Addressing the Climate Change Challenge – what can agriculture do?

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With Pete Smith and others from EU-PICCMAT

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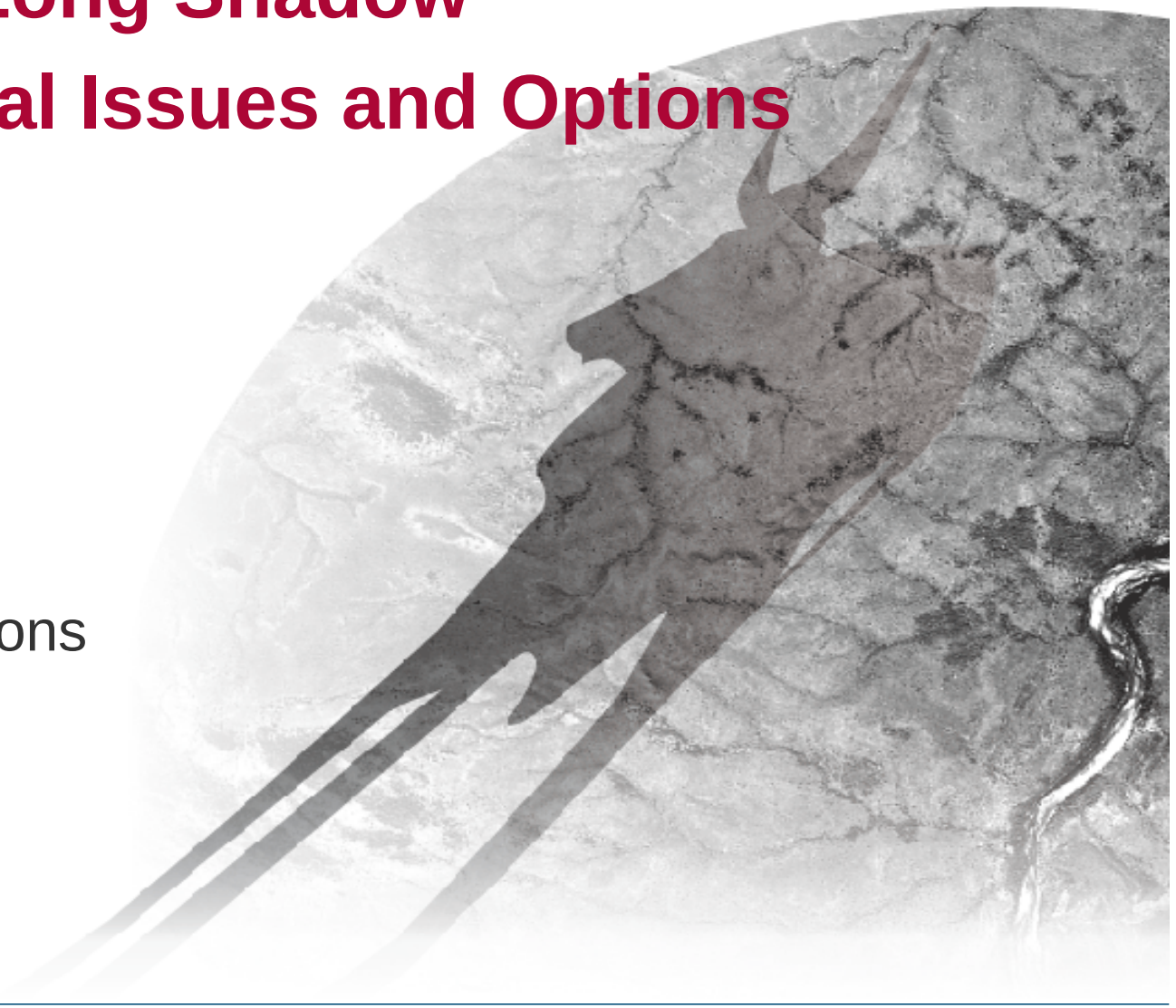
Climate Change and agricultural production

Issues … not just food also fuel, fiber & imagination

- Can we eat without or with fewer GHG?
- Travel ... and dress and live ‘biobased’ without using fossil fuel?
- Imagine we could ‘see’ the CO_2, the CH_4 and N_2O in our food

