Global Greenhouse Gas Mitigation Potential in Agriculture – the way forward after Copenhagen

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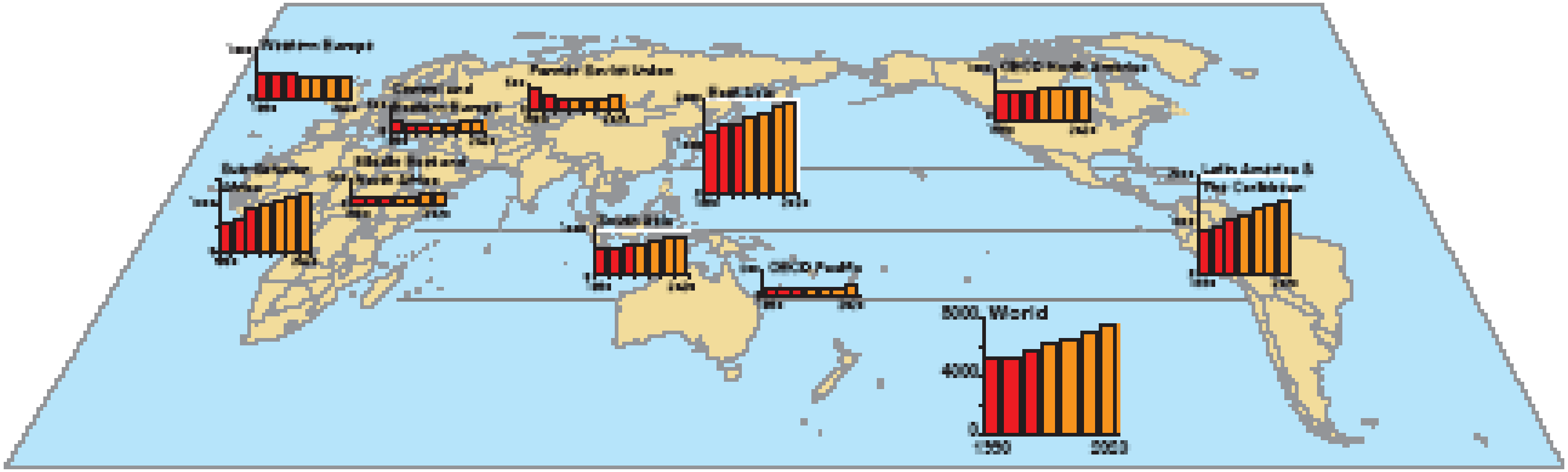
Climate change and mitigation in agriculture in Latin America and the Caribbean: investments and actions, 19-20th April, 2010

GHG emissions from agriculture

Agricultural GHG emissions

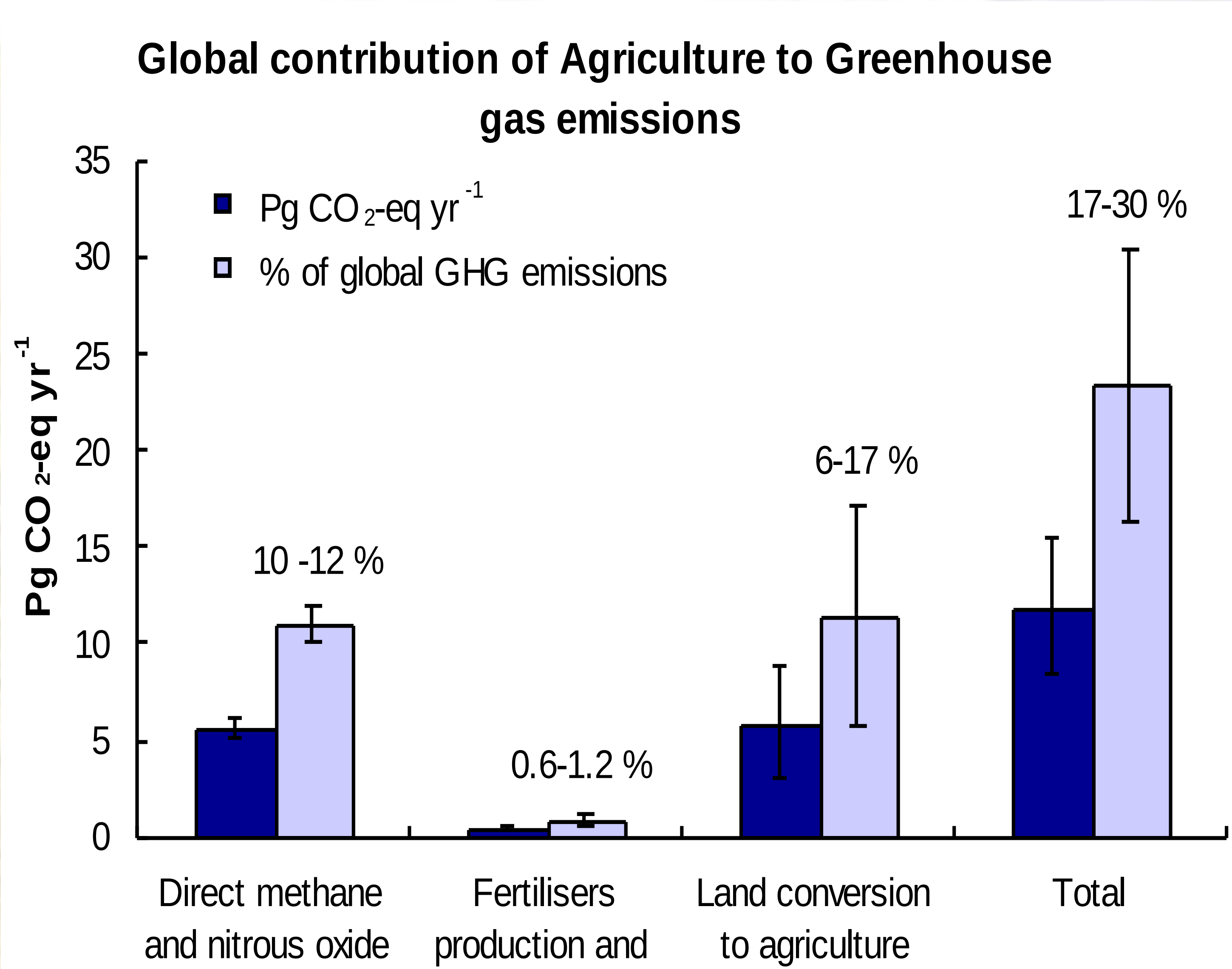


CH_4 and N_2O emissions by world region, 1990-2020

- Agriculture - 5.1 to 6.1 $GtCO_2$-eq/yr in 2005 (10-12% of total global anthropogenic emissions of GHGs).
- CH_4 contributes 3.3 $GtCO_2$-eq/yr and N_2O 2.8 $GtCO_2$-eq/yr.
- Of global anthropogenic emissions in 2005, agriculture accounts for about 60% of N_2O and about 50% of CH_4.

