Livestock and GHG emissions: mitigation options and trade-offs

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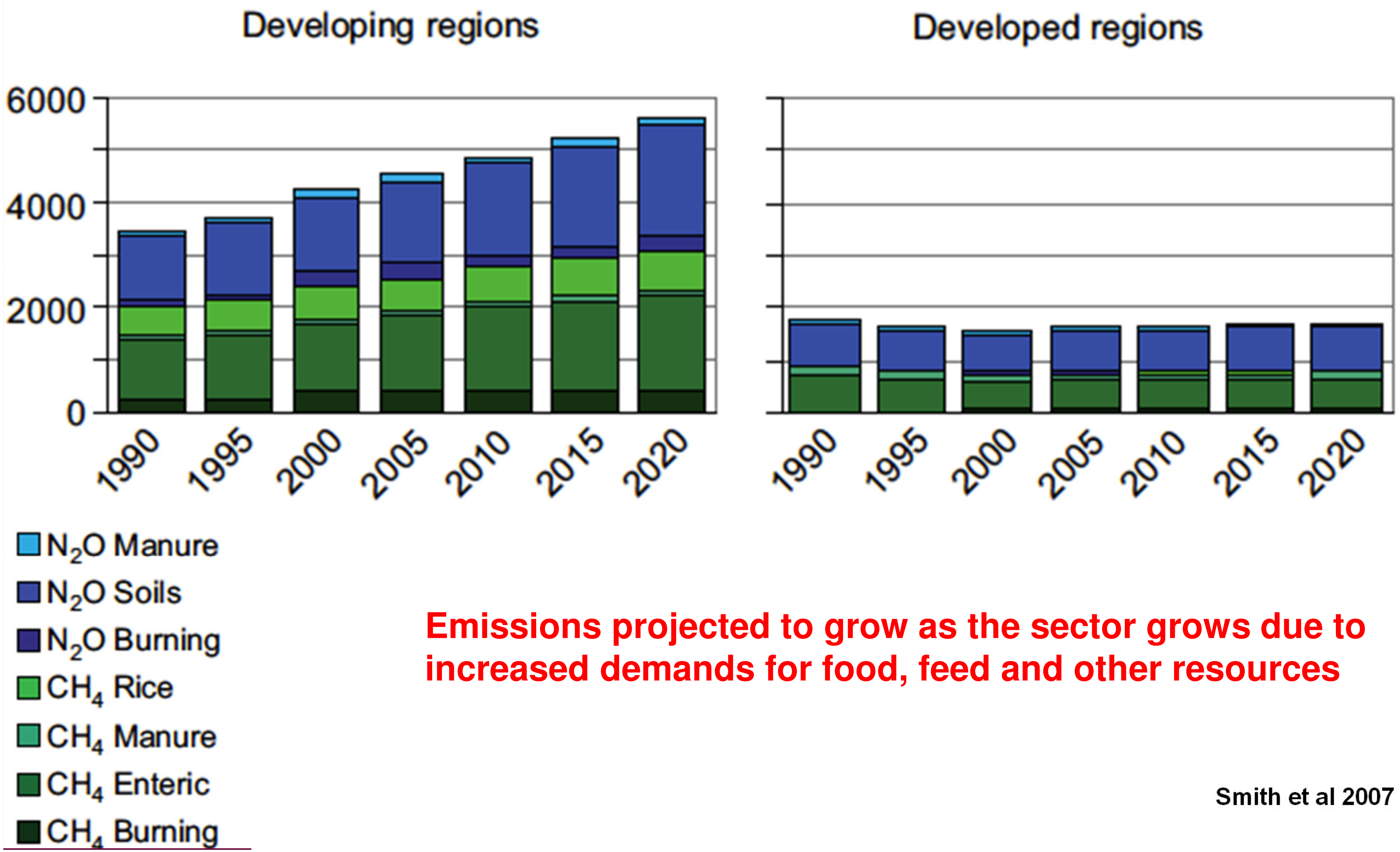
Introduction

- Livestock sector is growing
- Need to think how we could decrease its environmental footprint
- …while maintaining livelihoods, economic and social benefits
- Carbon constrained markets in the future
- Mitigation in the livestock sector a real option

Livestock and GHG emissions

Emissions from the agricultural sector



Emissions projected to grow as the sector grows due to increased demands for food, feed and other resources