Livestock's Long Shadow
Environmental Issues and Options



- Awareness
- Diagnoses
- Hypotheses
- Design of solutions

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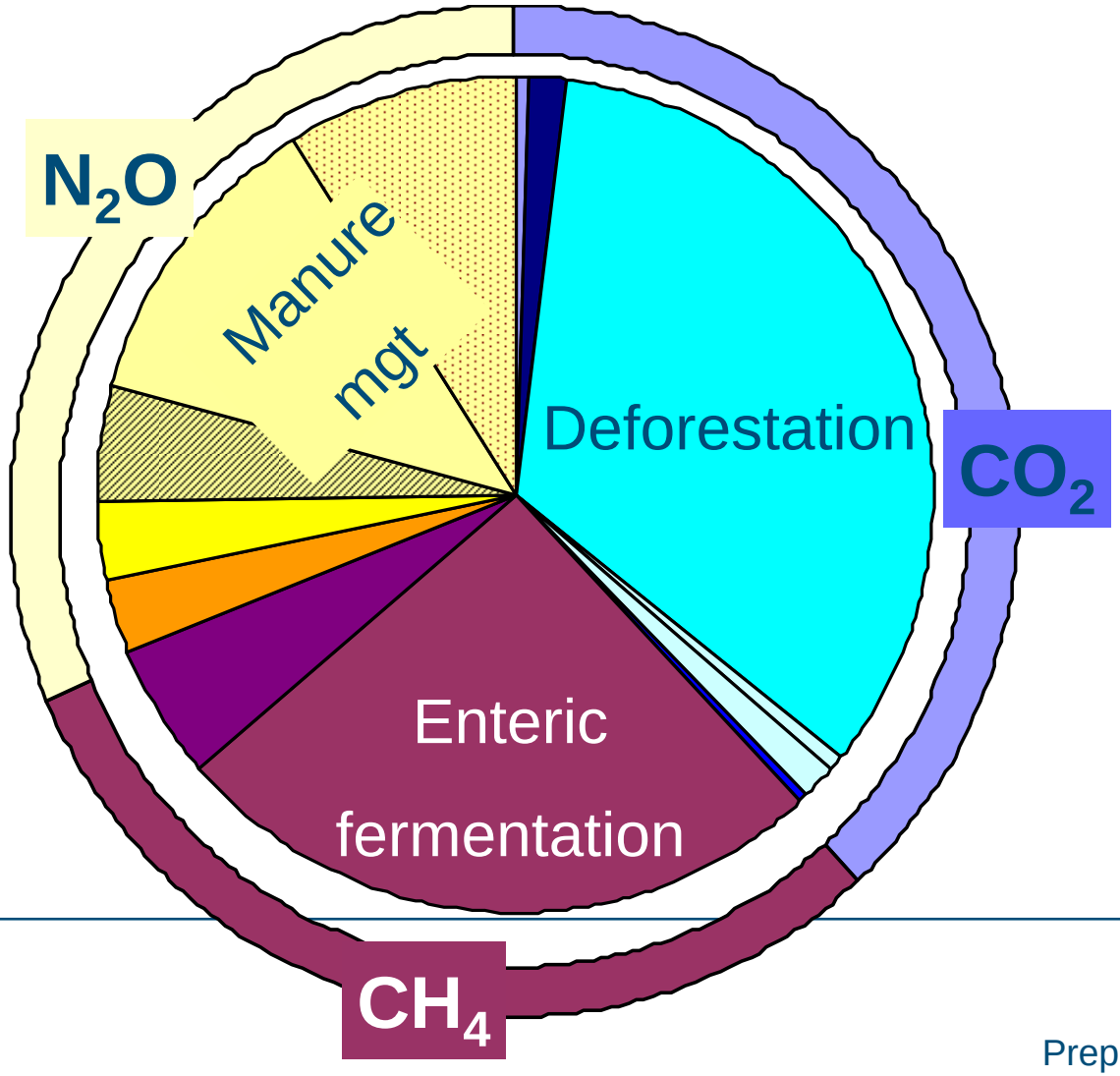
FAO, Steinfeld et al. (2006)

Relative contributions in the food chain



- Chemical N. fert. production
- On-farm fossil fuel
- Deforestation
- OM release from ag. soils
- Pasture degradation
- Processing fossil fuel
- Transport fossil fuel
- Enteric fermentation
- Manure storage / processing
- N fertilization
- Legume production
- Manure storage / processing
- Manure spreading / dropping
- Manu indirect emissions

Prepared by Bonneau, 2008

Contribution livestock sector to GHG emissions

(Source: FAO, 2006. Emissions per year in 10^9 ton CO_2 eq.)

- CO_2 ….. Total 24.0 -> Livestock 0.16 (< 1%)
- CH_4 ….. Total 5.9 -> Livestock 2.2 (37%)
- N_2O ….. Total 3.4 -> Livestock 2.2 (65%)

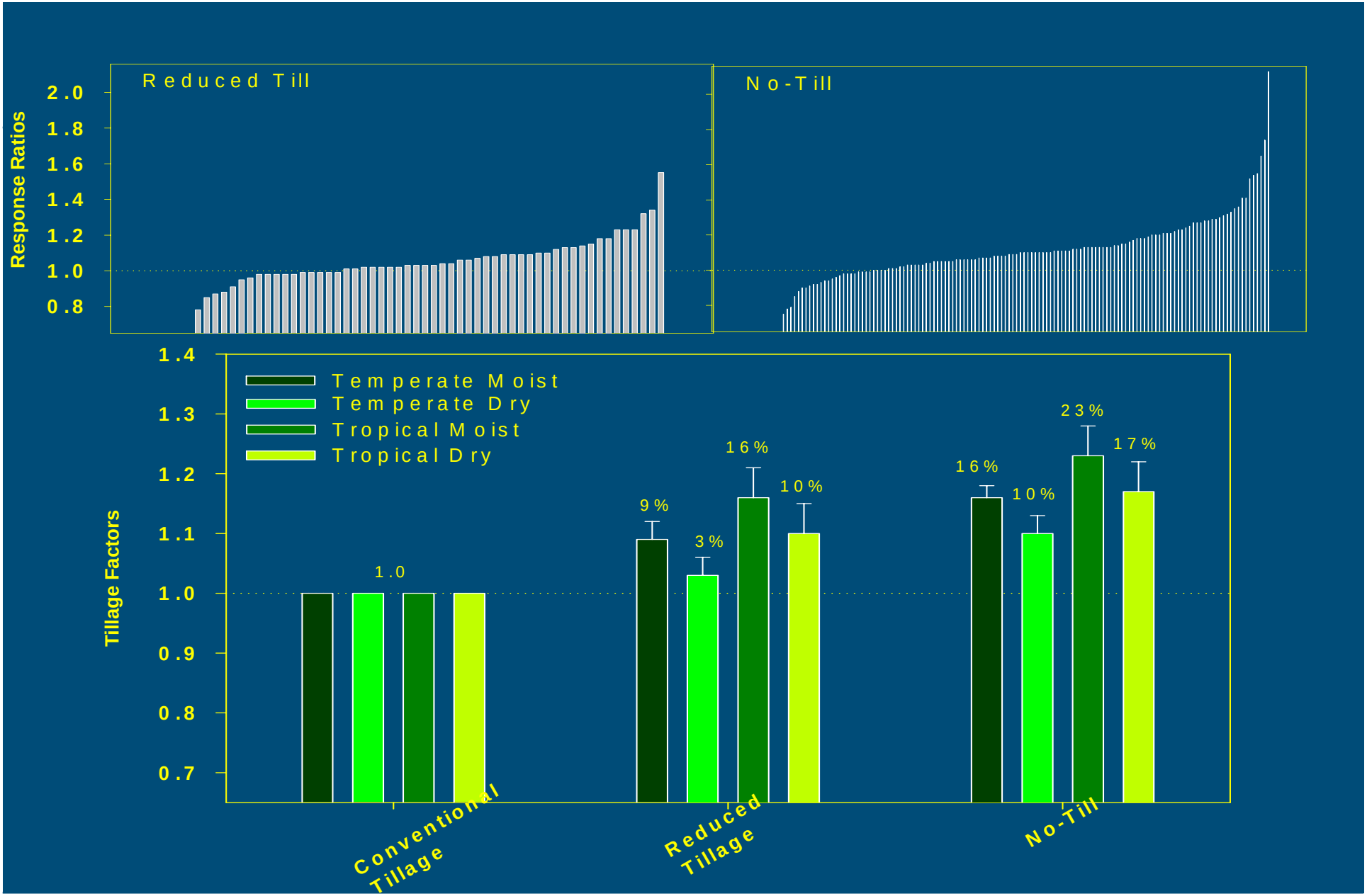
- Plus …. 4.5 CO_2-eq land-use with major uncertainties and difficult to attribute to sectors and activities

What ‘can’ or really what ‘need’ agriculture do?

