Livestock and climate change: can we steer a path between the devil and the deep blue sea?

CGIAR

RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security

CCAFS

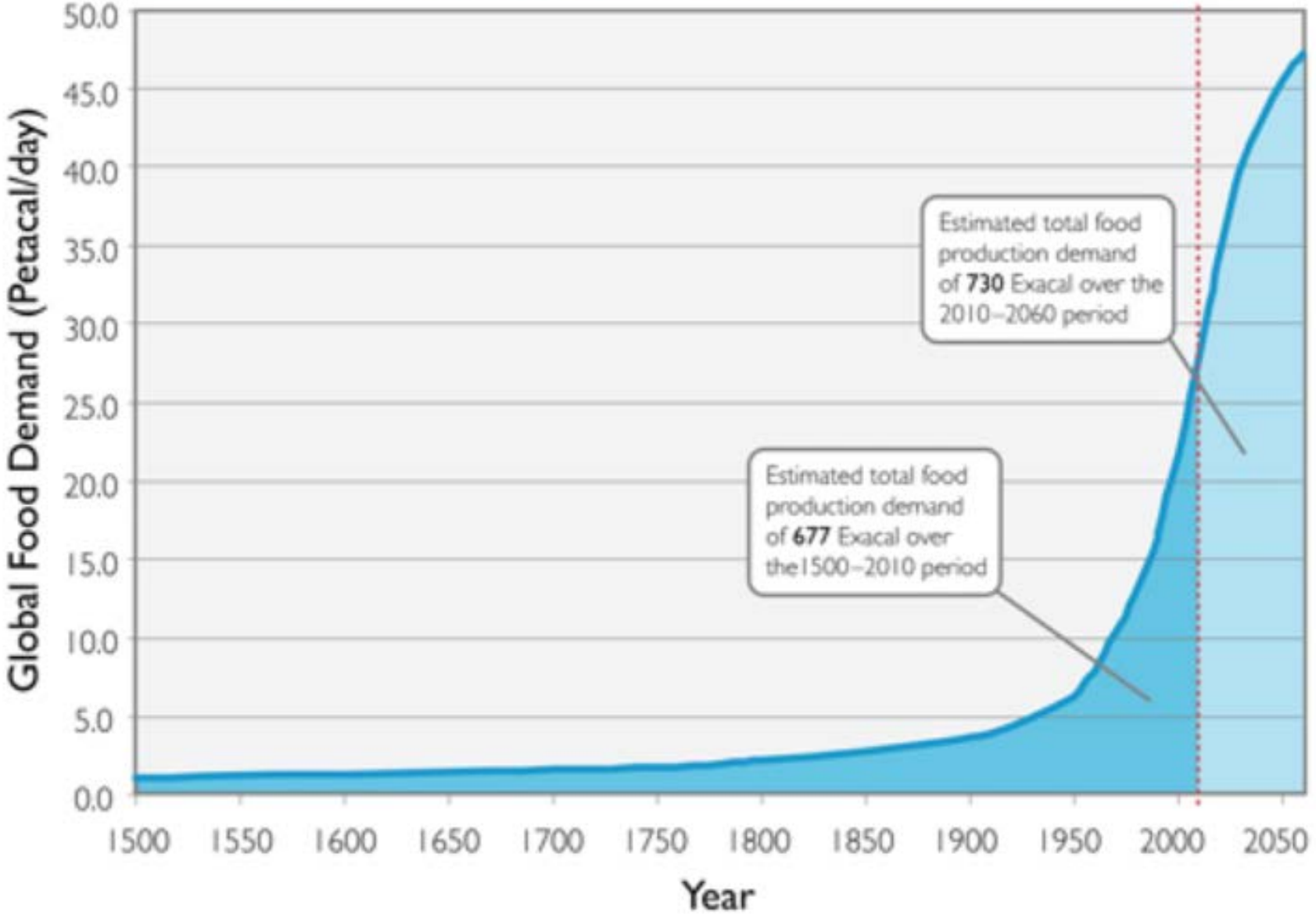
Philip Thornton

Livestock and climate change: current knowledge and policy challenges EAAP, Belfast, 30 August 2016

Outline

- The food challenge
- Impacts of climate change on livestock
- Impacts of livestock on climate change
- Issues around livestock's goods and bads
- What we need to do

The challenge to produce enough food will be greater over the next 50 years than in all human history



http://www.csiro.au/Portals/Multimedia/On-the-record/Sustainable-Agriculture-Feeding-the-World.aspx

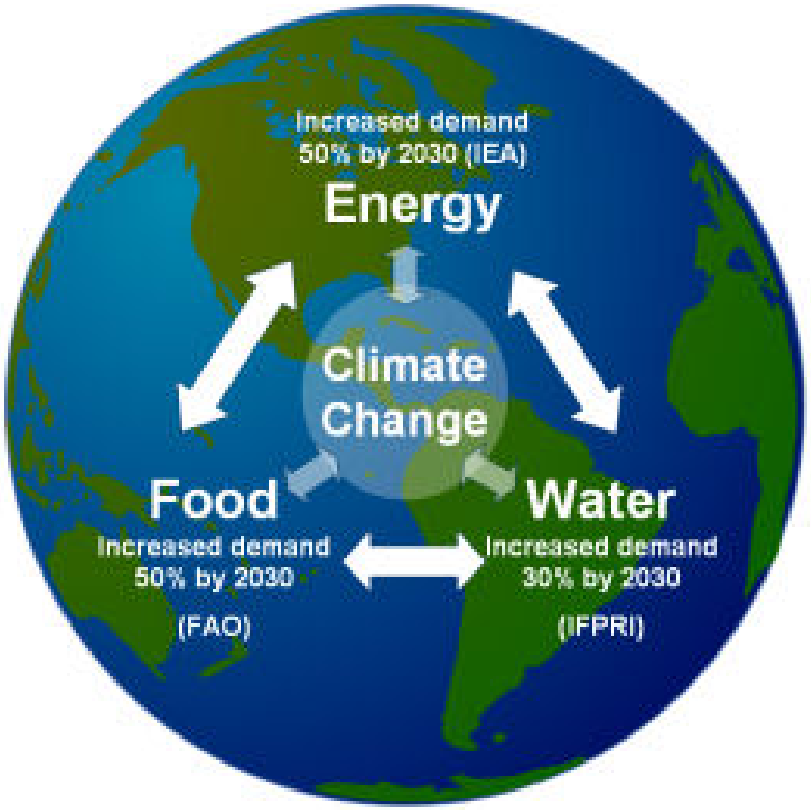
The demand for livestock products to 2050