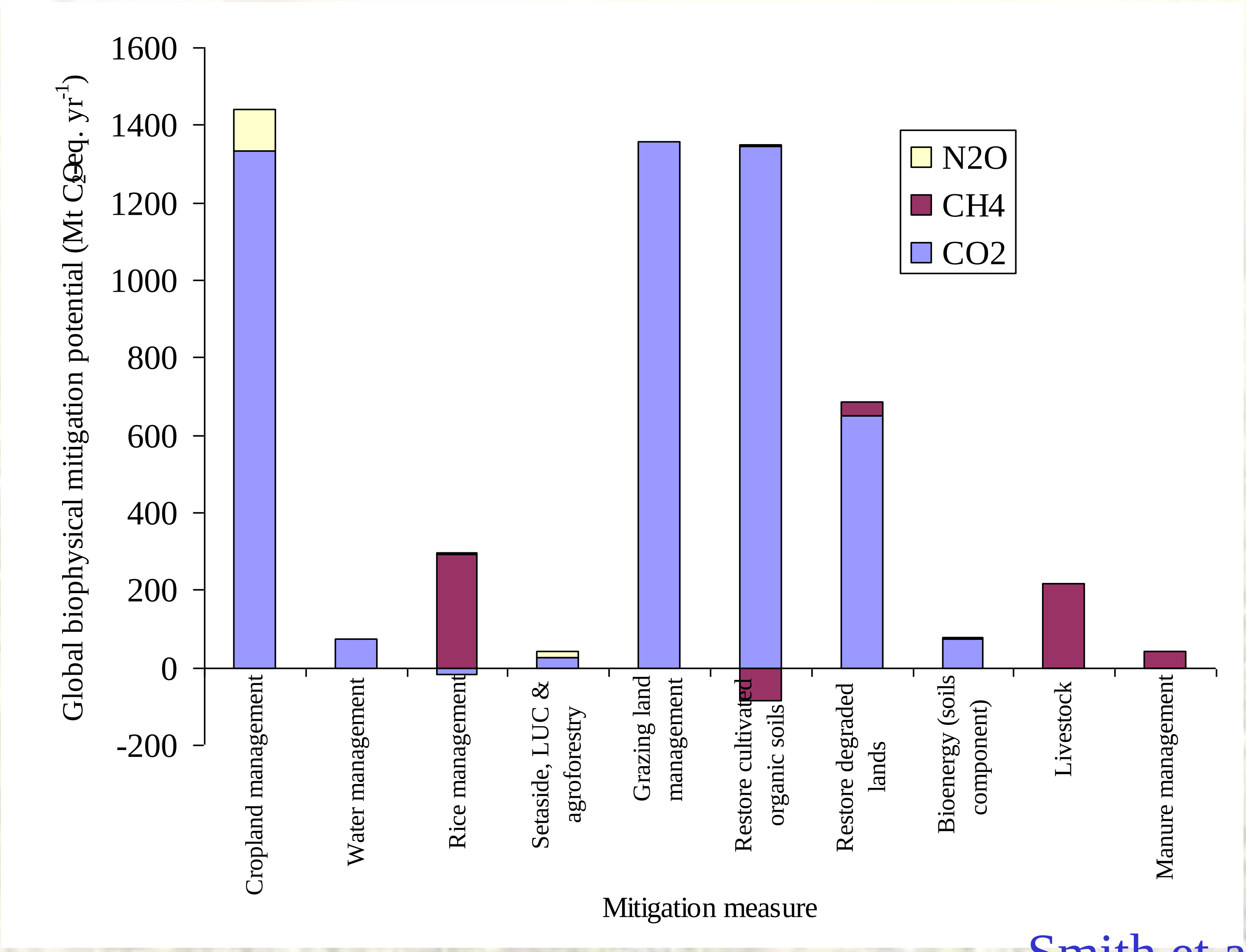
Smith et al. (2007)

