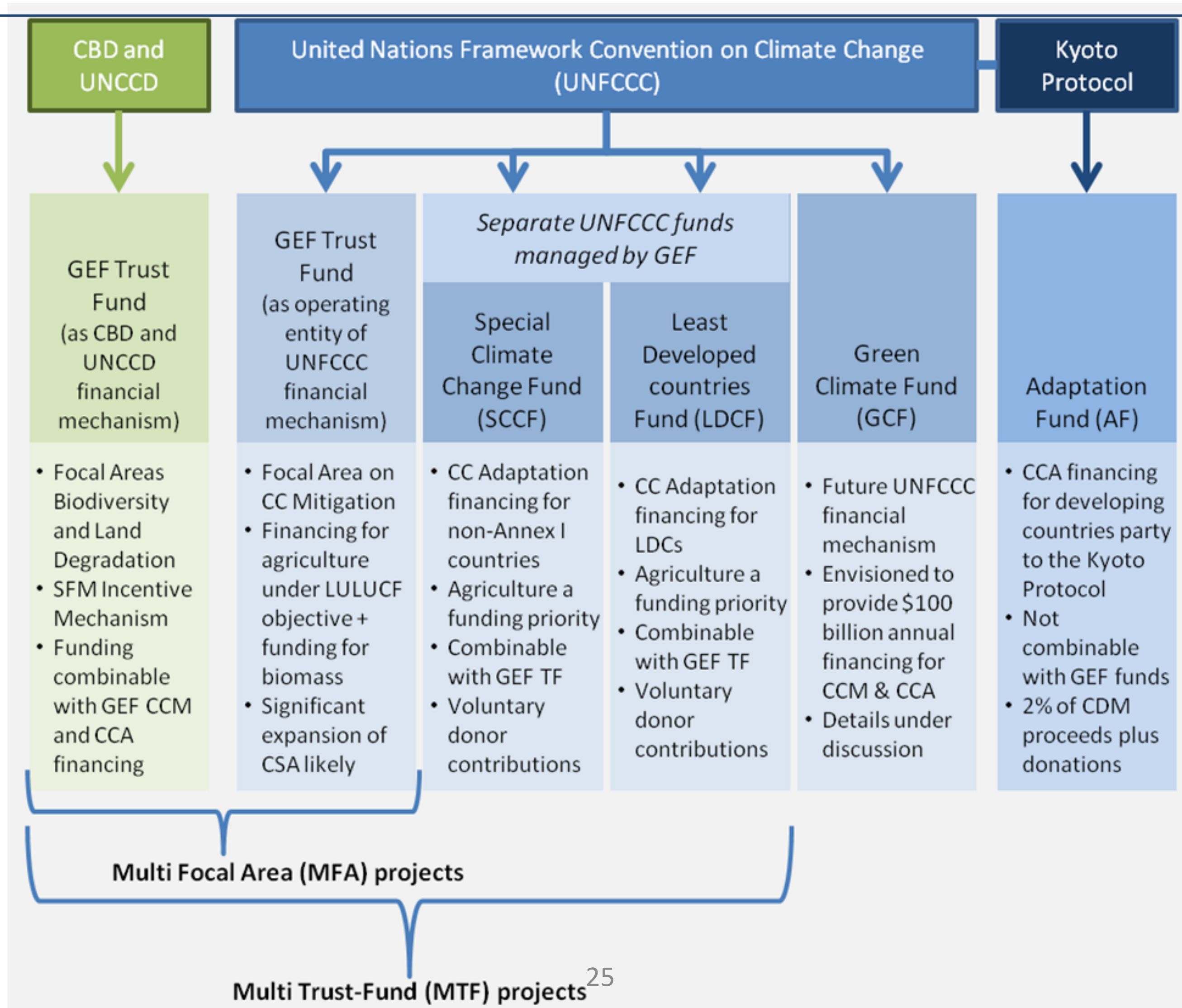
- Climate finance to support adaptation or mitigation activities
- Includes public (GEF, ASAP-IFAD) and private (carbon markets) sectors
- Green Climate Fund (GCF) $100 billion/year by 2020

Climate finance



Can represent a significant but small share of overall yearly investment requirements for agricultural growth