		Annual per capita consumption		Total consumption	
	Year	Meat (kg)	Milk (kg)	Meat (Mt)	Milk (Mt)
Developing	2002 2050	28 44	44 78	137 326	222 585
Developed	2002 2050	78 94	202 216	102 126	265 295

Rosegrant et al. 2009

The challenge is …

- … to increase food production
  - in the face of climate change
  - whilst reducing the carbon cost of farming
  - but not simply by farming at lower intensity and taking more land (because there isn't enough)



Livestock messages from the IPCC's Fifth Assessment

- Prior conclusions confirmed (like crops): more evidence, higher confidence
- Only limited, semi-robust evidence (unlike crops) for impacts on livestock systems already: livestock disease, disease vectors
- For future impacts, widespread negative impacts on forage quality at both high and low latitudes → impacts on livestock productivity, production, incomes, food security
- Robust evidence for negative effects of increased temperature on feed intake, reproduction, performance across all livestock species

IPCC (2014)

Livestock messages from the IPCC's Fifth Assessment

- Impacts of increasing climate variability on downside risk, stability of livestock production, human well-being, have not been robustly elucidated

- Summaries of impacts on livestock systems with / without adaptation still not available

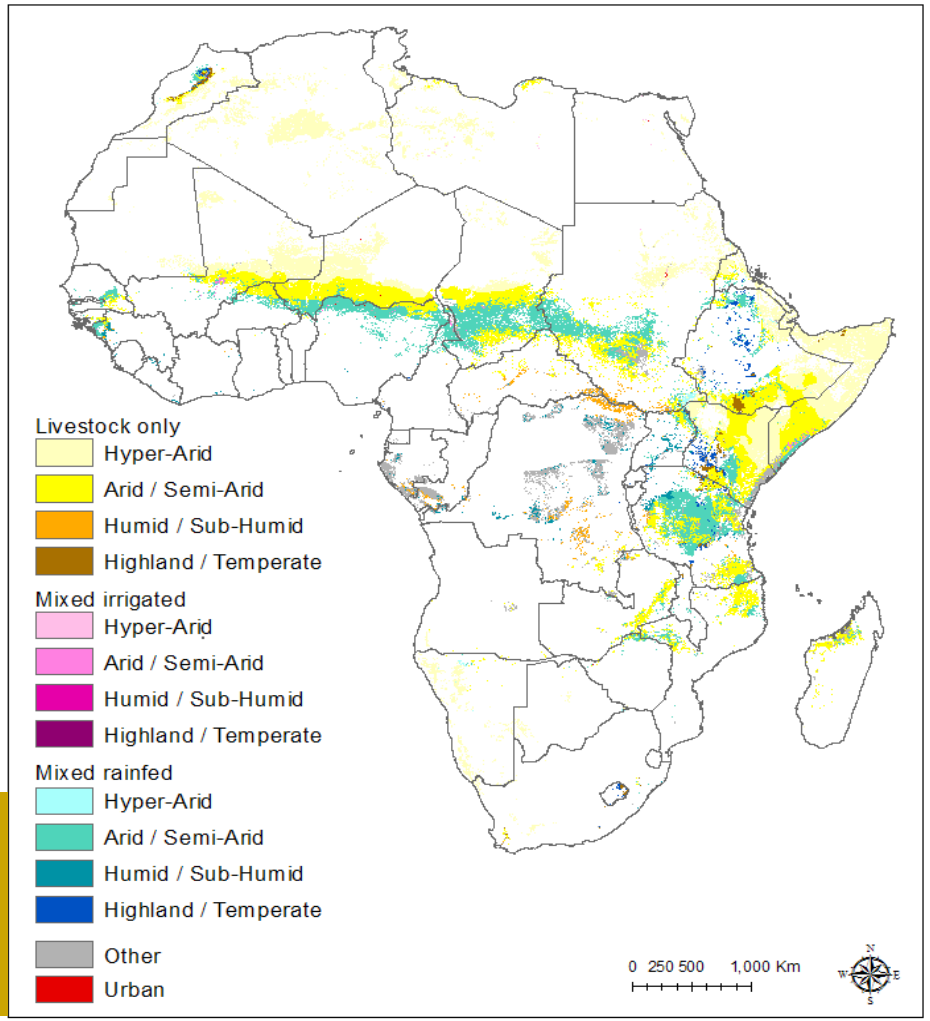
- Many adaptation options possible in livestock systems tailored to local conditions (like cropping, fishery systems)

- Costs, benefits (social, private) of adaptations not known, although:
  - Substantial benefit, particularly if implemented in combination
  - Benefits in managing crop-livestock interactions in mixed systems

IPCC (2014)

Livestock systems in some places face major challenges related to climate change

- **Disease** and pest distributions
- Quantity, quality, and composition of feed
- Increased **cost** of housing and feed
- **Water** availability and quality
- Decreased productivity due to heat stress
- Impaired reproduction/increased **mortality**