- Global agricultural production still growing
- No decoupling of growth and emissions GHG-ses
- Interventions required for effective mitigation

Mitigation options

- Control Land Use change
  - Avoid deforestation & use organic soils and keep permanent grass
  - Intensification of animal production and of pasture management
- Conserve/restore C and N in cultivated soils
  - increase tree cover and live fences
  - pasture rotation and improved pasture species
- Manure management
  - balanced feeding, less methane and lowering N content
  - anaerobic digestion (methane production)
  - manure and waste application (dosing and injection)
- Enteric fermentation
  - productivity gains
  - feed formulation & rumen manipulation/control



Ogle et al. (2005)

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Per-area / per-animal mitigation potential

Climate zone	Activity	Practice	CO_2 (t CO_2 ha^{-1} y^{-1})			CH_4 (t CO_2-eq. ha^{-1} y^{-1})			N_2O (t CO_2-eq. ha^{-1} y^{-1})			All GHG (t CO_2-eq. ha^{-1} y^{-1})		
			Mean estimate	Low	High	Mean estimate	Low	High	Mean estimate	Low	High	Mean estimate	Low	High
Cool-dry	Croplands	agronomy	0.29	0.07	0.51	0.00	0.00	0.00	0.10	0.00	0.20	0.39	0.07	0.71
	Croplands	nutrient management	0.26	-0.22	0.73	0.00	0.00	0.00	0.07	0.01	0.32	0.33	-0.21	1.05
	Croplands	tillage and residue management	0.15	-0.48	0.77	0.00	0.00	0.00	0.02	-0.04	0.09	0.17	-0.52	0.86
	Croplands	water management	1.14	-0.55	2.82	0.00	0.00	0.00	0.00	0.00	0.00	1.14	-0.55	2.82
	Croplands	set-aside and LUC	1.61	-0.07	3.30	0.02	0.00	0.00	2.30	0.00	4.60	3.93	-0.07	7.90
	Croplands	agro-forestry	0.15	-0.48	0.77	0.00	0.00	0.00	0.02	-0.04	0.09	0.17	-0.52	0.86
	Grasslands	grazing, fertilizaltion, fire	0.11	-0.55	0.77	0.02	0.01	0.02	0.00	0.00	0.00	0.13	-0.54	0.79
	Organic soils	restoration	36.67	3.67	69.67	-3.32	-0.05	-15.30	0.16	0.05	0.28	33.51	3.67	54.65
	Degraded lands	restoration	3.45	-0.37	7.26	0.08	0.04	0.14	0.00	0.00	0.00	3.53	-0.33	7.40
	Manure / biosol	application	1.54	-3.19	6.27	0.00	0.00	0.00	0.00	-0.17	1.30	1.54	-3.36	7.57
	Bioenergy	soils only	0.15	-0.48	0.77	0.00	0.00	0.00	0.02	-0.04	0.09	0.17	-0.52	0.86
Cool-moist	Croplands	agronomy	0.88	0.51	1.25	0.00	0.00	0.00	0.10	0.00	0.20	0.98	0.51	1.45
	Croplands	nutrient management	0.55	0.01	1.10	0.00	0.00	0.00	0.07	0.01	0.32	0.62	0.02	1.42
	Croplands	tillage and residue management	0.51	0.00	1.03	0.00	0.00	0.00	0.02	-0.04	0.09	0.53	-0.04	1.12
	Croplands	water management	1.14	-0.55	2.82	0.00	0.00	0.00	0.00	0.00	0.00	1.14	-0.55	2.82
	Croplands	set-aside and LUC	3.04	1.17	4.91	0.02	0.00	0.00	2.30	0.00	4.60	5.36	1.17	9.51
	Croplands	agro-forestry	0.51	0.00	1.03	0.00	0.00	0.00	0.02	-0.04	0.09	0.53	-0.04	1.12
	Grasslands	grazing, fertilizaltion, fire	0.81	0.11	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.11	1.50
	Organic soils	restoration	36.67	3.67	69.67	-3.32	-0.05	-15.30	0.16	0.05	0.28	33.51	3.67	54.65
	Degraded lands	restoration	3.45	-0.37	7.26	1.00	0.69	1.25	0.00	0.00	0.00	4.45	0.32	8.51
	Manure / biosol	application	2.79	-0.62	6.20	0.00	0.00	0.00	0.00	-0.17	1.30	2.79	-0.79	7.50
	Bioenergy	soils only	0.51	0.00	1.03	0.00	0.00	0.00	0.02	-0.04	0.09	0.53	-0.04	1.12
Warm-dry	Croplands	agronomy	0.29	0.07	0.51	0.00	0.00	0.00	0.10	0.00	0.20	0.39	0.07	0.71
	Croplands	nutrient management	0.26	-0.22	0.73	0.00	0.00	0.00	0.07	0.01	0.32	0.33	-0.21	1.05
	Croplands	tillage and residue management	0.33	-0.73	1.39	0.00	0.00	0.00	0.02	-0.04	0.09	0.35	-0.77	1.48
	Croplands	water management	1.14	-0.55	2.82	0.00	0.00	0.00	0.00	0.00	0.00	1.14	-0.55	2.82
	Croplands	set-aside and LUC	1.61	-0.07	3.30	0.02	0.00	0.00	2.30	0.00	4.60	3.93	-0.07	7.90
	Croplands	agro-forestry	0.33	-0.73	1.39	0.00	0.00	0.00	0.02	-0.04	0.09	0.35	-0.77	1.48
	Grasslands	grazing, fertilizaltion, fire	0.11	-0.55	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.11	-0.55	0.77
	Organic soils	restoration	73.33	7.33	139.33	-3.32	-0.05	-15.30	0.16	0.05	0.28	70.18	7.33	124.31
	Degraded lands	restoration	3.45	-0.37	7.26	0.00	0.00	0.00	0.00	0.00	0.00	3.45	-0.37	7.26
	Manure / biosol	application	1.54	-3.19	6.27	0.00	0.00	0.00	0.00	-0.17	1.30	1.54	-3.36	7.57
	Bioenergy	soils only	0.33	-0.73	1.39	0.00	0.00	0.00	0.02	-0.04	0.09	0.35	-0.77	1.48
Warm-moist	Croplands	agronomy	0.88	0.51	1.25	0.00	0.00	0.00	0.10	0.00	0.20	0.98	0.51	1.45
	Croplands	nutrient management	0.55	0.01	1.10	0.00	0.00	0.00	0.07	0.01	0.32	0.62	0.02	1.42
	Croplands	tillage and residue management	0.70	-0.40	1.80	0.00	0.00	0.00	0.02	-0.04	0.09	0.72	-0.44	1.89
	Croplands	water management	1.14	-0.55	2.82	0.00	0.00	0.00	0.00	0.00	0.00	1.14	-0.55	2.82
	Croplands	set-aside and LUC	3.04	1.17	4.91	0.02	0.00	0.00	2.30	0.00	4.60	5.36	1.17	9.51
	Croplands	agro-forestry	0.70	-0.40	1.80	0.00	0.00	0.00	0.02	-0.04	0.09	0.72	-0.44	1.89
	Grasslands	grazing, fertilizaltion, fire	0.81	0.11	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.11	1.50
	Organic soils	restoration	73.33	7.33	139.33	-3.32	-0.05	-15.30	0.16	0.05	0.28	70.18	7.33	124.31
	Degraded lands	restoration	3.45	-0.37	7.26	0.00	0.00	0.00	0.00	0.00	0.00	3.45	-0.37	7.26
	Manure / biosol	application	2.79	-0.62	6.20	0.00	0.00	0.00	0.00	-0.17	1.30	2.79	-0.79	7.50
	Bioenergy	soils only	0.70	-0.40	1.80	0.00	0.00	0.00	0.02	-0.04	0.09	0.72	-0.44	1.89