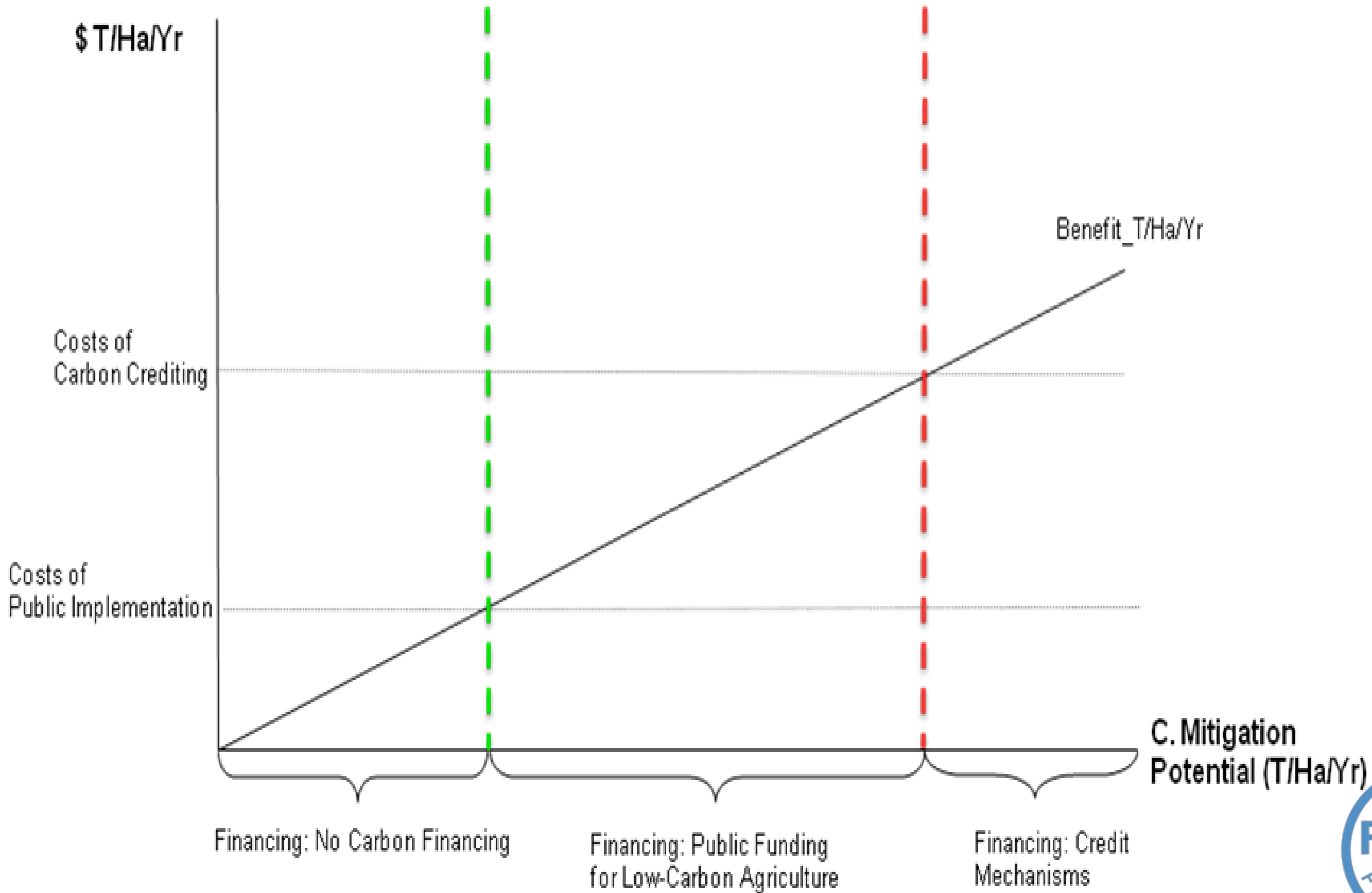
CC financing channels under UNFCCC



The role of climate finance for land management?