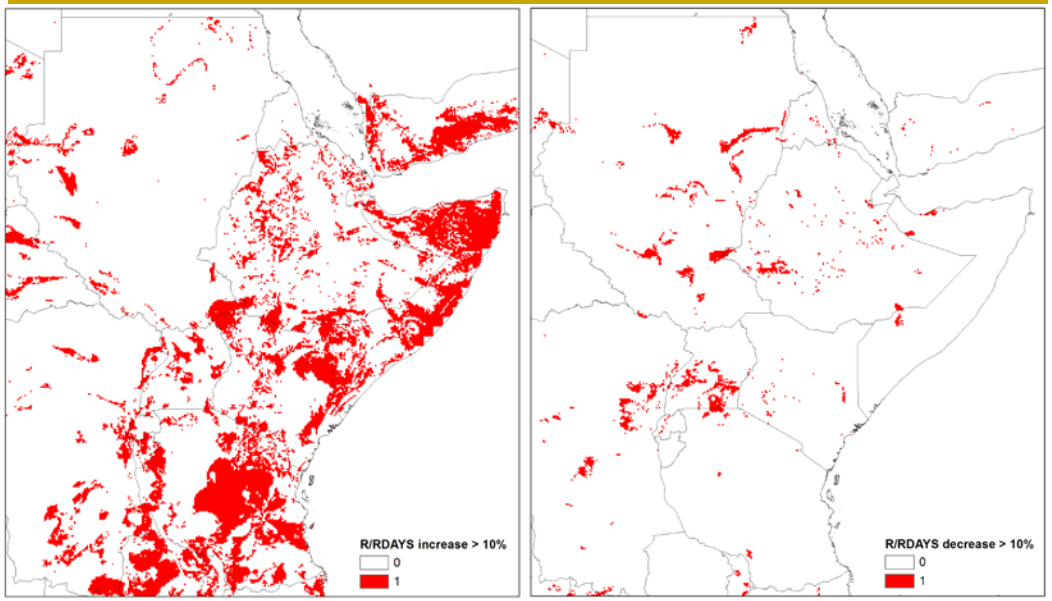
Livestock production system in areas projected to undergo over 20 per cent reduction in Length of Growing Period to 2050

Ericksen et al. (2011)

Livestock systems in some places face major challenges related to climate change

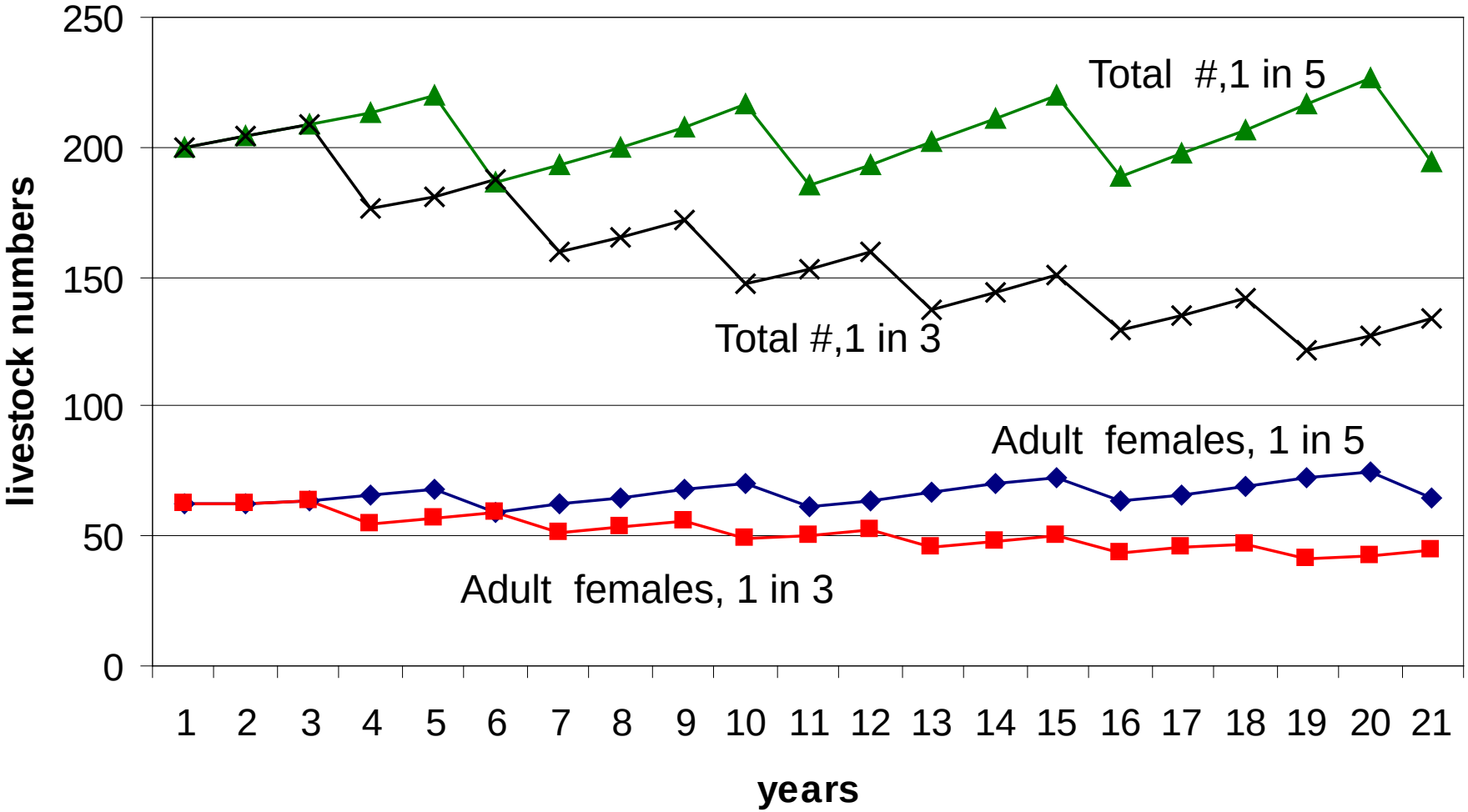
- Greatest impacts will be felt in grazing systems in **arid/semi-arid** areas
- Changes in range-fed livestock numbers proportional to change in **annual precipitation**
  - Several GCMs project **precipitation decreases of 10-20%** in semi-arid zones of Africa

Areas in East Africa where a) rain per rainy day may increase by more than 10 per cent and b) rain per rainy day may decrease by more than 10 per cent