Smith et al 2007

Livestock's long shadow
A food-chain perspective of GHG emissions

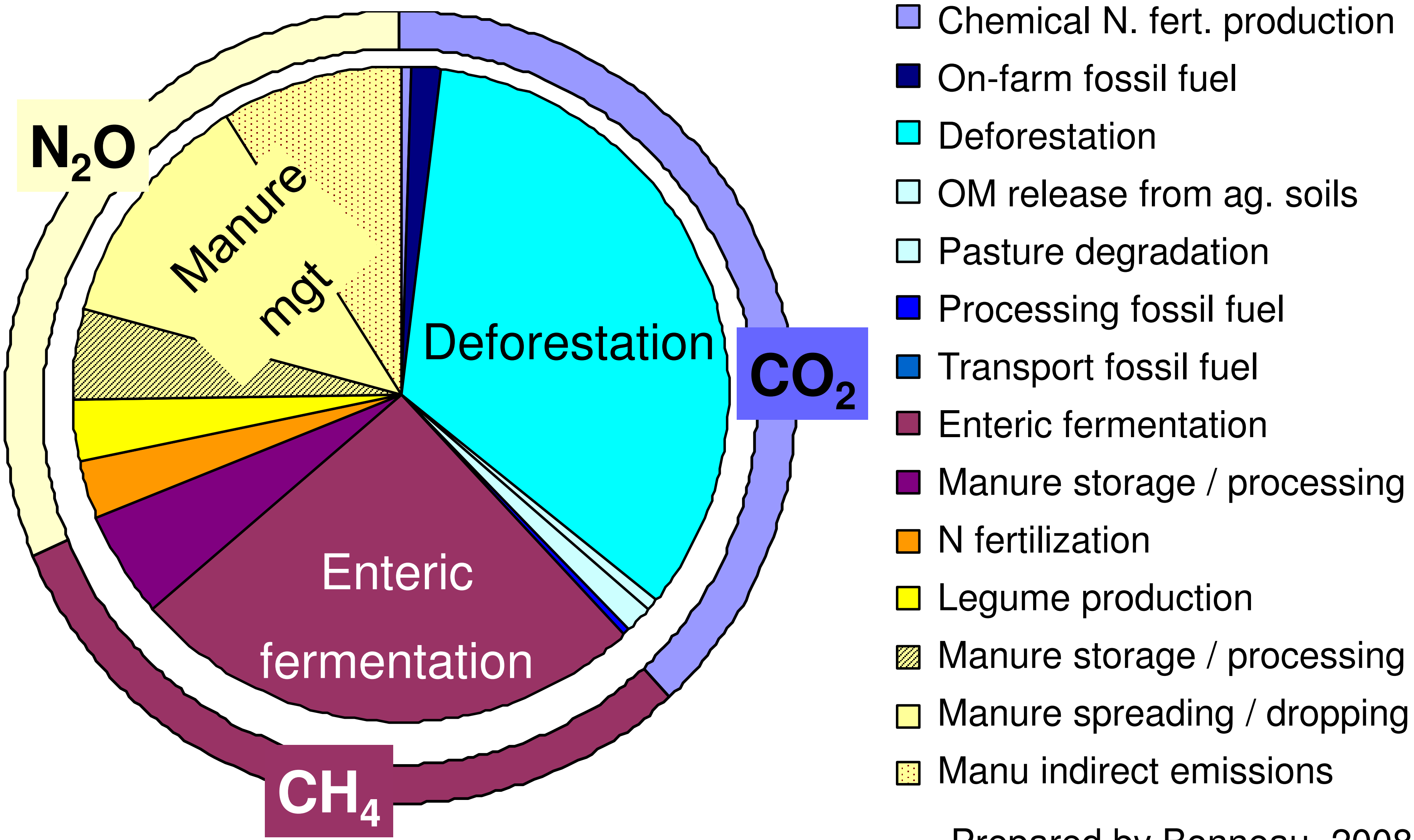
- Emissions from **feed** production
  - chemical fertilizer fabrication and application
  - on-farm fossil fuel use
  - livestock-related land use changes
  - C release from soils
  - [Savannah burning]

- Emissions from **livestock rearing**
  - enteric fermentation
  - animal manure management
  - [respiration by livestock]

- **Post harvest** emissions
  - slaughtering and processing
  - international transportation
  - [national transportation]

Steinfeld et al 2006

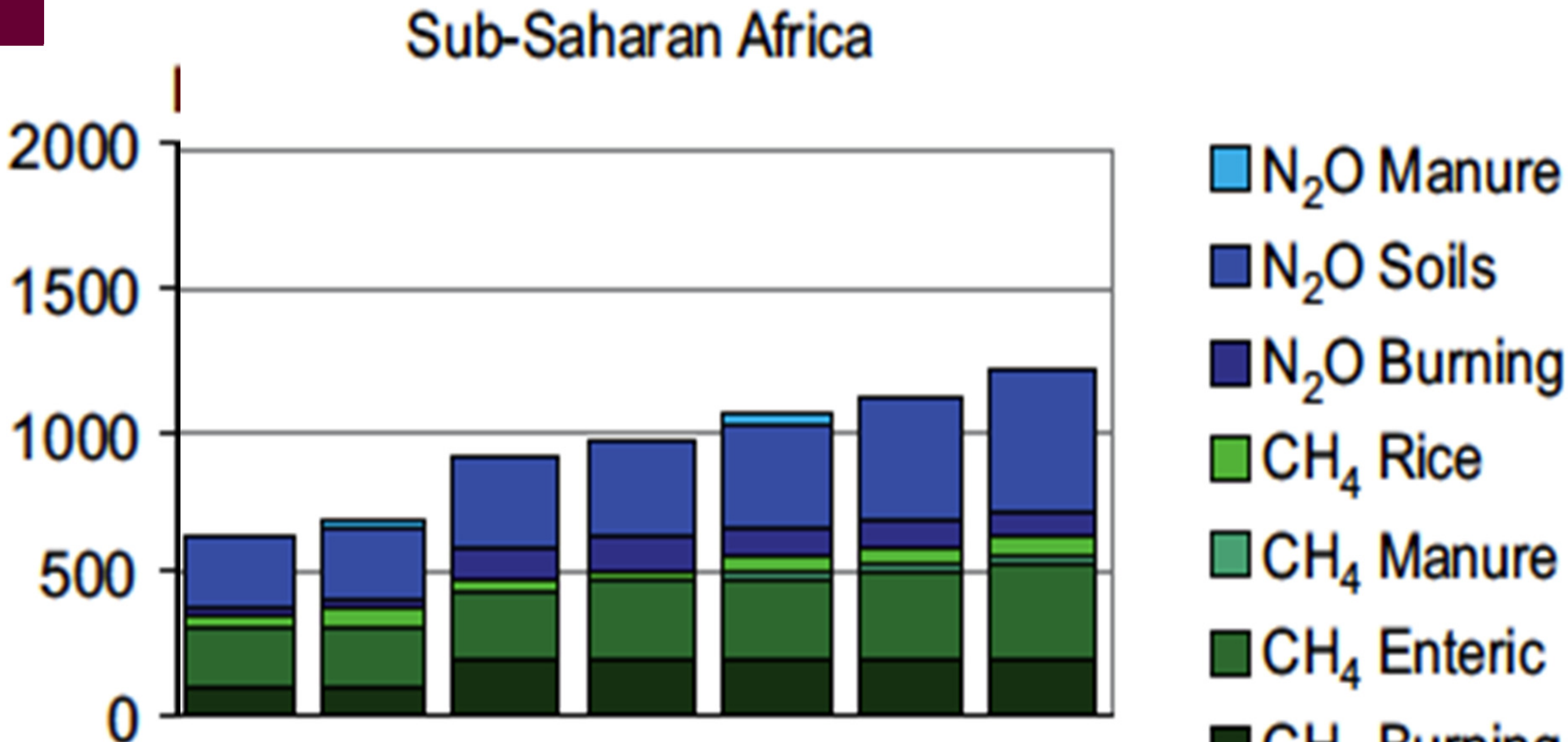
Livestock and GHG: 18% of global emissions