For 14 practices, for 4 climate zones, for CO_2, N_2O & CH_4, estimates for mean and +/- 95%CI

Smith et al. (2008)

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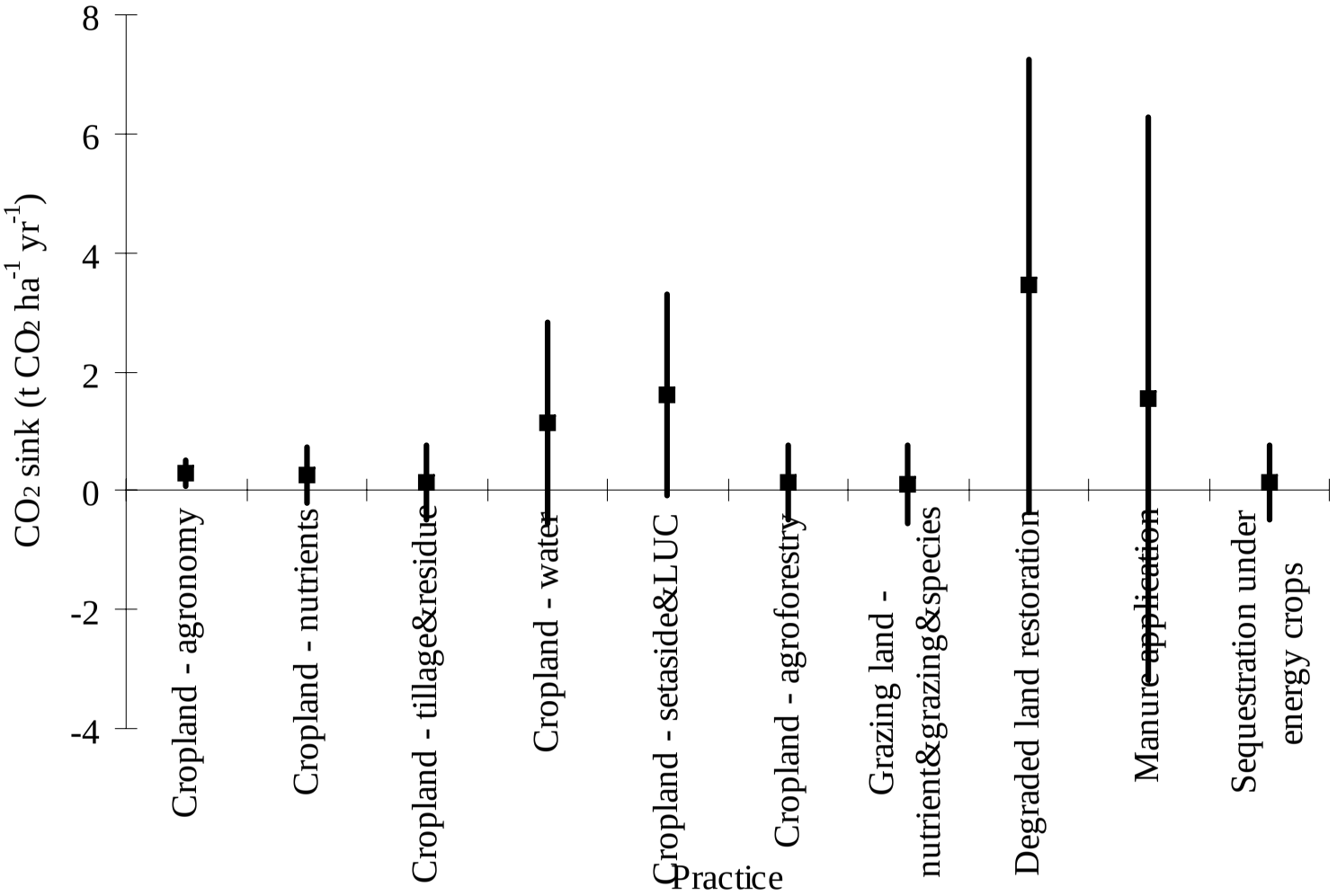
Soil C sequestration rates for cool dry climate