Ericksen et al. 2011

Herd evolution in Kenyan rangelands under two scenarios of climate variability: (1) a drought once every five years, and (2) a drought once every three years

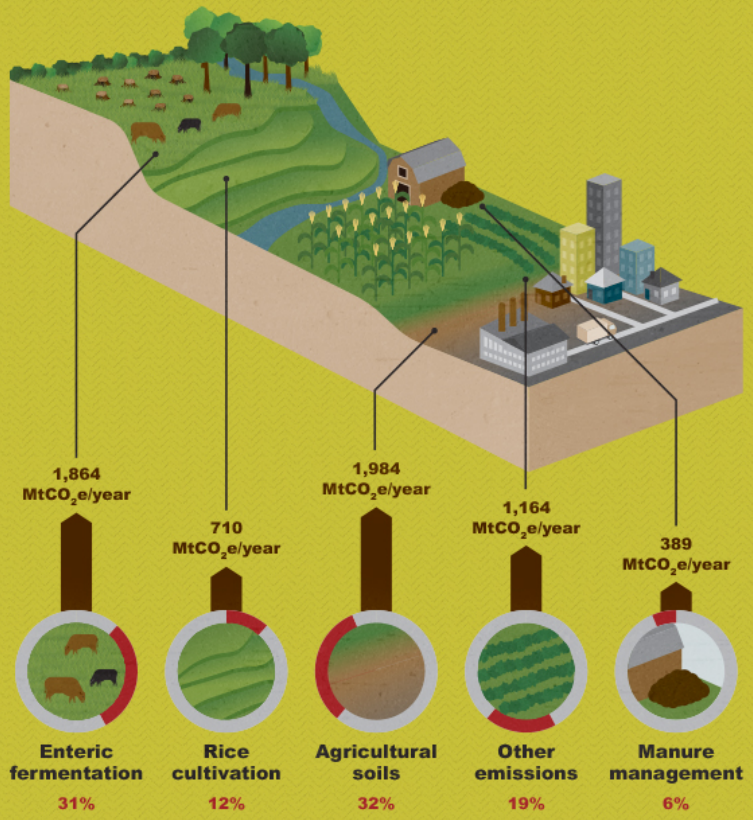


Thornton & Herrero, 2010

Direct agricultural emissions

Non-CO_2 agricultural emissions are about 6,100 million metric tonnes of carbon dioxide equivalent ($MtCO_2e$) per year—about 11 percent of total global greenhouse gas emissions and 56 percent of global non-CO_2 greenhouse gas emissions.

US-EPA, 2011



PERCENT AND AMOUNT OF DIRECT AGRICULTURAL EMISSIONS

Data from US-EPA, 2011

Big Facts

Where agriculture and climate change meet

ccafs.cgiar.org/bigfacts

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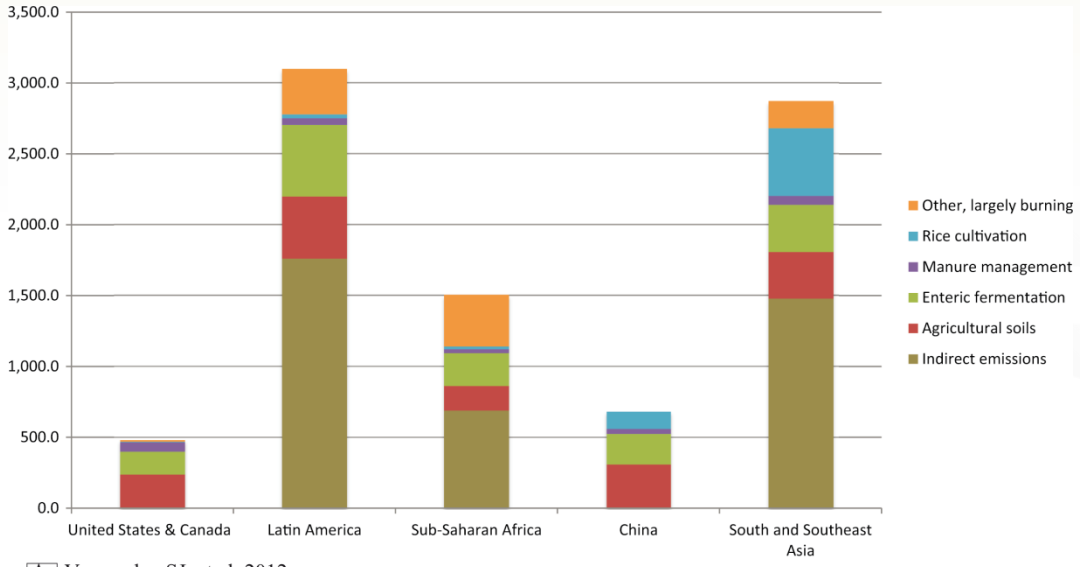
Agriculture responsible for 19-29%