Agricultural GHG emissions



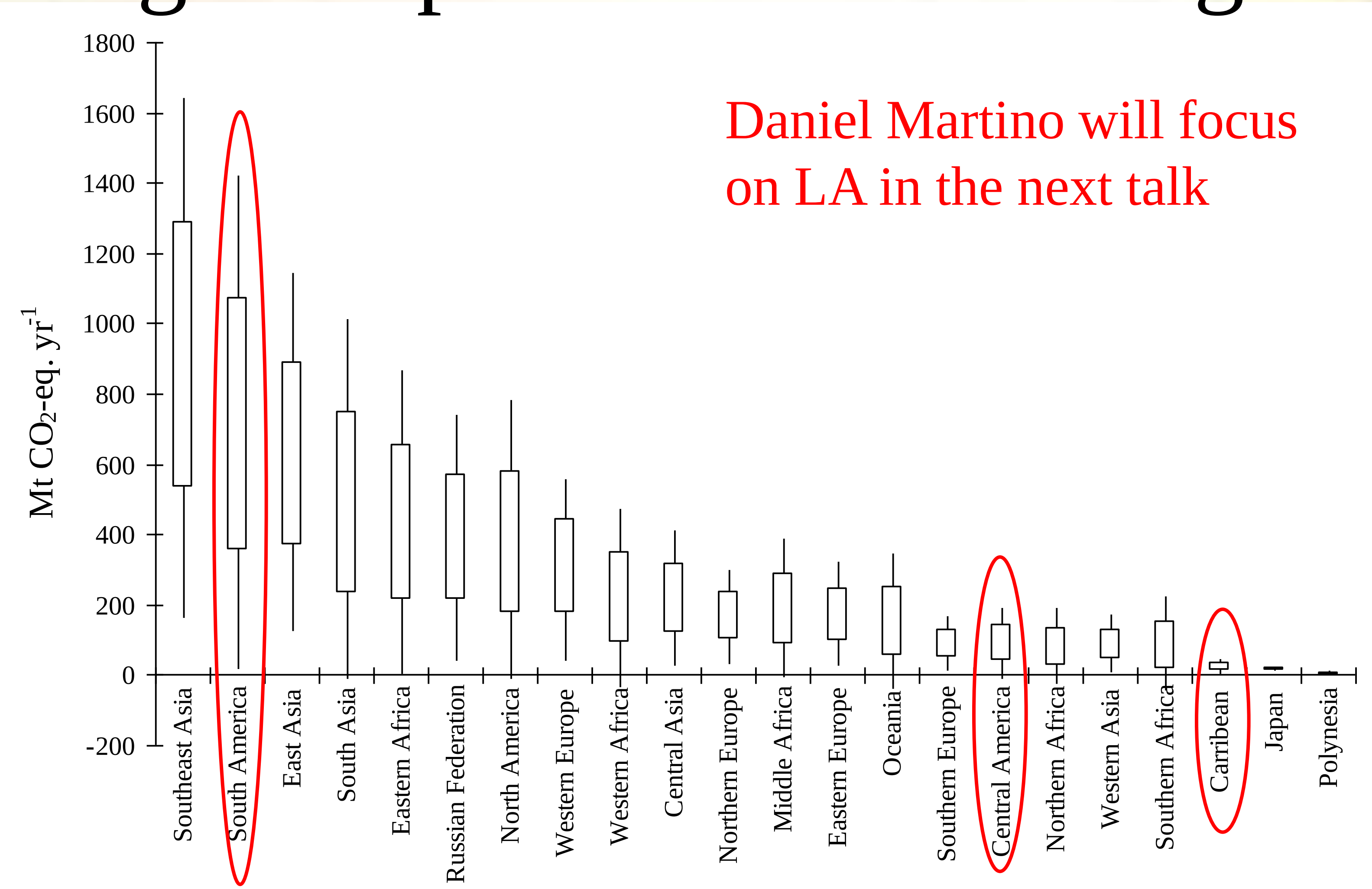

GHG mitigation potential in agriculture


Global mitigation potential in agriculture



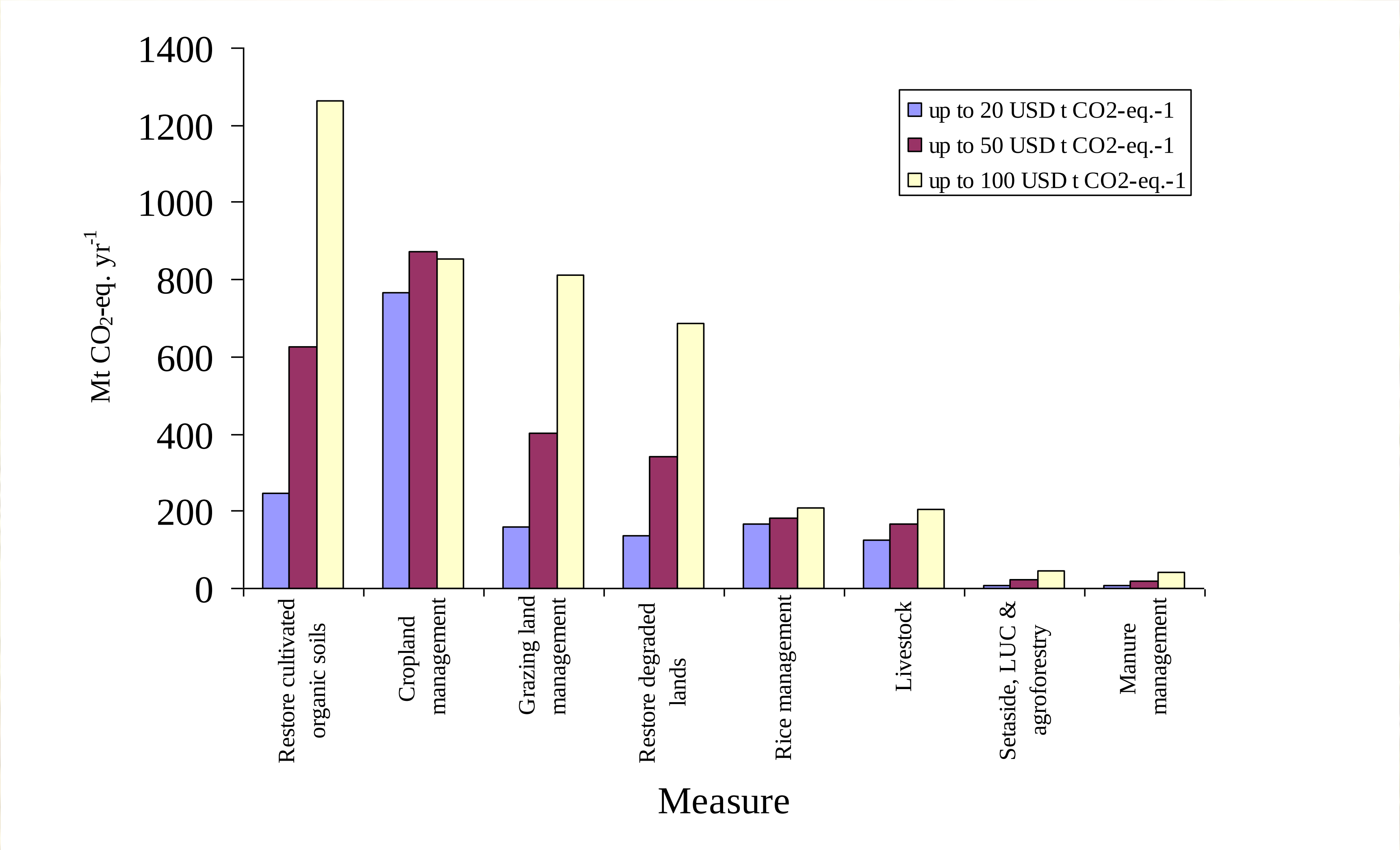
Smith et al. (2008)

High and low estimates of the mitigation potential in each region



Smith et al. (2007)

Effect of C price on implementation



Smith et al. (2007)

Global mitigation potential in agriculture (Mt CO_2-eq. yr^{-1})

	Price range (USD t CO_2-eq. $^{-1}$)			
Scenario	**0-20**	**0-50**	**0-100**	**0->>100 (technical potential)**
B1	1925	2384	3149	5480
A1b	1982	2439	3254	5670
B2	2047	2495	3330	5844
A2	2119	2549	3330	5957

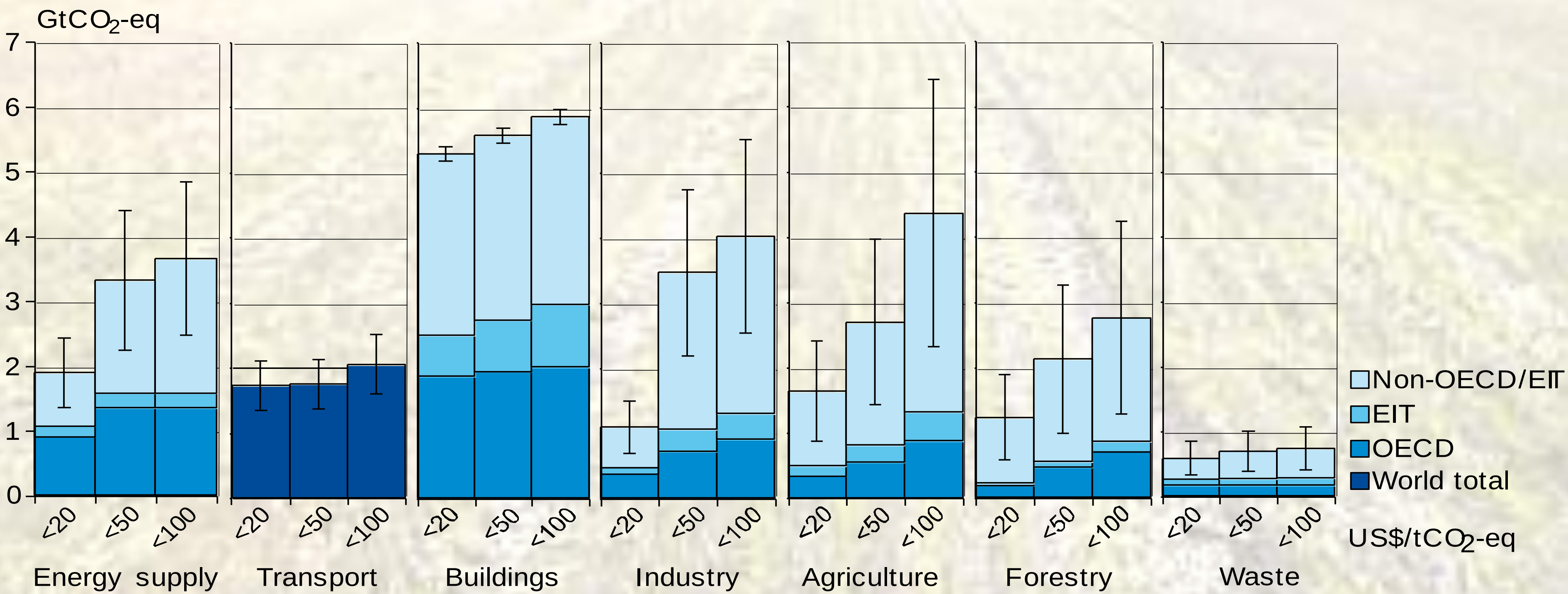
Smith et al. (2007a)

Additional mitigation from agriculture

- **Feed-stocks for bio-energy** (residues, dung and dedicated energy crops).
- The economic mitigation potential for agricultural bio-energy in 2030 is estimated to be 70-1260, 560-2320 and 2720 Mt CO_2-eq. yr^{-1} at prices up to 20, 50 and above 100 USD t CO_2-eq.$^{-1}$, respectively (5-90% of all other measures together).
- Additional mitigation of 770 Mt CO_2-eq. yr^{-1} could be achieved by 2030 by **improved energy efficiency** in agriculture