Prepared by Bonneau, 2008

GHG outlook 2020 Sub-Saharan Africa

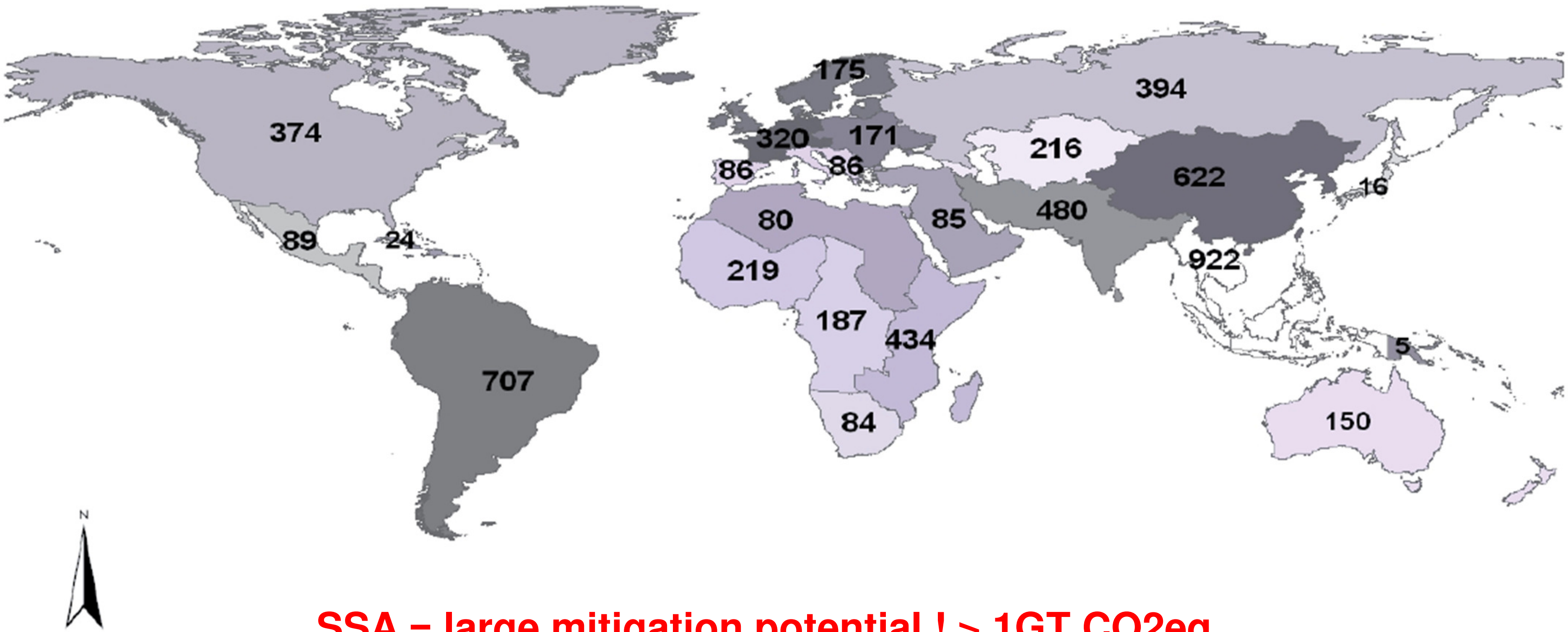
Livestock contribute 50-60% of agricultural emissions



1990 **2020**

US EPA 2006, Smith et al 2007

Mitigation potentials



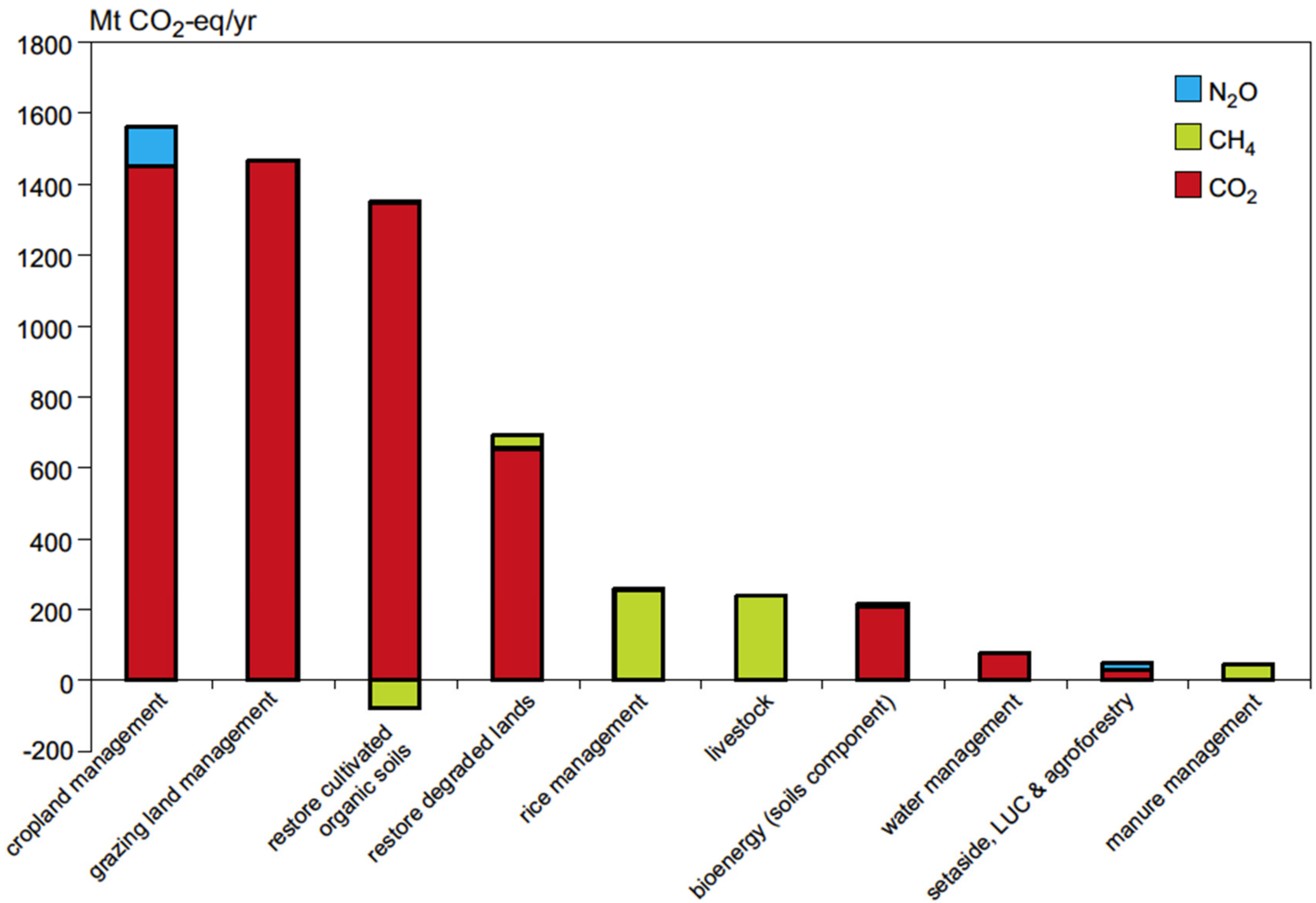
SSA = large mitigation potential ! > 1GT CO2eq