Data from: Smith et al. (2008)

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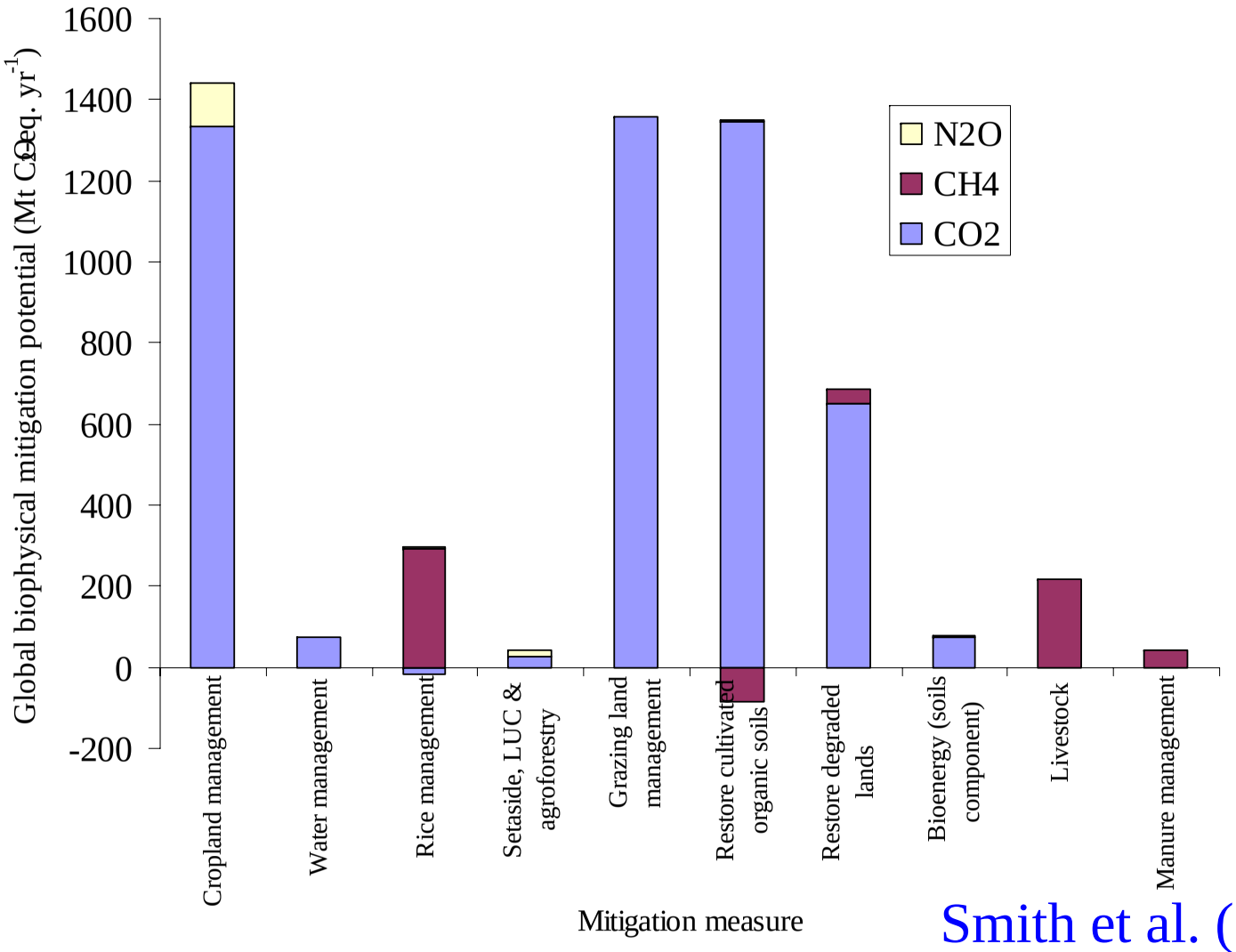
Global mitigation potential in agriculture



Smith et al. (2008)

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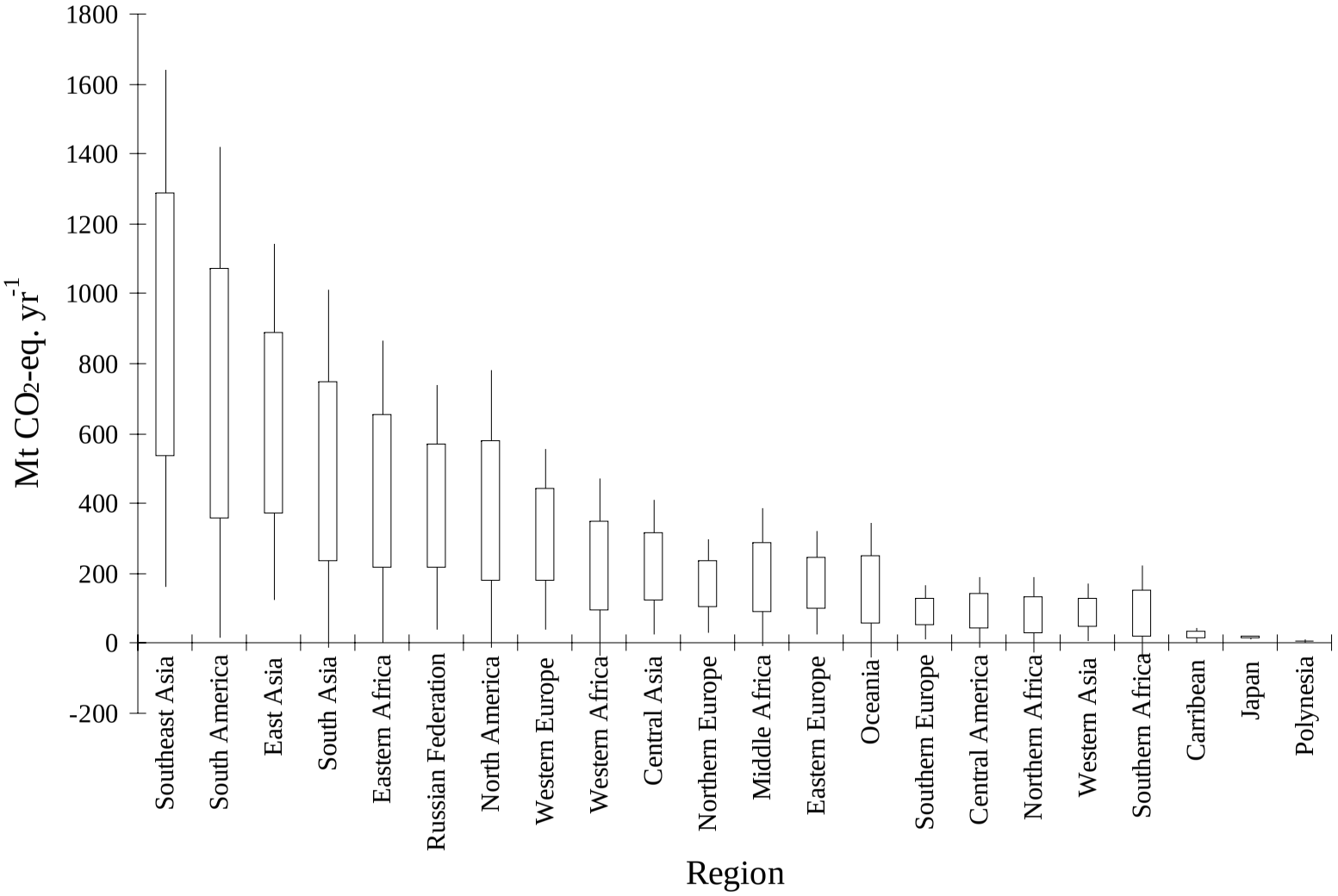
High and low potential of mitigation in each region