Part of the problem, natural source for solutions too



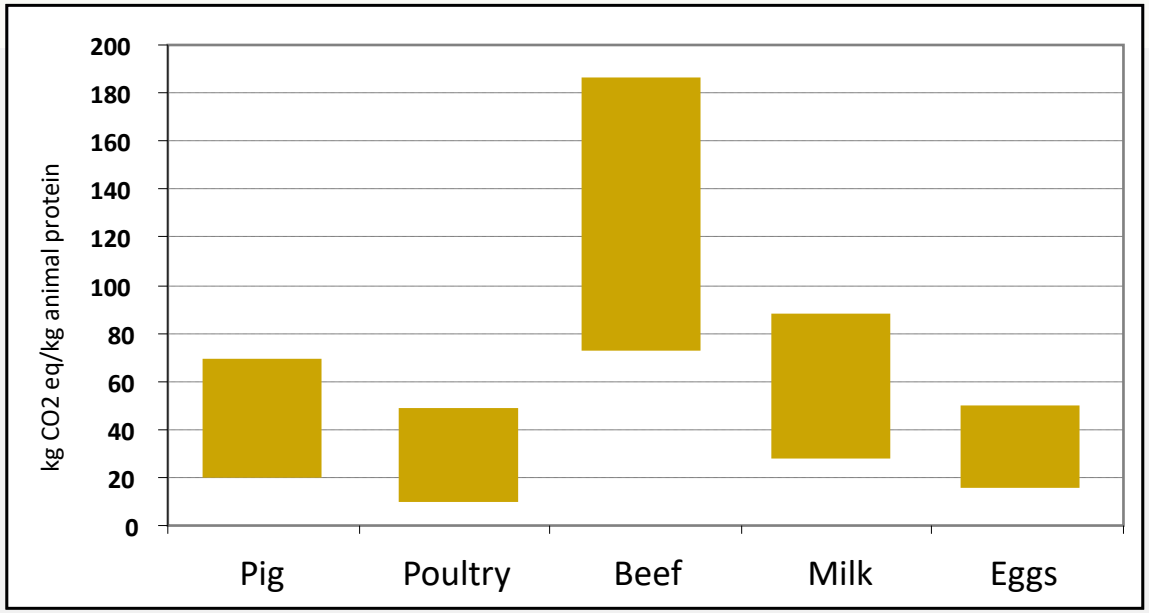
Vermeulen SJ, et al. 2012.
Annu. Rev. Environ. Resour. 37:195–222

Livestock alone is responsible for 8-18% of all global anthropogenic GHG emissions

Range arises from **methodological differences**

- Inventories vs. life cycle assessments, attribution of land use to livestock, omissions, misallocations, …

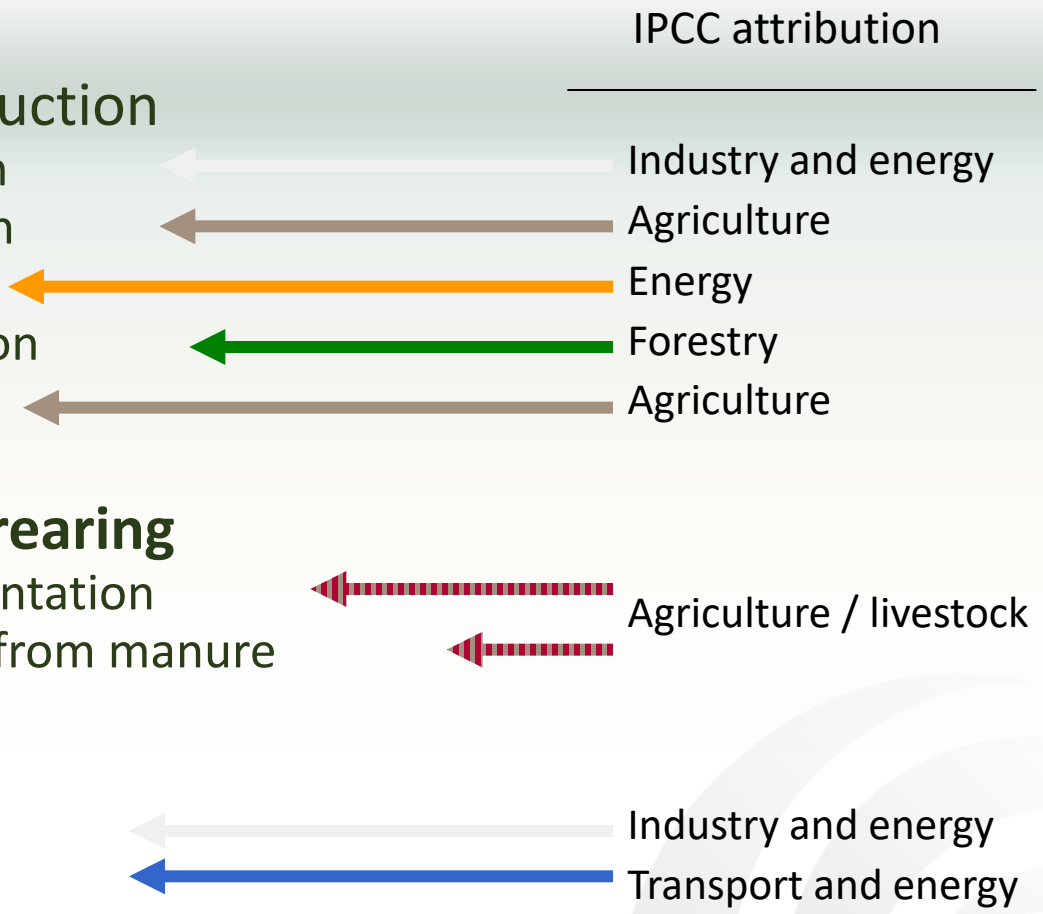
Range of GHG intensities for livestock commodities



Source: de Vries and de Boer (2009)

- Highest variation occurs for **beef**, due to variety of production systems
- Ruminants require more fossil energy use, emit more CH_4 per animal

A food-chain perspective of GHG emissions



- Emissions from **feed** production
  - chemical fertilizer fabrication
  - chemical fertilizer application
  - on-farm fossil fuel use
  - livestock-related deforestation
  - C release from ag. soils
- Emissions from **livestock rearing**
  - Methane from enteric fermentation
  - Methane and Nitrous Oxide from manure
- **Post harvest** emissions
  - slaughtering and processing
  - international transportation

Steinfeld, 2011

Livestock: some big numbers

- 20 billion domestic animals globally (FAOSTAT 2016)
- 45% of the Earth's surface (excluding Antarctica) occupied by livestock systems (Reid et al. 2008)
- 33% of global cropland used for feed production
- 8-18% of global greenhouse gas emissions (FAO 2006, 2013, Herrero et al. 2013, O'Mara 2013)
- 72% of deforestation (Nepstad et al. 2011)
- 30% of global freshwater consumption (Steinfeld et al. 2006)

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Save the planet: Stop eating meat

The UN says so, and so do a growing list of school boards. Meet the new eco enemy.