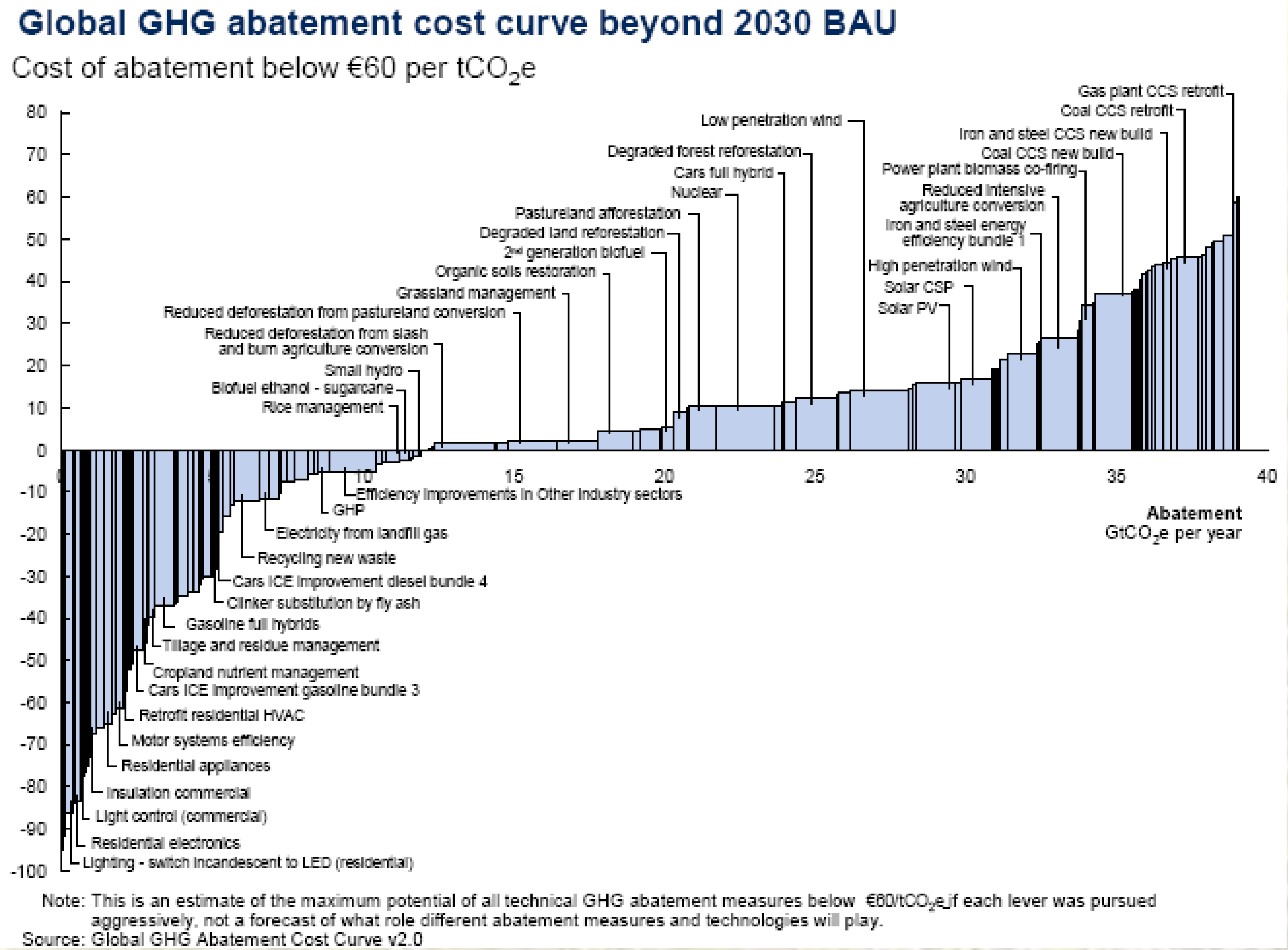
Smith et al. (2007a)

Global economic mitigation potential for different sectors at different carbon prices



IPCC, AR4, WGIII (2007)

How do we cut GHG emissions and how much will it cost?



From: McKinsey (2009) - Pathways to a low-carbon economy *Version 2 of the Global Greenhouse Gas Abatement Cost Curve*

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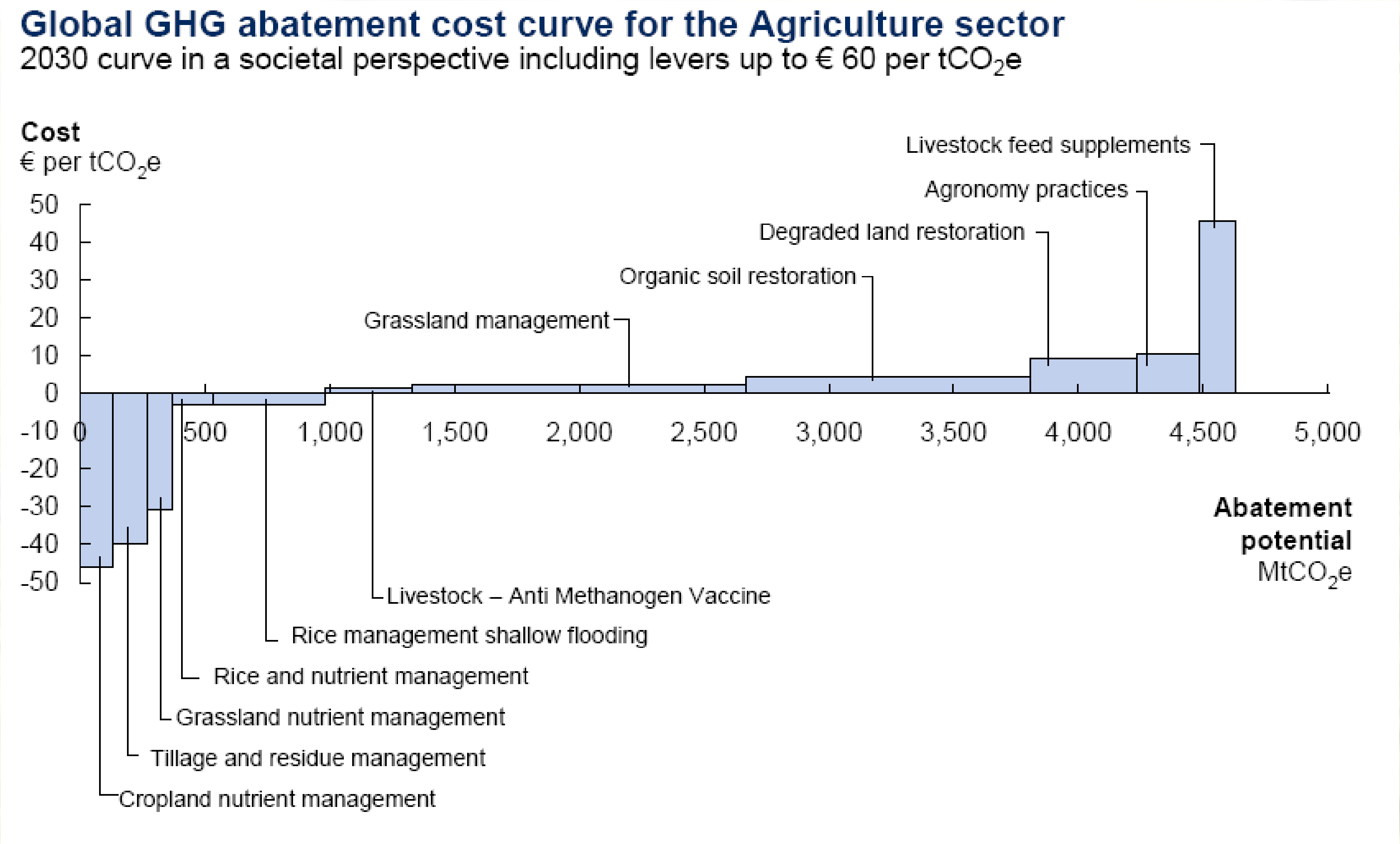