Smith et al. (2008)

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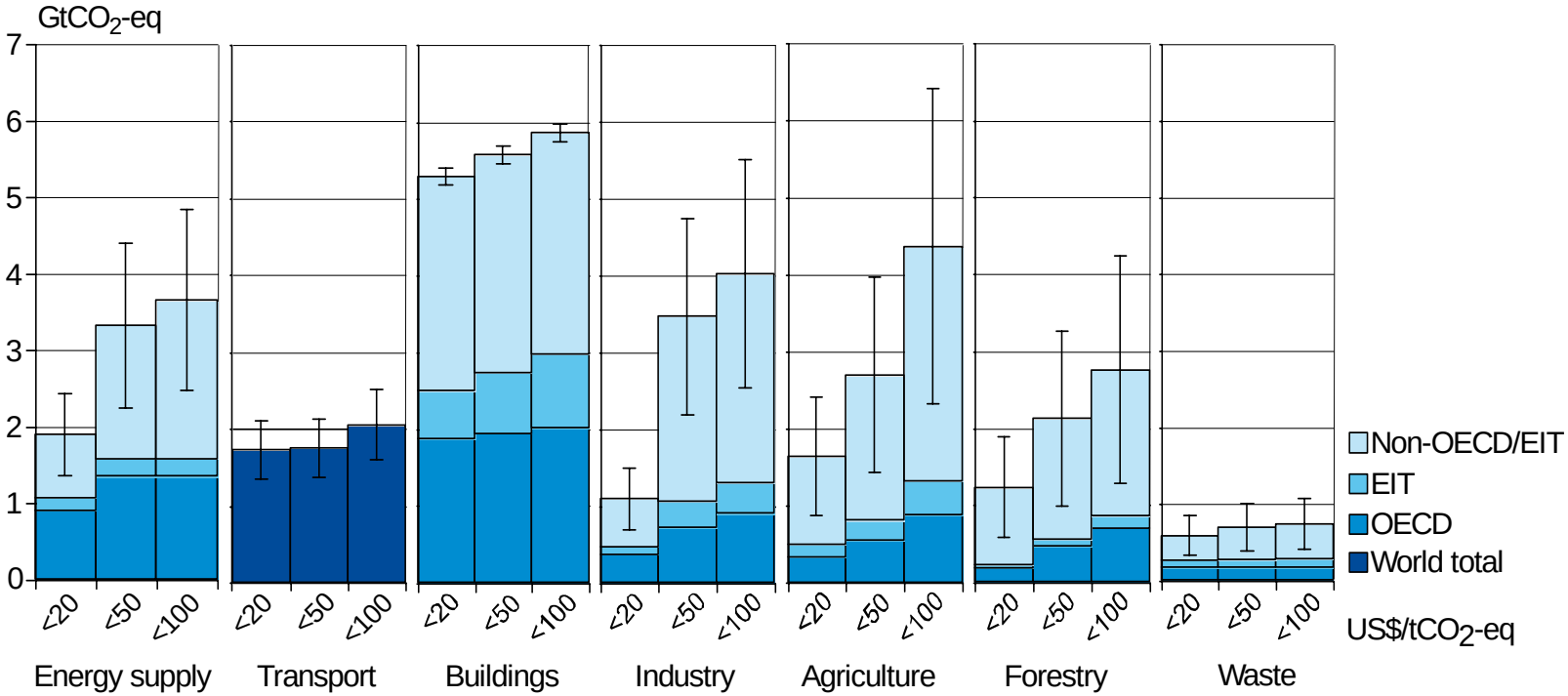
Global economic mitigation potential for different sectors at different carbon prices



IPCC WGIII (2007)

Additional mitigation from/outside 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)