COLUMBIA JOURNALISM REVIEW

Strong Press, Strong Democracy

The Observatory — March 29, 2010 03:44 PM

Meat vs. Miles

Coverage of livestock, transportation emissions hypes controversy

By Curtis Brainard

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As More Eat Meat, a Bid to Cut Emissions

Los Angeles Times | ARTICLE COLLECTIONS

A WARMING WORLD

Pollution on the hoof

Livestock emissions are a leading source of greenhouse gases. One solution may be to eat less meat.

October 15, 2007

It's a silent but deadly source of greenhouse gases that contributes more to global warming than the entire world transportation sector, yet politicians almost never discuss it, and environmental lobbyists and other green activist groups seem unaware of its existence.

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Meat-free diet good for a healthy planet

Vegetarian restaurant owner Li Yu believes in the health benefits of plant-based eating. (Photo: China Daily)

What's on the other side of the balance?

Livestock's socio-economic benefits

- Livestock are a significant global asset: value >$1.4 trillion (excluding infrastructure that supports livestock industries) (Thornton and Herrero 2008)
- Livestock industries organised in long market chains that provide incomes and/or employ at least 1.3 billion people (LID 1999)
- Livestock GDP: 30-40% of agricultural GDP (Nigeria 7%, Tanzania 26%, Ethiopia 25%). In developing countries, most livestock production is from ruminants (Nigeria 73%, Eth 93%, TZ 90%)
- Livestock important as a risk management tool, especially for the poor: ~430 million poor livestock keepers (Thornton in FAO/ILRI 2011)
- Livestock are key for nutritional security: 17% of the global kilocalories and 33% of protein (FAOSTAT 2008); Africa, 8% of calories

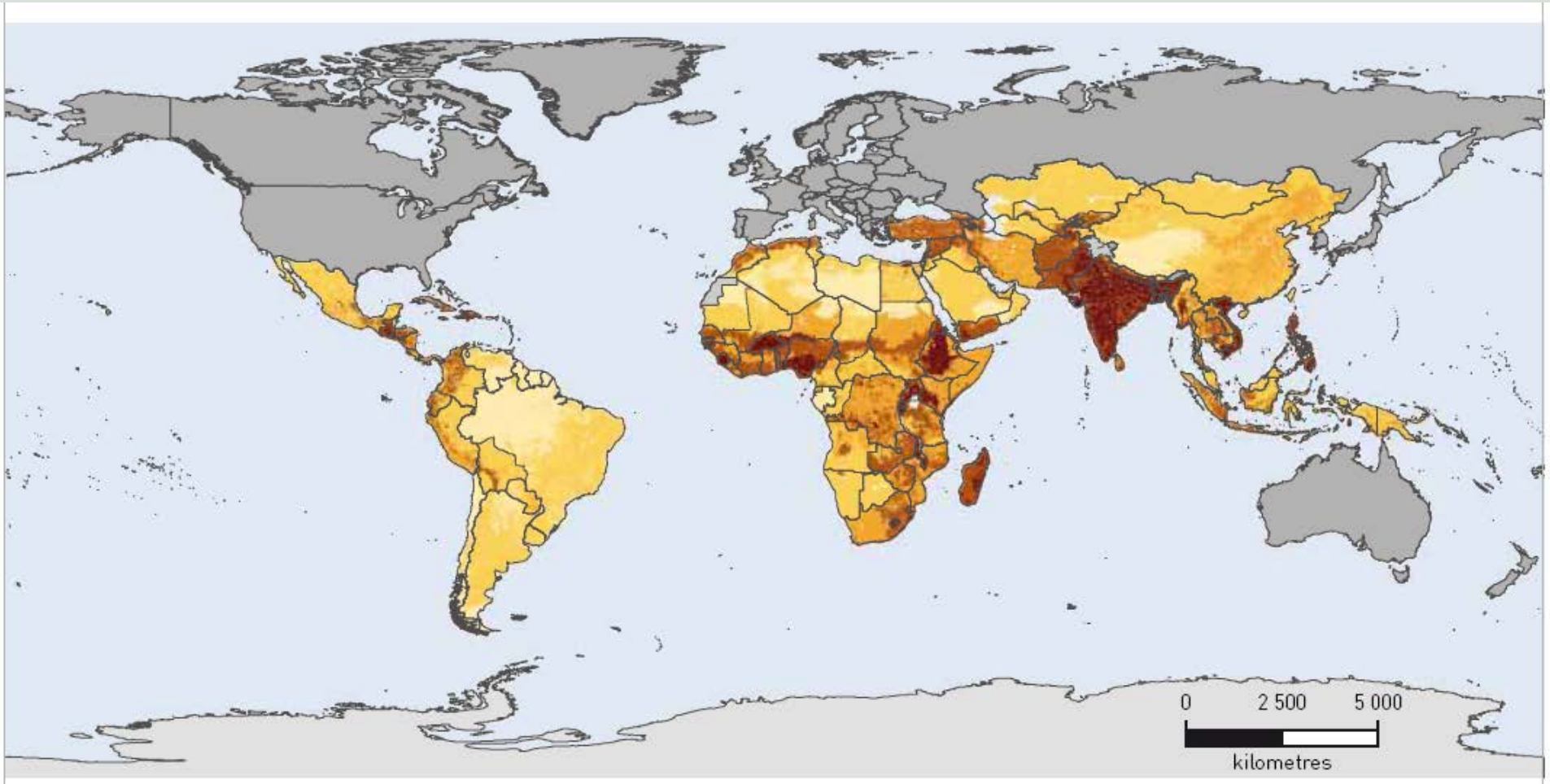
African and Asian livelihoods continue to depend on livestock

COUNTRY AND YEAR	SHARE OF RURAL HOUSEHOLDS OWNING LIVESTOCK	SHARE OF INCOME FROM LIVESTOCK[1]	SHARE OF LIVESTOCK PRODUCTION SOLD	NUMBER OF LIVESTOCK HELD PER RURAL HOUSEHOLD[1]
		(Percentage)		*(TLU[2])*
Africa				
Ghana (1998)	50	4	23	0.7
Madagascar (1993)	77	13	47	1.6
Malawi (2004)	63	9	9	0.3
Nigeria (2004)	46	4	27	0.7