- Can bring a small, but significant share of new finance to agricultural sector of developing countries.
- Financing mechanisms and institutions are only now being developed: there is opportunity to shape them to support CSA
- Needs to support specific features of CSA:
  - Financing for long term transitions
  - Focus on resilience vs. average productivity gains
  - Attention to efficiency of input/resource use
  - Focus on adaptive capacity/flexibility

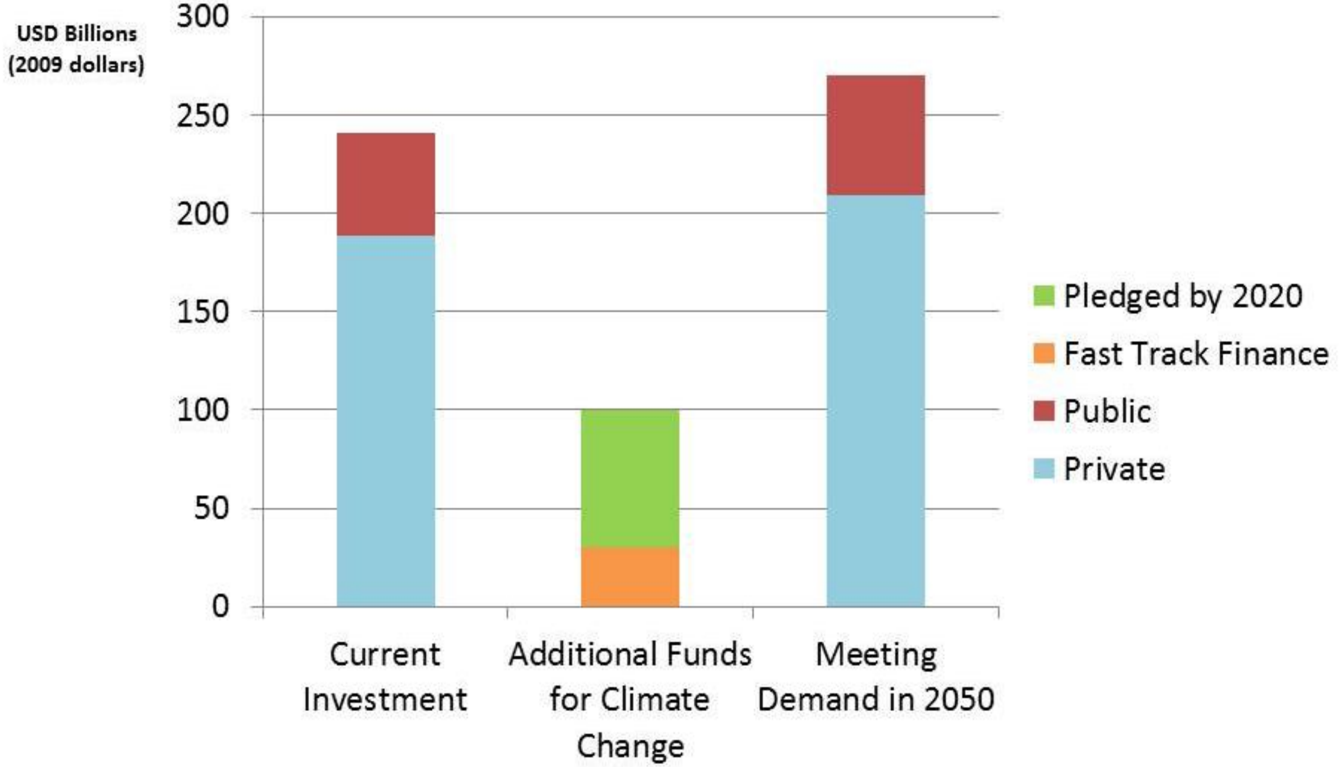
Transactions costs in linking climate finance to smallholder agriculture a key issue



Conclusions

- Public benefits of land management often greater than private
- Climate change increases both private and public values
- CC driven changes in public/private values of land management varies by agro-ecology
- Climate finance offers considerable potential to overcome barriers to adopting better land management
- Transactions costs in linking climate finance to smallholder agriculture: public sector financing for major efforts at sectoral level may be most feasible

Climate finance



can represent a significant but small share of overall yearly investment requirements for agricultural growth

Thank you!

If interested in the CSA evidence-base for Malawi, Viet Nam, and Zambia go to:

www.fao.org/climatechange/epic

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