Land use and change: adaptation & mitigation

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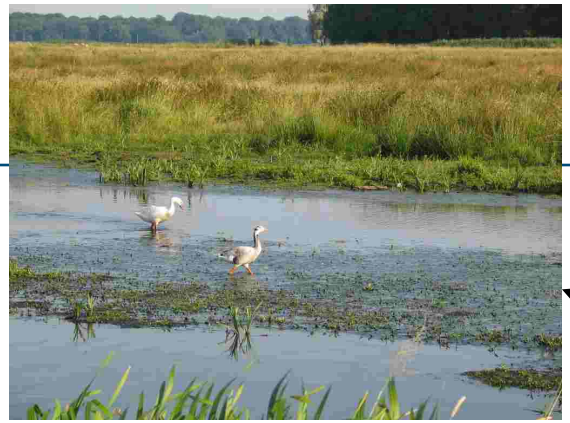
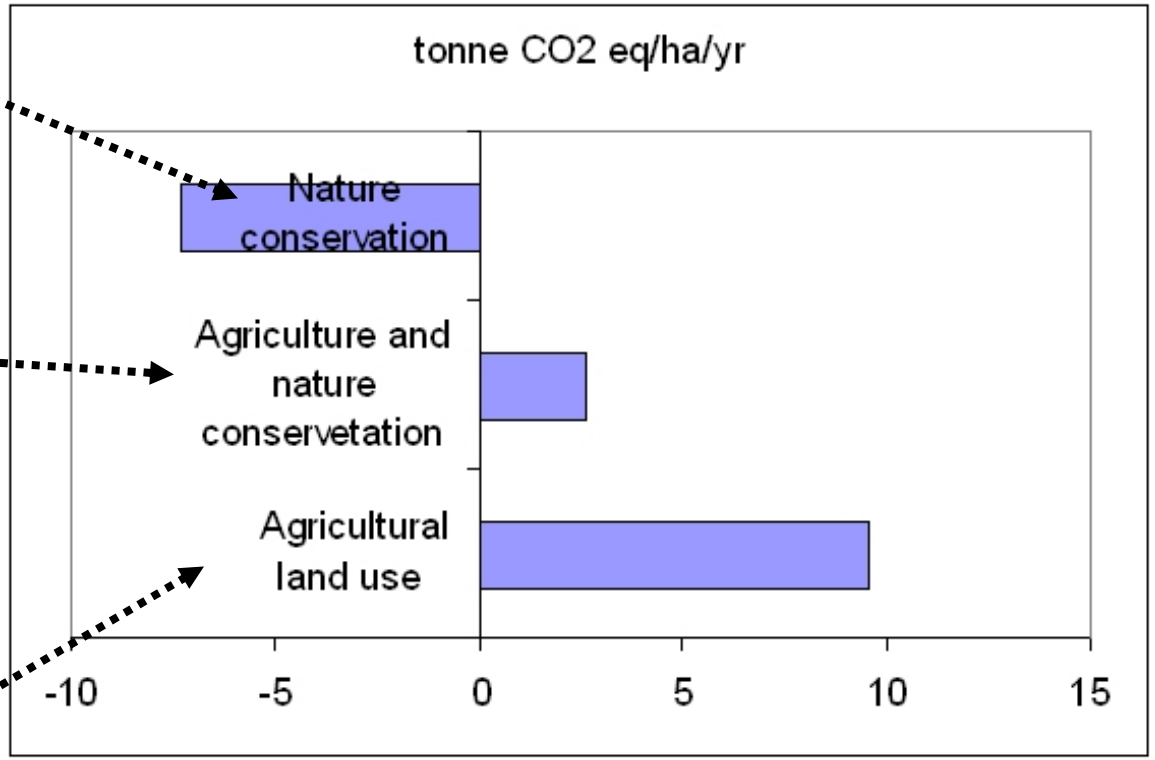
GHG balance in peat meadow area



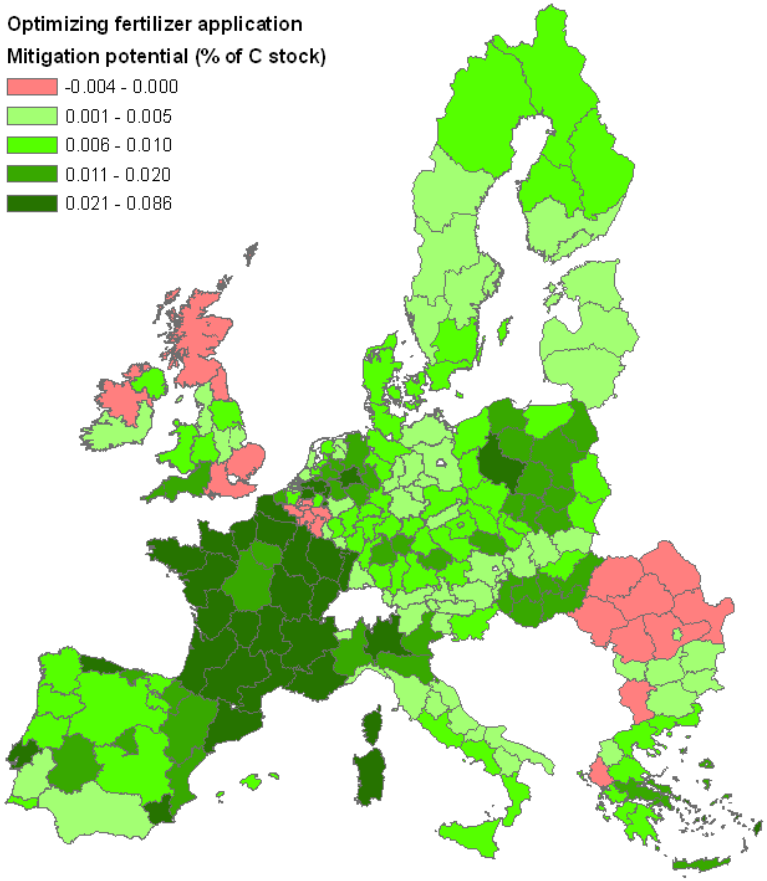


RIVM: GJ vd Born et al. 2003

EU - PICCMAT

- Assess the potential for agricultural GHG mitigation in Europe
- Assess current extent and future possibilities for GHG mitigation in European agriculture
- Assess best European options for mitigation
- Assess cost - effectiveness and feasibility of agricultural GHG mitigation options in Europe
- Examine the policy context for GHG mitigation in European agriculture, and suggest mechanisms for promoting GHG mitigation

EU PICCMAT – Optimizing fertilizer application



Mitigation potential:

4.2 Mton CO_2-eq for N_2O

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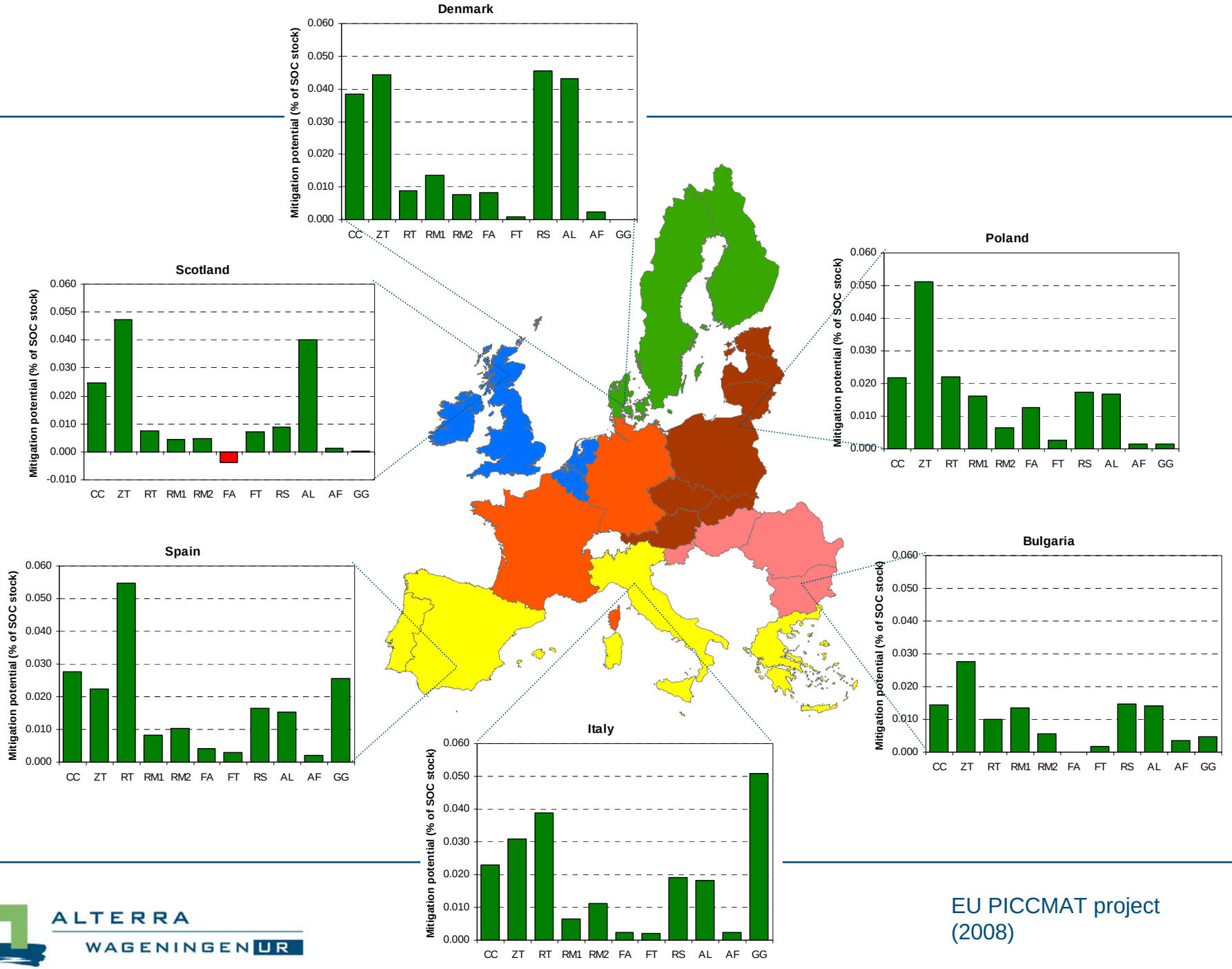

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EU PICCMAT project (2008)

Conclusions – mitigation potentials

- Agriculture has a significant role to play in climate mitigation
- Agriculture is cost competitive with mitigation options 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 – EU at work

- The potential across EU27 is region specific
- PICCMAT estimated mitigation is 15% of agricultural GHG emissions in EU today
- The preservation of existing carbon stocks is a top mitigation priority additional to the PICCMAT measures
- Bio-energy crops and improved energy efficiency in agriculture can further contribute to climate mitigation, but the savings are usually counted in other sectors

Conclusions – practical challenges

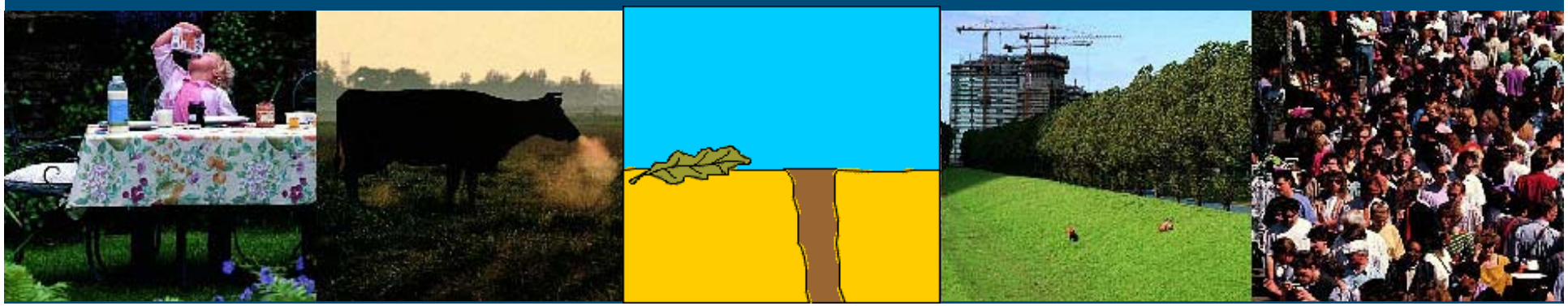
- *Structure* (how much, where) to *technology* (what) and *management* (how and strategy)
- Ultimately, all measures need to be feasible at the farm scale
- Design of specific packages required to achieve full potential – no one size fits all
- Need to choose – not all at the same time and same place!
- Awareness among farmers communities, training and education of - better - managers
- Agri complex may well be net energy producer

Conclusions – policy challenges

- Mitigation only one of many environmental constraints of farming
- Resources – brains versus money
- Assessment is complex and effects not widely been tested in fields, await verification, yet secure measures exist and political *courage* needed despite uncertainties
- Message for developed versus developing world
- Food industry and consumer awareness helps

Thank you!

And many colleagues: PICCMAT team and Pete Smith, Oene Oenema, Gerard Velthof, Jan Peter Lesschen, Rene Schils, Jan Willem van Groenigen, Gert Jan van den Born, John Porter and others



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