More than half of this potential associated to livestock

Smith et al 2007

Mitigation potentials

Livestock 1.7 GtCO2 eq (Smith et al 2007)



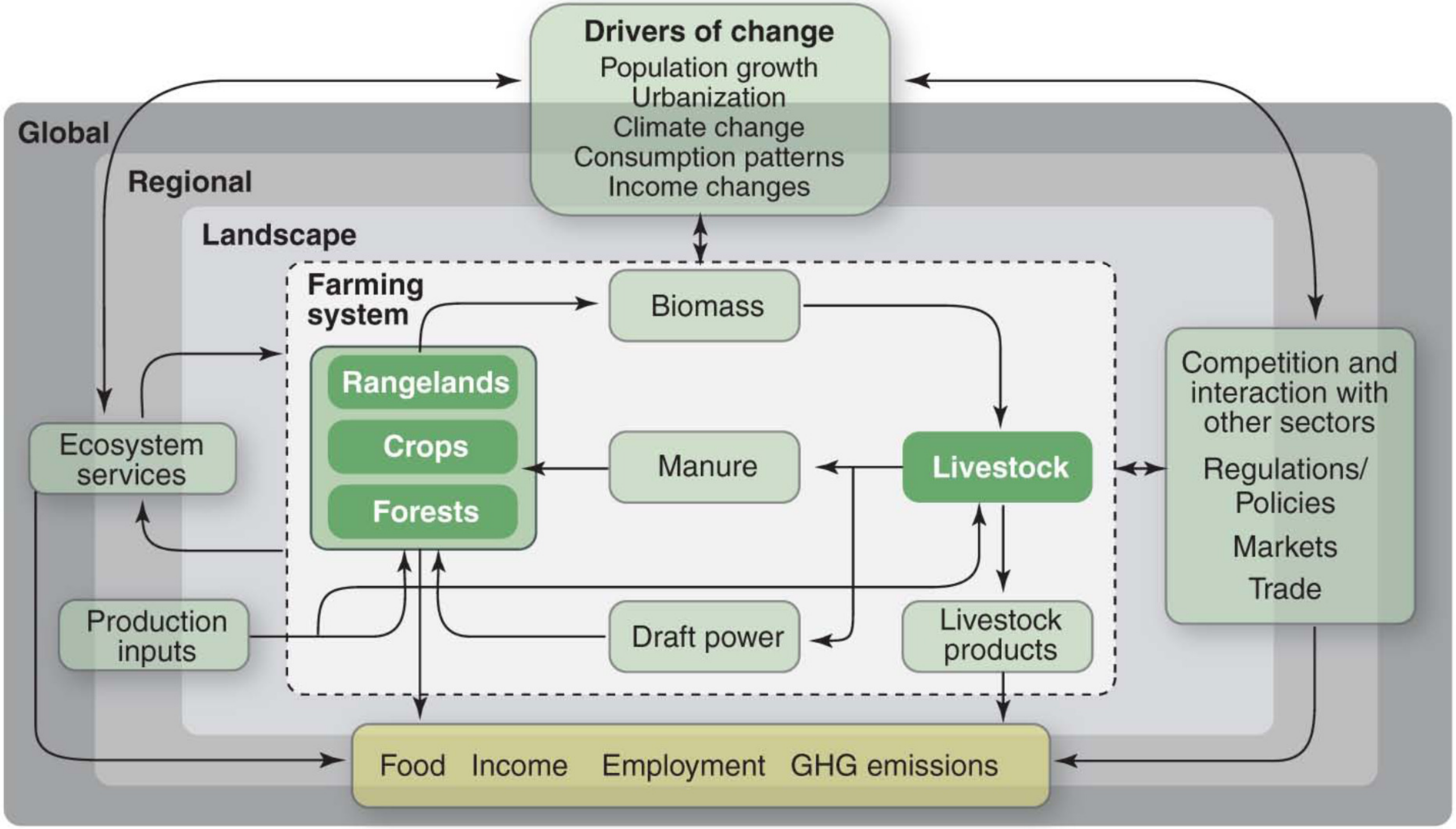
Mitigation options

		Mitigative effects[a]			Net mitigation[b] (confidence)	
Measure	**Examples**	**CO_2**	**CH_4**	**N_2O**	**Agreement**	**Evidence**
Cropland management	Agronomy	+		+/-	***	**
	Nutrient management	+		+	***	**
	Tillage/residue management	+		+/-	**	**
	Water management (irrigation, drainage)	+/-		+	*	*
	Rice management	+/-	+	+/-	**	**
	Agro-forestry	+		+/-	***	*
	Set-aside, land-use change	+	+	+	***	***
Grazing land management/ pasture improvement	Grazing intensity	+/-	+/-	+/-	*	*
	Increased productivity (e.g., fertilization)	+		+/-	**	*
	Nutrient management	+		+/-	**	**
	Fire management	+	+	+/-	*	*
	Species introduction (including legumes)	+		+/-	*	**
Management of organic soils	Avoid drainage of wetlands	+	-	+/-	**	**
Restoration of degraded lands	Erosion control, organic amendments, nutrient amendments	+		+/-	***	**
Livestock management	Improved feeding practices		+	+	***	***
	Specific agents and dietary additives		+		**	***
	Longer term structural and management changes and animal breeding		+	+	**	*