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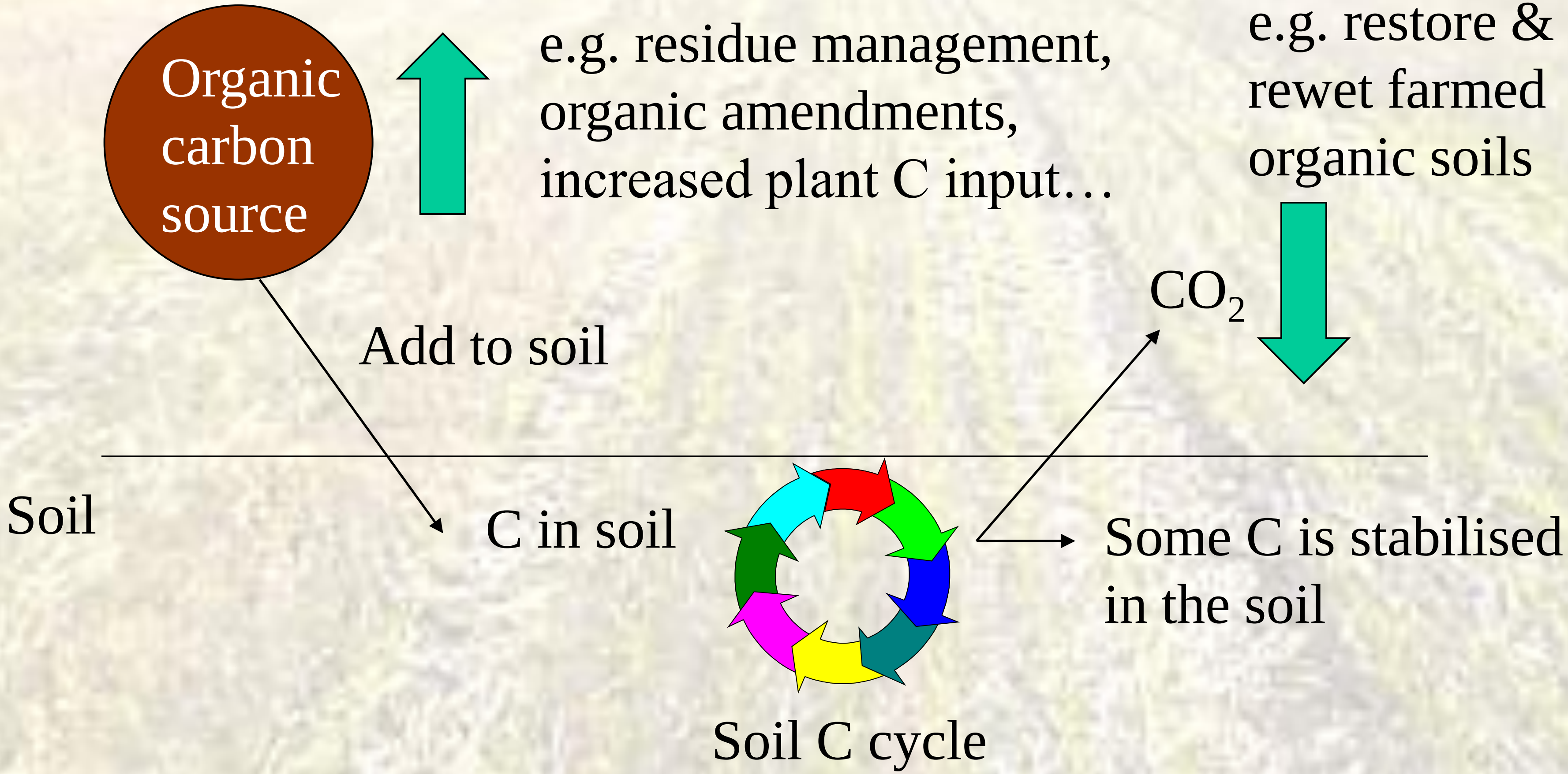
Soil C sequestration

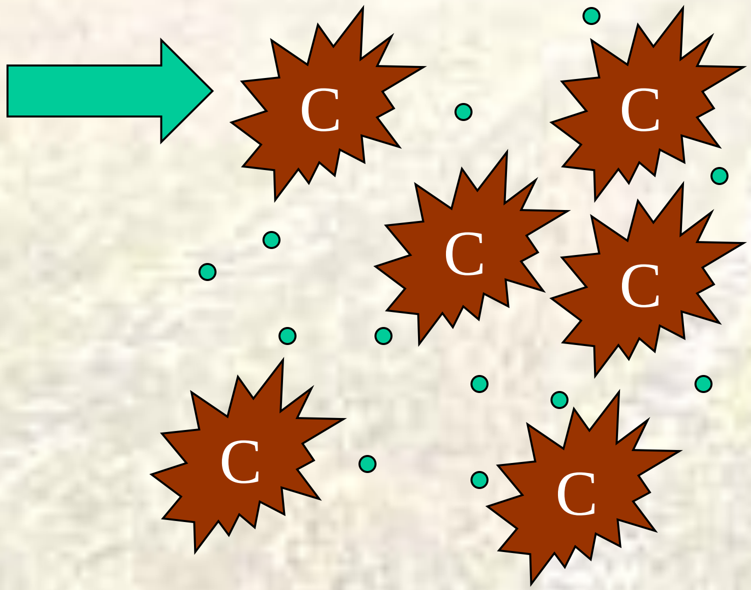

How does soil C sequestration work?

Increase C inputs……..or reduce C losses

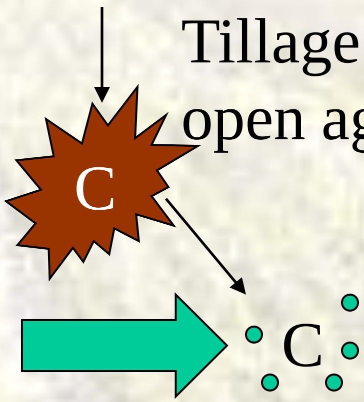


How does soil C sequestration work? – reduced disturbance

No-till



Tillage



Tillage breaks open aggregates

Organic material (C) more exposed to microbial attack and weathering

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Key:

- = microbe

= C inside aggregate

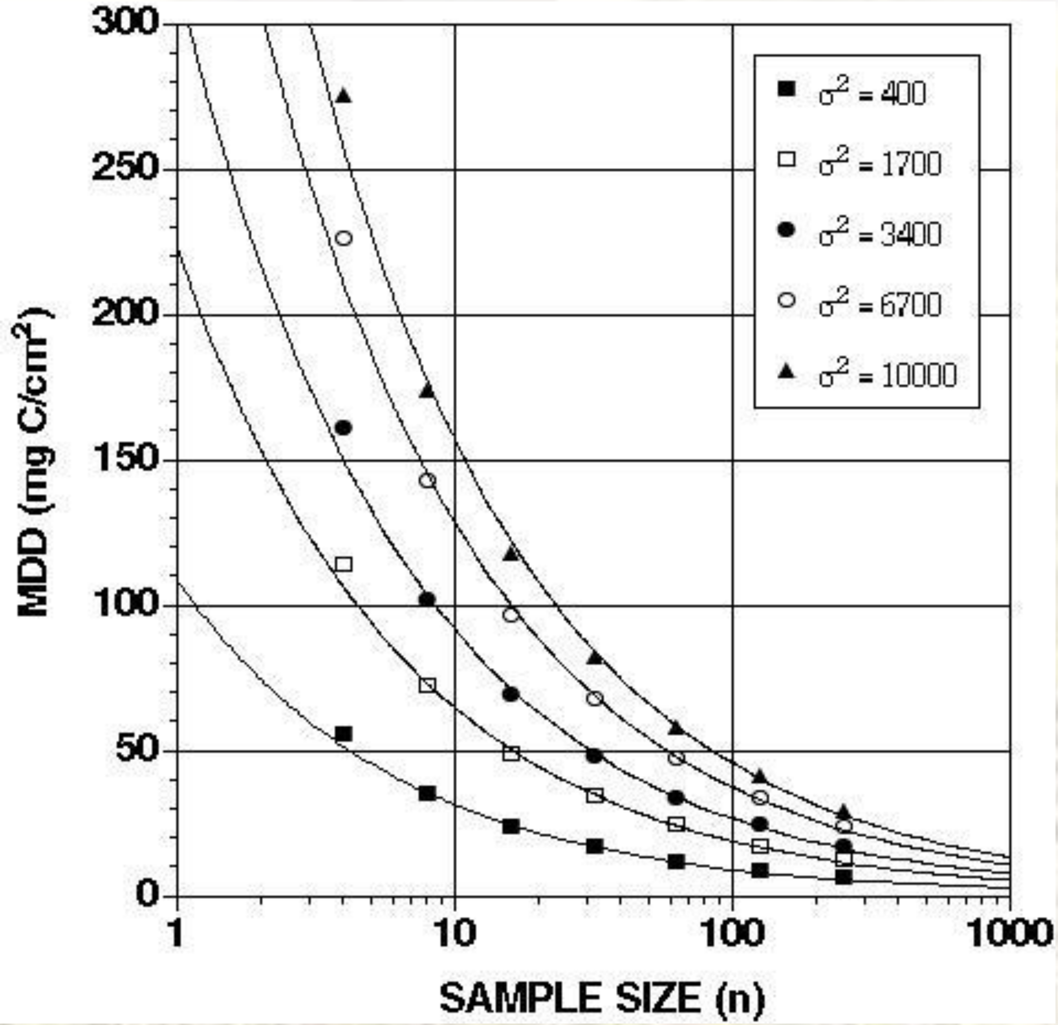
= weathering

Mechanisms for soil C sequestration in agriculture

Activity	Practice	Specific management change	Increase C inputs	Decrease C losses	Reduce disturbance
Cropland management	Agronomy	Increased productivity	X		
		Rotations	X		
		Catch crops	X		
		Less fallow	X		
		More legumes	X		
		Deintensification			X
		Improved cultivars	X		
	Nutrient management	Fertilizer placement	X		
		Fertilizer timing	X		
	Tillage / residue management	Reduced tillage			X
		Zero tillage			X
		Reduced residue removal	X		X
		Reduced residue burning	X		X
	Upland water management	Irrigation	X		
		Drainage	X		
	Set-aside and land use change	Set aside	X		X
		Wetlands	X	X	
	Agroforestry	Tree crops inc. Shelterbelts etc.	X		X
Grazing land management	Livestock grazing intensity	Livestock grazing intensity		X	
	Fertilization	Fertilization	X		
	Fire management	Fire management		X	
	Species introduction	Species introduction	X		
	More legumes	More legumes	X		
	Increased productivity	Increased productivity	X		
Organic soils	Restoration	Rewetting / abandonment		X	X
Degraded lands	Restoration	Restoration	X	X	X

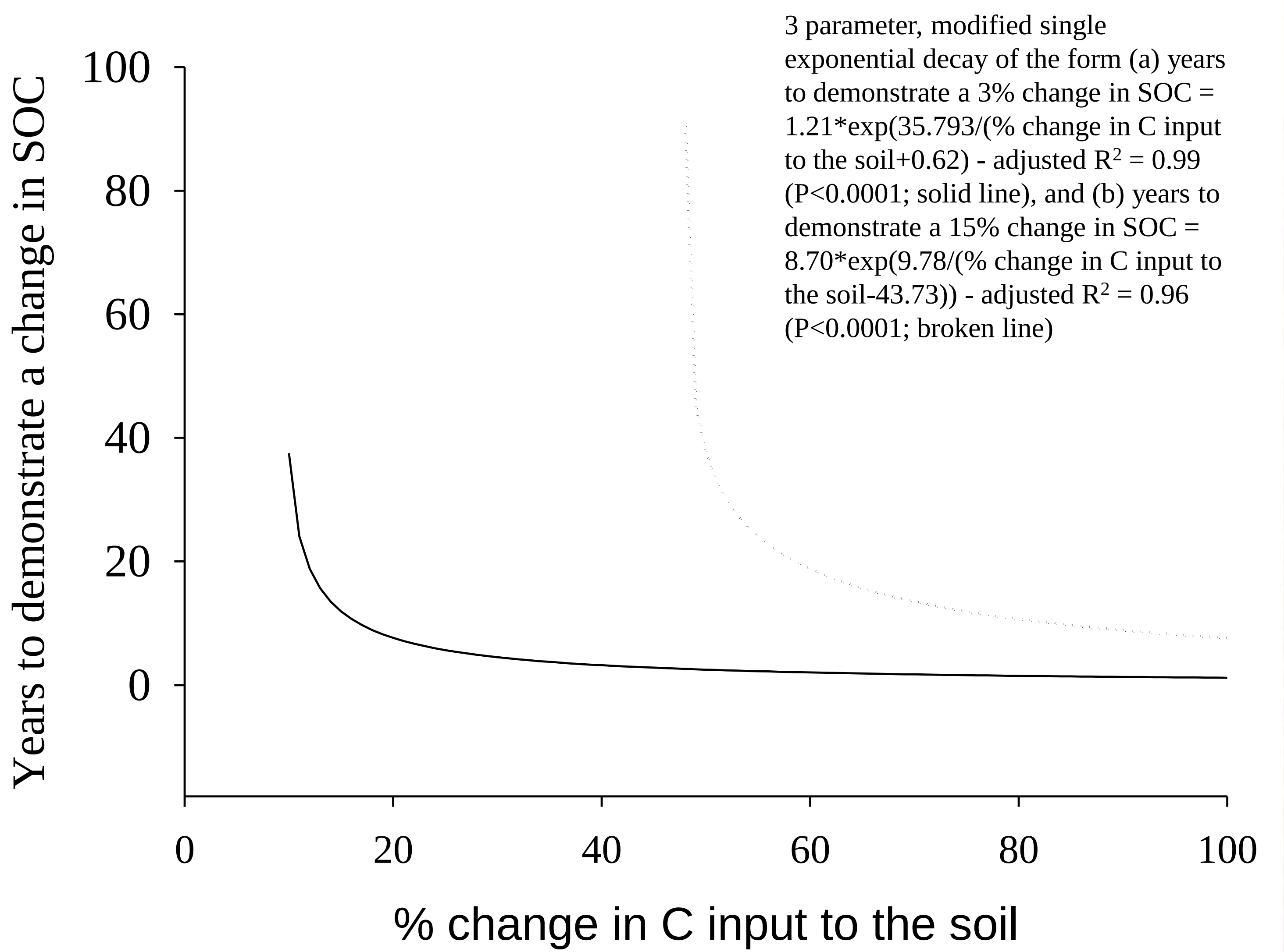
Smith et al. (2007a)

Minimum detectable difference and sample size



Garten & Wullschleger (1999) JEQ

Time before it is possible to demonstrate a change in SOC for minimum detectable difference of 3% (solid) and 15% (broken line)