FAO 2011

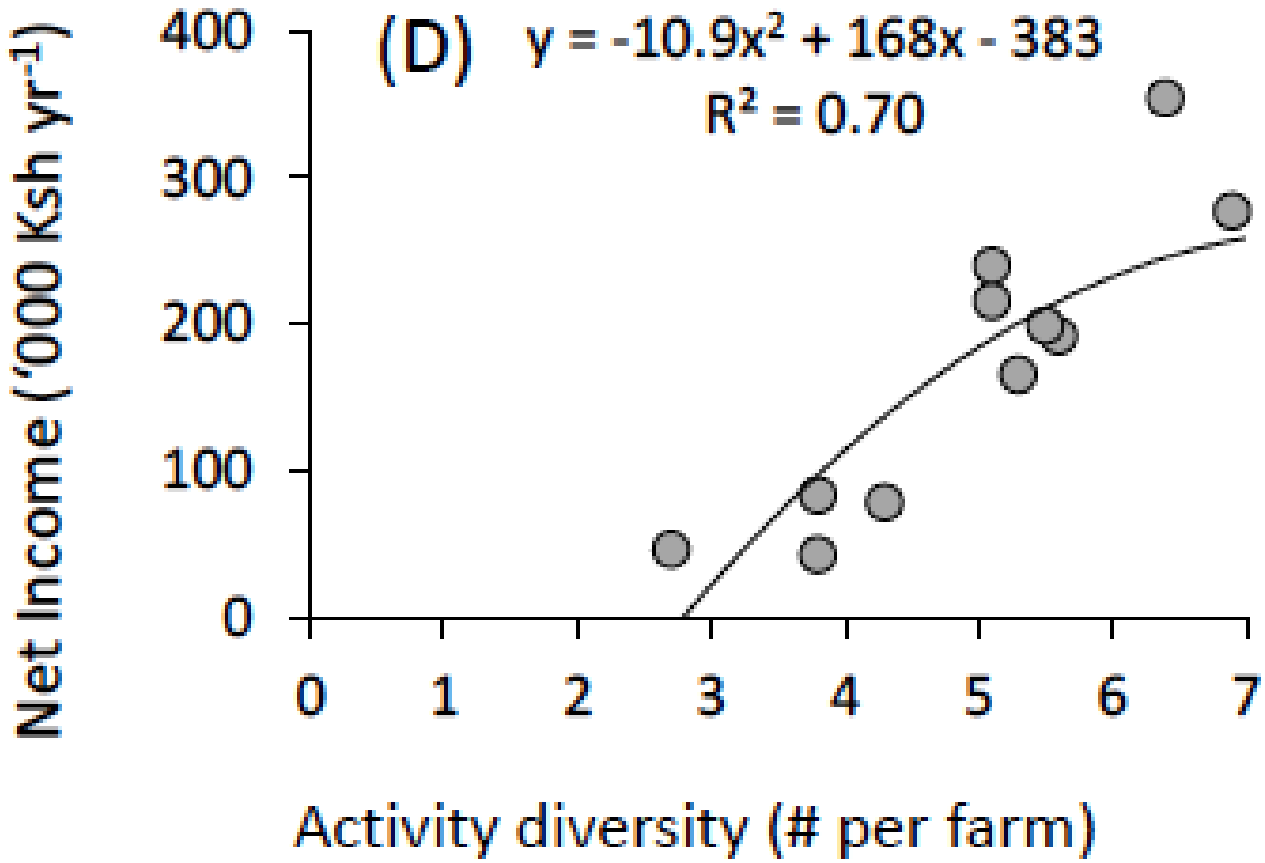
- E Africa: **40-50%** meat comes from pastoral systems, but transitioning to mixed crop-livestock
- Concentrated in **arid/semi-arid** zones
- Use of animals for **draft power** has increased over most of Africa: from 350,000 to 2 million oxen in the past 50 years in W Africa alone

Density of “poor livestock keepers” using national rural poverty lines, 2010



>430 million PLKs globally.
Thornton in Robinson et al. (2011)