Manure/biosolid management	Improved storage and handling		+	+/-	***	**
	Anaerobic digestion		+	+/-	***	*

Smth et al 2007

Livelihoods systems = Complex production systems

Need to think of system-level mitigation practices



Herrero et al (2010) *Science* 325, 822-825

Mitigation options

- Reductions in emissions: significant potential!
  - Managing demand for animal products
  - Improved / intensified diets for ruminants
  - Reduction of animal numbers
  - Reduced livestock-induced deforestation
  - Change of animal species
  - Feed additives to reduce enteric fermentation
  - Manure management (feed additives, methane production, regulations for manure disposal)

Herrero et al. (Current Opinion in Environmental Sustainability 2009, 1: 111-120)

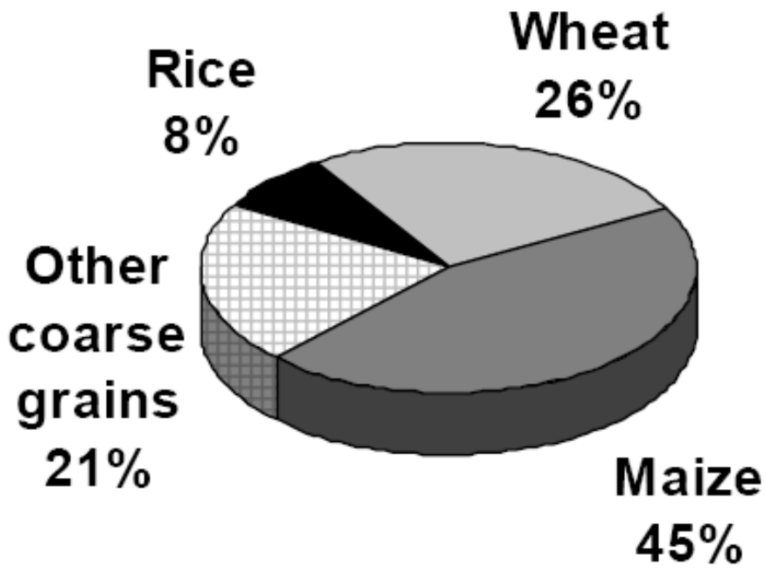
The world will require 1 billion tonnes of additional cereal grains to 2050 to meet food and feed demands
(IAASTD 2009)

Grains
1048 million tonnes
more to 2050

Livestock
430 million MT
Monogastrics mostly

biofuels
160 million MT

human consumption
458 million MT



Changing diets

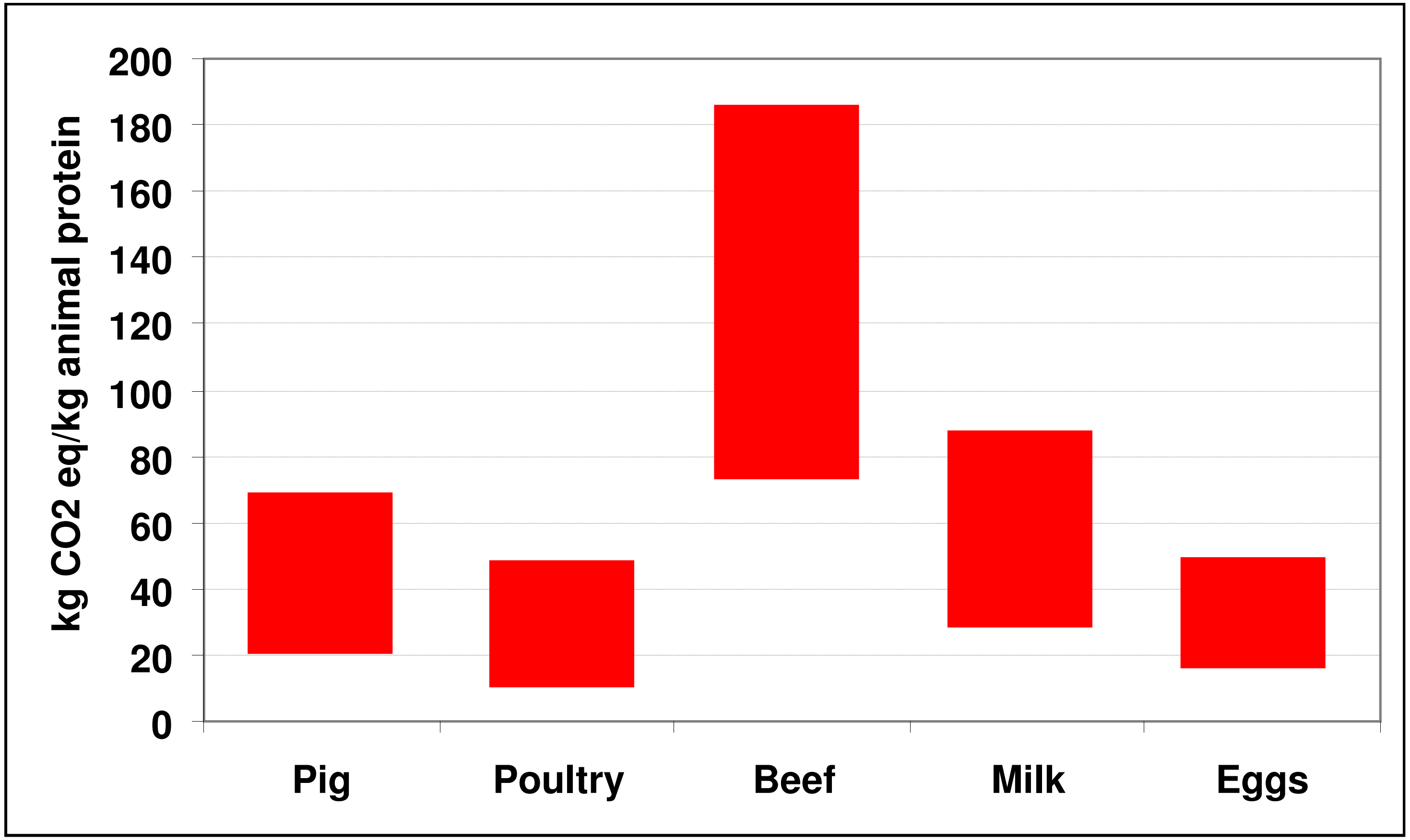
Consuming less meat or different types of meat could lower GHG emissions