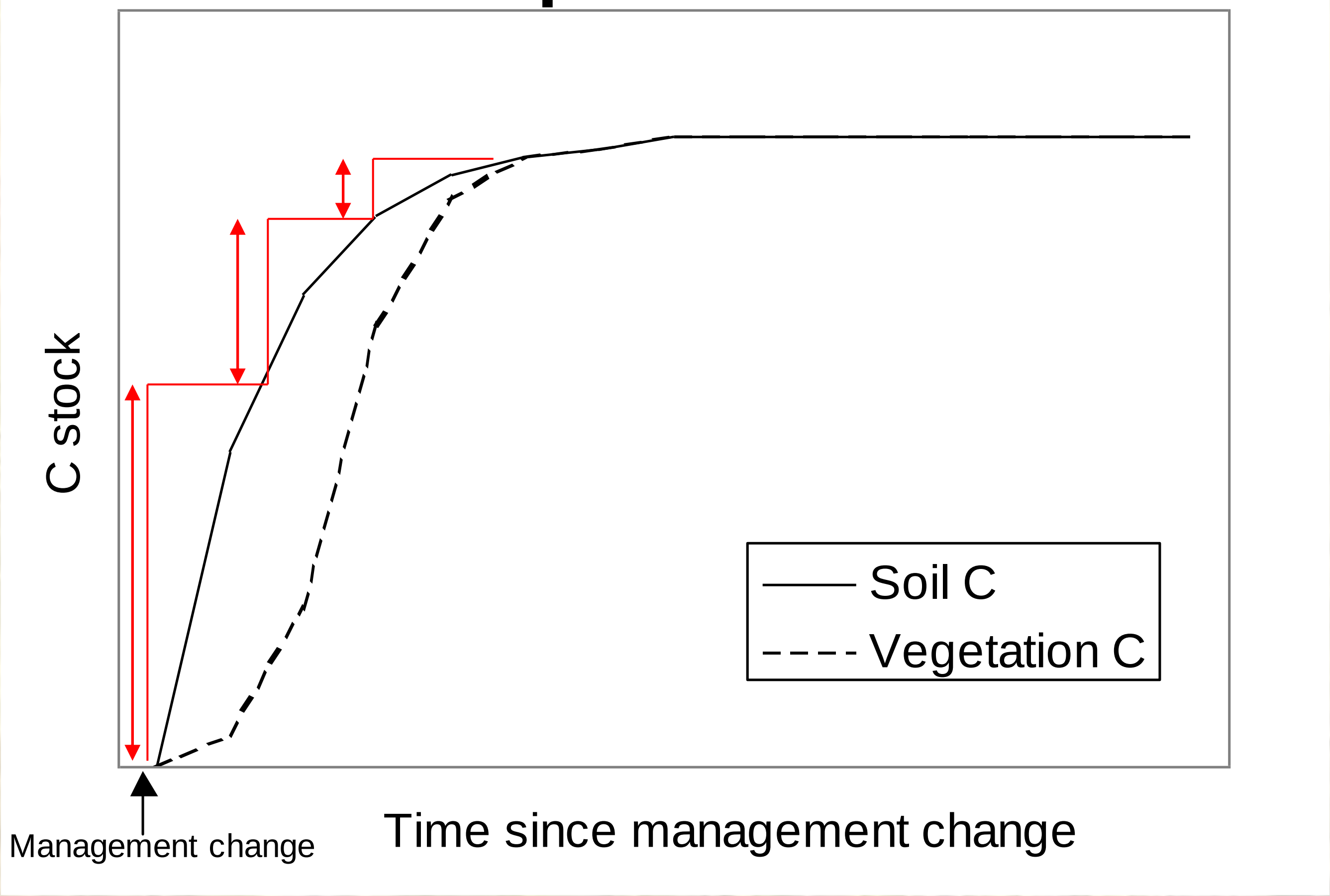


Smith (2004) GCB

Smith (2008) International Journal of Agricultural Sustainability 6(3),169–170

- “There are a number of well rehearsed arguments against reliance on carbon sequestration for tackling climate change, involving saturation of the carbon sink (the carbon is only removed from the atmosphere while the tree is growing or until the soil reaches a new equilibrium soil carbon level; Smith, 2005), permanence (carbon sinks can be reversed at any stage by deforestation or poor soil management; Smith, 2005), leakage/displacement (e.g. planting trees in one area leads to deforestation in another; Intergovernmental Panel on Climate Change (IPCC), 2000), verification issues (can the sinks be measured; Smith, 2004), and total effectiveness relative to emission reduction targets (only a fraction of the reduction can be achieved through sinks; IPCC, 2007)”.

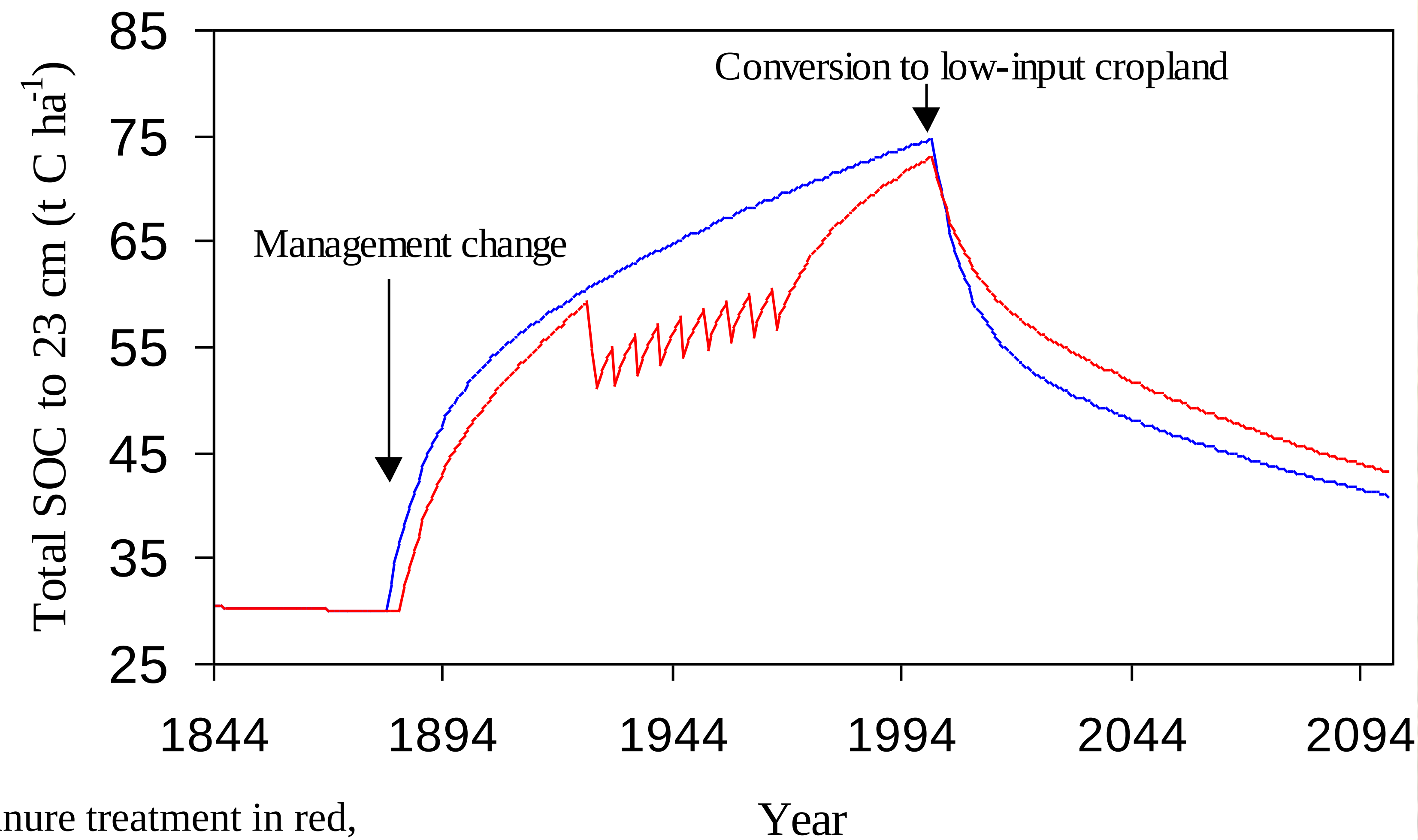
Saturation – the time course of C sequestration



- Sink saturation ~ 20-100 years
- Sink strength declines towards new equilibrium

Smith (2004a)

Permanence



Manure treatment in red,
Woodland in blue

Smith (2005)

Leakage / displacement: are we actually sequestering carbon or just moving it about?

More manure here….but……..less manure here

Manure

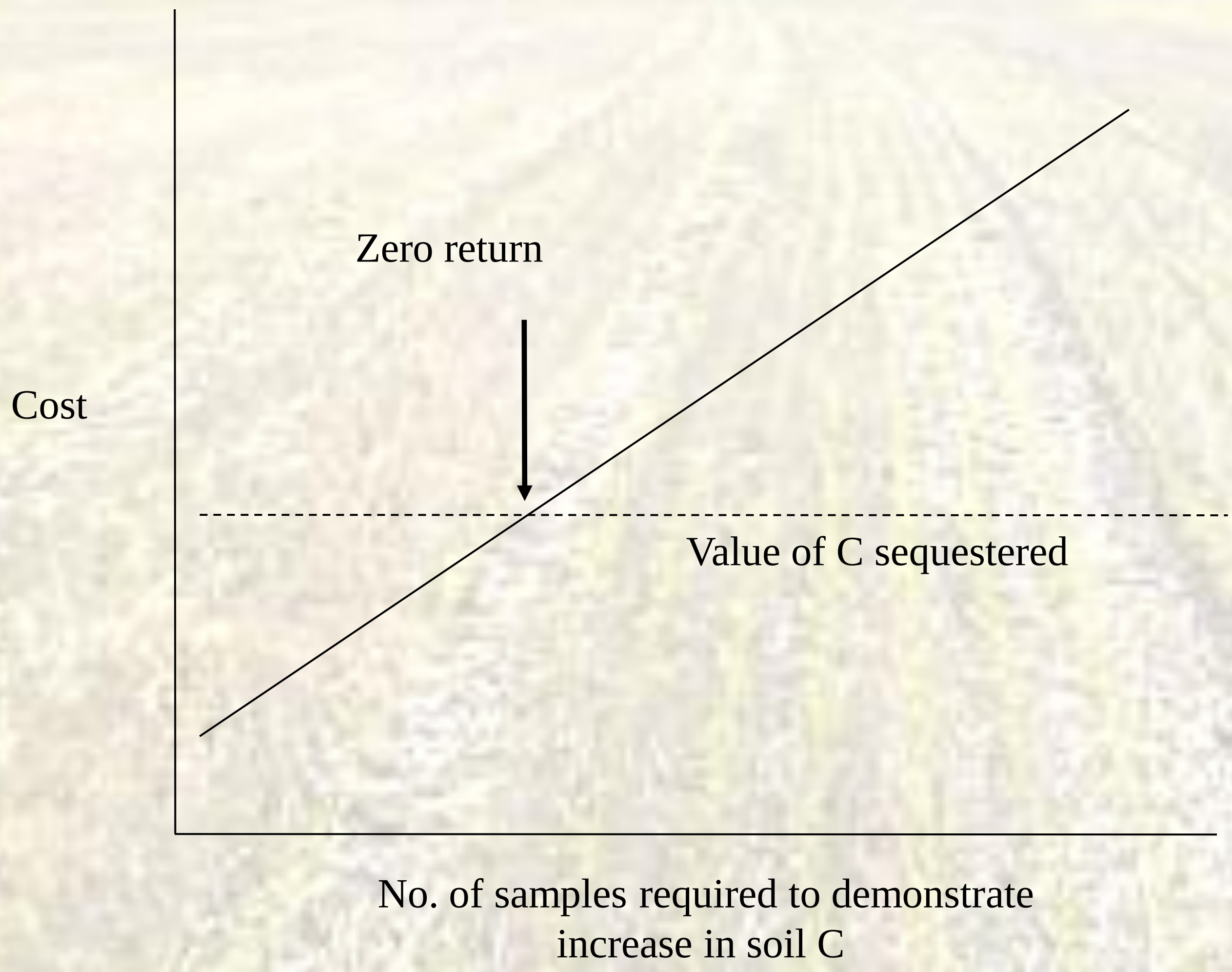
Farm with more manure

Manure Mineral N

Farm with less manure

Effect over the whole cropland area = zero

Verification



Smith (2004b)

"Trying to sequester the geosphere in the biosphere"

- The C we release through fossil fuel burning has been locked up for ~300 Million years and was accumulated over many millions of years – we are trying to lock that up over years / decades – it does not add up!
- "It is easier to leave the marbles in the jar than to tip them out and try to pick them all up again" W.H. (Bill) Schlesinger
- Soil C sequestration is time limited, non-permanent, difficult to verify and is no substitute for GHG emission reduction
- Soil C sequestration may have a role in reducing the short term atmospheric CO_2 concentration, and buying us time to develop longer term solutions, largely in the energy sector

Impact of the Copenhagen Accords

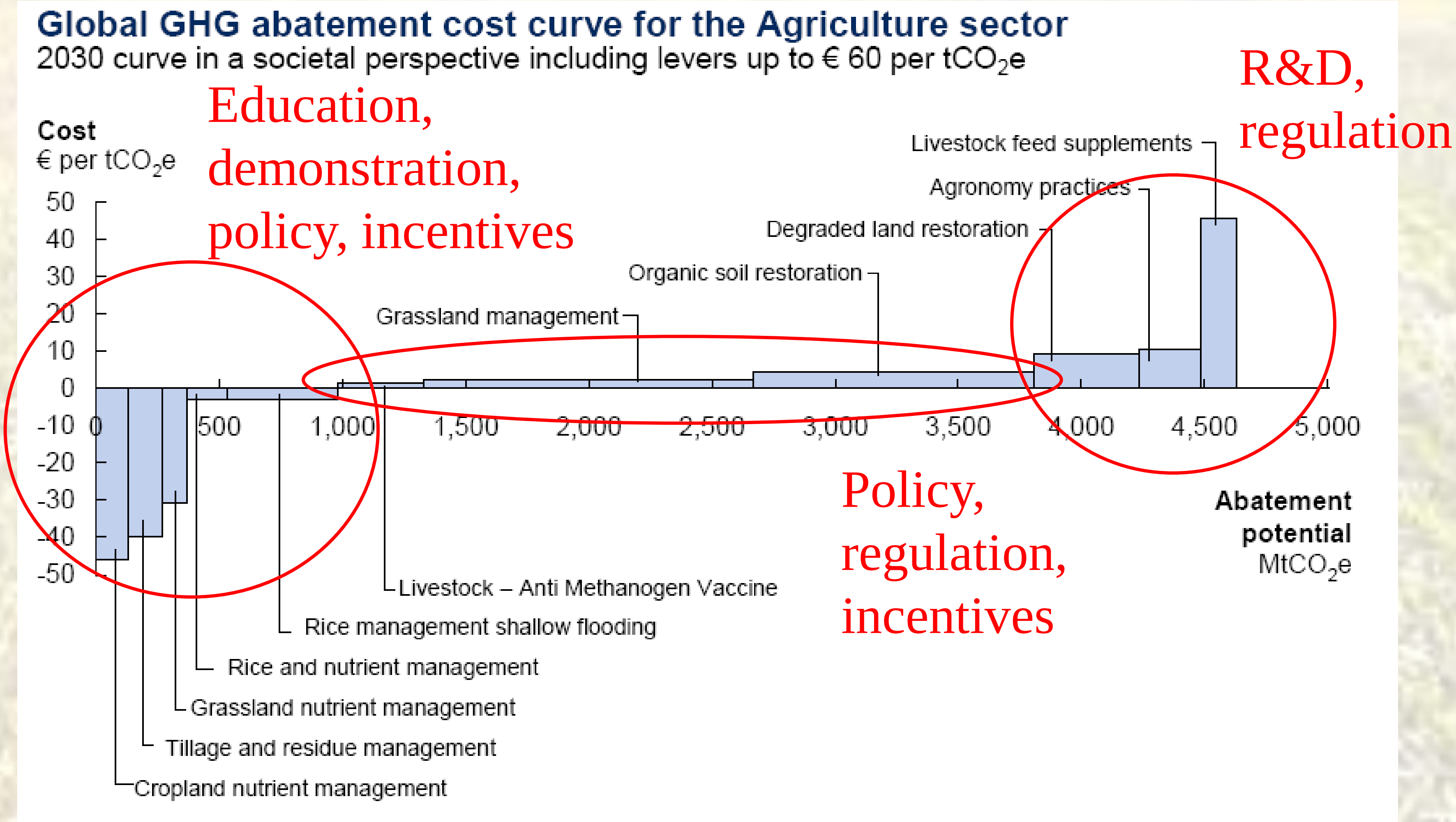
Copenhagen outcomes…

- Positive
  - Negotiation on REDD+
  - Developing countries and developed countries striving for global agreements
- Negative
  - Failure to get quantified, binding, time-bound emission reduction targets
  - Most targets very un-ambitious
  - Agriculture gets virtually no mention – looks unlikely it will be included

Implications of not including agriculture…

- Possible positive
  - Leaves food production un-impinged (good for food security?)
- Possible negative
  - Leaves potential for perverse incentives in the agricultural sector
  - Bars agriculture from easy access to carbon / GHG trading mechanisms – a market potentially worth 420, 130 or 32 Billion USD yr^{-1} for C prices of 100, 50 and 20 USD t CO_2-eq.$^{-1}$, respectively.
  - Misses a significant "wedge" of the global mitigation potential – makes global emission reduction targets less achievable

Which developing country actions / investments would work best?



Conclusions I

- Agriculture has a significant role to play in climate mitigation
- Agriculture is cost competitive with mitigation options in other sectors
- Bio-energy crops and improved energy efficiency in agriculture can contribute to further climate mitigation, but the savings are usually counted in other sectors
- Agricultural mitigation should be part of a portfolio of mitigation measures to reduce emissions / increase sinks whilst new, low carbon energy technologies are developed.

Conclusions II

- Soil C sequestration is a globally significant and cost competitive climate mitigation measure
- Soil C sequestration is not permanent and is of limited duration (due to sink saturation)
- Response of soil C sinks to future climate change remains uncertain
- Agriculture should be included in global climate agreements – push in Mexico but not likely to be successful
- Agricultural climate mitigation in developing countries could be encouraged in a number of ways – I look forward to this workshop!


Thank you for your attention