Table 5 Land-use emissions in 2000 and 2050 for the reference scenario and four dietary variants

	GtC eq.
2000	3.0
2050-Reference	3.3
2050-NoRM	1.7
2050-NoM	1.5
2050-NoAP	1.1
2050-HDiet	2.1

Stehfest et al. 2009. Climatic Change

Range of GHG intensities for livestock products in OECD-countries



Source: DeVries & DeBoer (2009)

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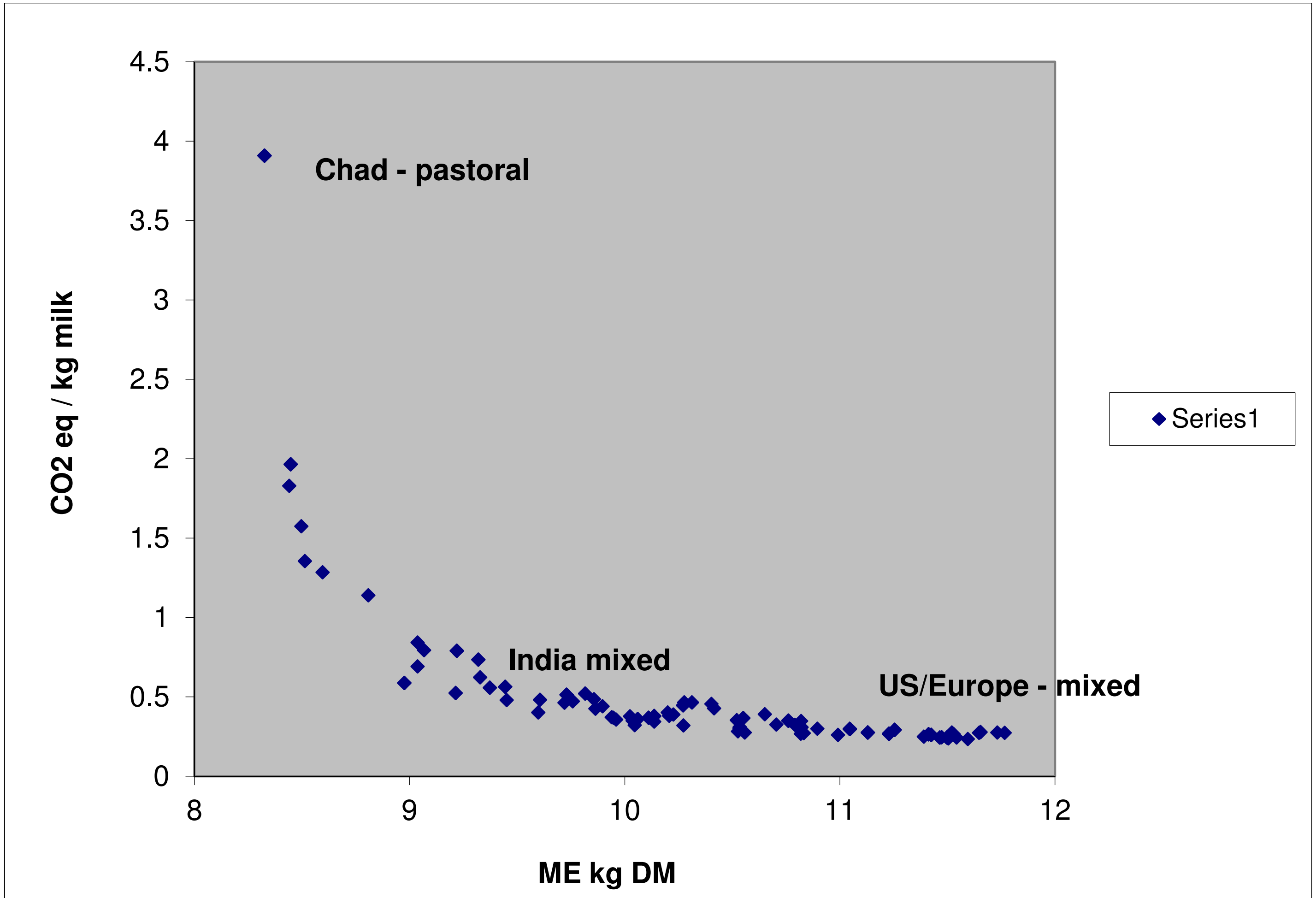
Less land needed
....but social and economic impacts?
....displacement of people?

Stehfest et al. 2009. Climatic Change

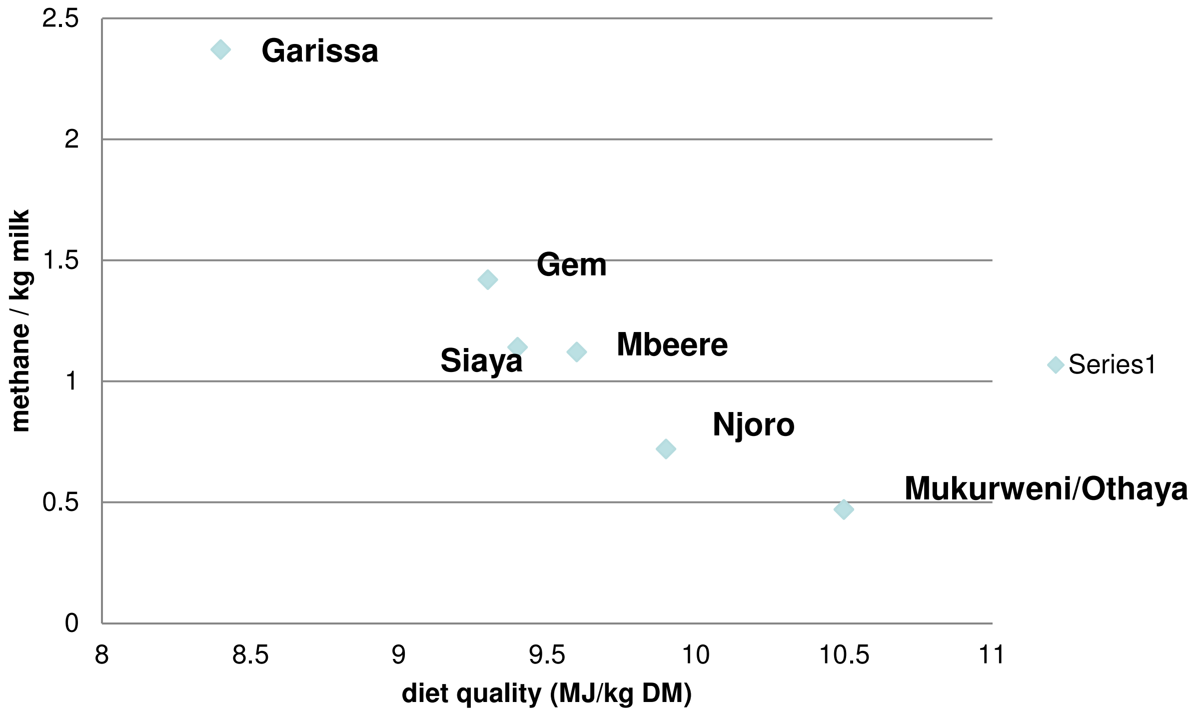
Mitigation 101 – intensification is essential

The better we feed cows the less methane per kg of milk they produce



Herrero et al (forthcoming)

Efficiency of GHG emissions from milk production in 6 districts of Kenya



Bryan et al 2012, Climatic Change (in press)

Impact of alternative feeding strategies on milk, manure and methane production (% change) (Bryan et al in press)

District	Scenario	Milk production	Manure production	Methane production	Methane per kg milk
Garissa	Prosopis				
	1.5 kg	64	0	-2	-40
	3 kg	136	0	-5	-60
Gem	Desmodium				
	1 kg	21	5	-3	-20
	2 kg	36	10	0	-26
Mbeere	Napier grass				
	2 kg	12	11	3	-8
	3 kg	17	16	2	-12
Njoro	Hay				
	1 kg	18	-5	6	-10
	2 kg	49	-5	18	-21
Mukurweni	Desmodium				
	1 kg	9	11	2	-7
	2 kg	8	11	0	-7
Othaya	Hay				
	2 kg	9	11	2	-7
	4 kg	8	11	0	-7
Siaya	Napier grass				
	2 kg	42	0	12	-21
	3 kg	79	10	16	-35
6 districts	Average	36	6	4	-20

Mitigation options – intensifying diets

Option	CH_4 production (kg) per t of		No. of bovines ($\times 10^6$) needed to satisfy demand in 2030 for		Mitigation of CH_4 via reduction in bovine nos. (Mt CO_2-eq)
	Milk	Meat	Milk	Meat	
2a. Diet intensification: stover digestibility improvement in MR, MI systems in SSA, SA					
Baseline diet[§]	58	1,958	490.1	490.1	—
100% adoption[†] of stover with 50% digestibility (from 40%)	25	548	177.0	114.3	61.6
23% adoption[†] of stover with 50% digestibility (from 40%)	50	1,634	418.1	403.6	14.2

Reduction of animal numbers needs to be considered seriously

Increasing adoption rates of mitigation practices essential also

Thornton and Herrero 2010 (PNAS 107, 19667-19672)

Can we untap the potential for carbon sequestration in rangeland systems?

Largest land use system

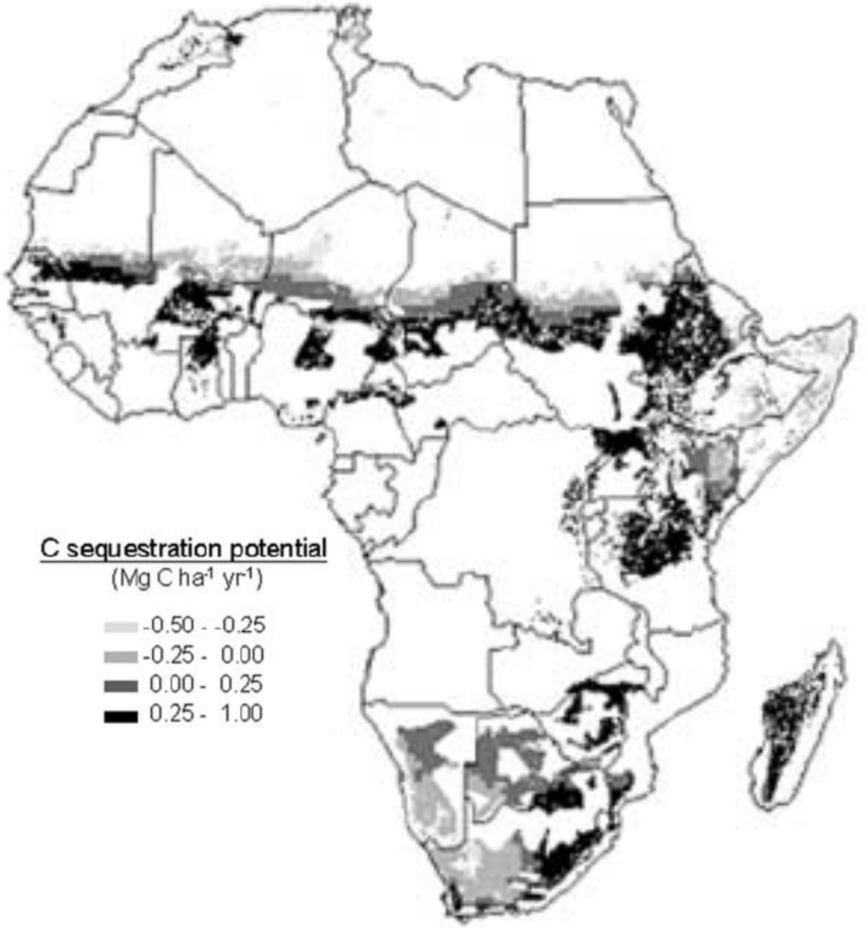
Potentially a large C sink

Could be an important income diversification source

Difficulties in:
Measuring and monitoring C stocks

Establishment of payment schemes

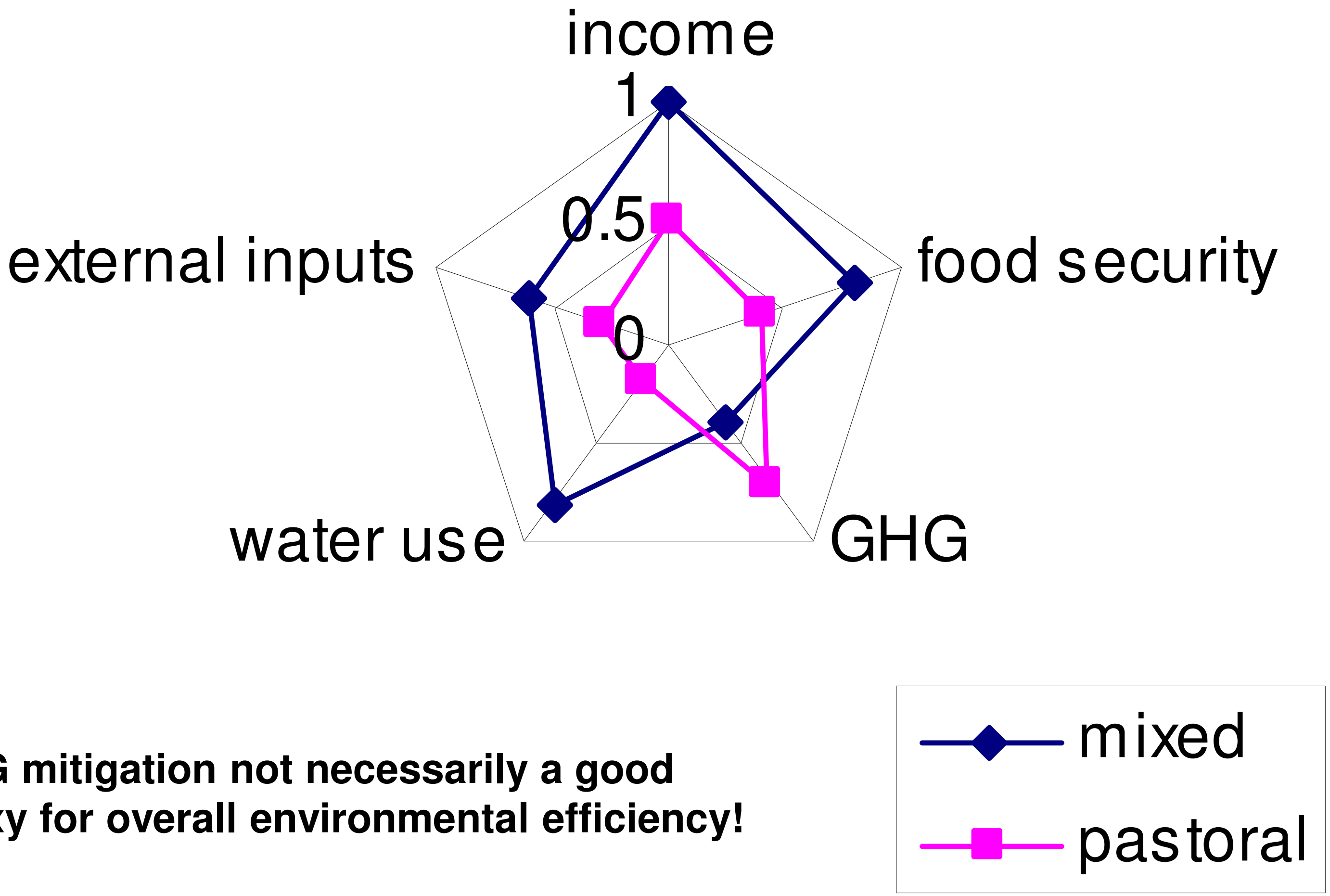
Dealing with mobile pastoralists



Potential for carbon sequestration in rangelands (Conant and Paustian 2002)

Trade-offs and synergies

Large differences depending on type of livelihood system and its objectives



GHG mitigation not necessarily a good proxy for overall environmental efficiency!

Some conclusions

- Mitigation in livestock systems: Large potential!

- Mitigation in livestock systems requires the fundamental recognition that societal benefits need to be met at the same time as the environmental ones

- Essential to link mitigation to broader agricultural development efforts to increase adoption rates of key practices

- No single option best: need packages of technologies, policies, incentives

- Understanding trade-offs requires a ‘multi-currency’ approach: energy, emissions, water, nutrients, incomes, etc along value chains (life cycles)…and adaptation/mitigation

Researchable issues

- Social and economic impacts of mitigation
- More needed on scenarios of consumption
- Mechanisms for implementing mitigation schemes (policies: carrots, sticks, institutions, etc): need to increase adoption rates!
- Carbon sequestration: worth it or not as a practice for SSA?
- What is sustainable intensification? Limits?
- Moving beyond inventory development for developing countries

Thank you!