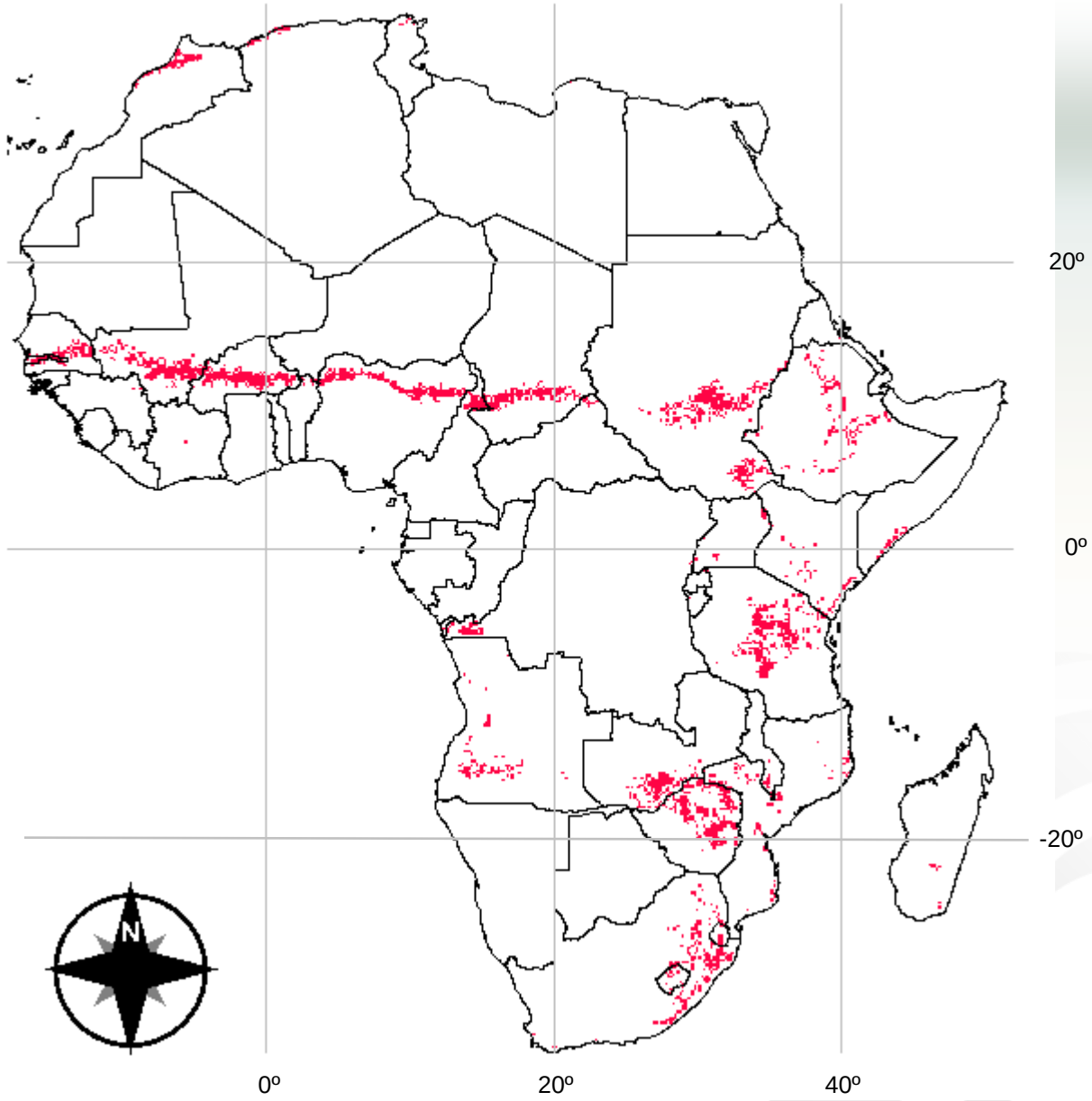
Diversification in low-rainfall areas of East Africa



Rufino et al. (2014)

Climate-induced livelihood transitions out of crops into livestock?

Areas where cropping of an indicator cereal may become unviable between now and 2050 and where farmers may have to rely more on livestock as a livelihood strategy



Jones & Thornton (2008)

Livestock a key ingredient of diverse, sustainable and healthy diets?

Country	Edible protein fed to livestock 1000 MT (A)	Edible protein provided by livestock 1000 MT (B)	Ratio (B/A)
Ethiopia	9	150	16.9
New Zealand	70	709	10.1
India	4,403	1,023	4.3
Brazil	3,304	3,854	1.2
Netherlands	752	773	1.0
China	11,129	8,454	0.8
United States	16,158	8,543	0.5

Steinfeld, based on FAOSTAT (2005-2007 average)

Steering a path between the devil and the deep blue sea: can we sustainably balance livestock's goods and bads?

Yes, in several (often additive) ways, including:

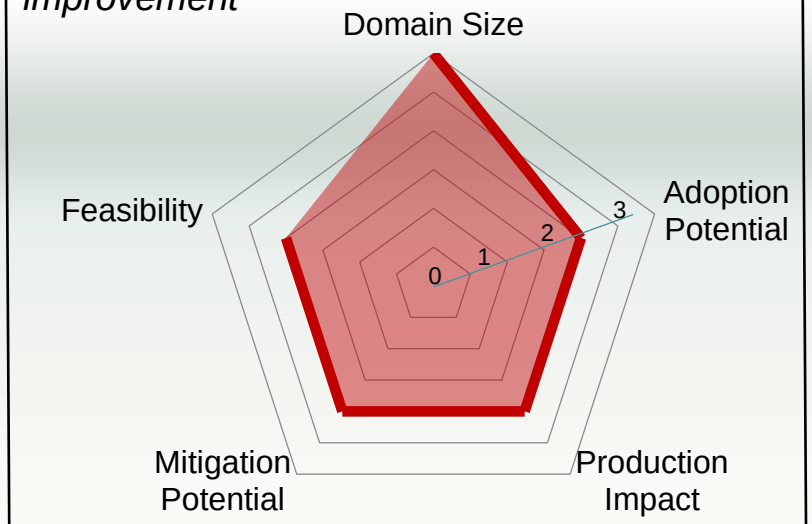
1 Increasing productivity (managing the supply side)

- Sustainably intensify production, e.g. improve ruminant diets, shifts in which livestock products are produced and where
- Decrease GHG emissions intensity of livestock products in developing countries → reduce livestock numbers
- Carbon sequestration in degraded grasslands: enhances land productivity, can improve lives of poor livestock farmers/pastoralists, requires carbon payments and institutional innovation

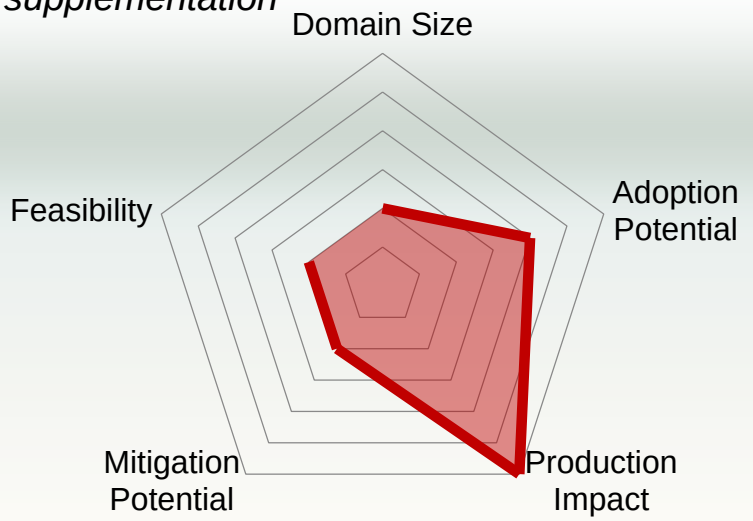
Evaluating options by different livestock production systems

Thornton & Herrero (2014)

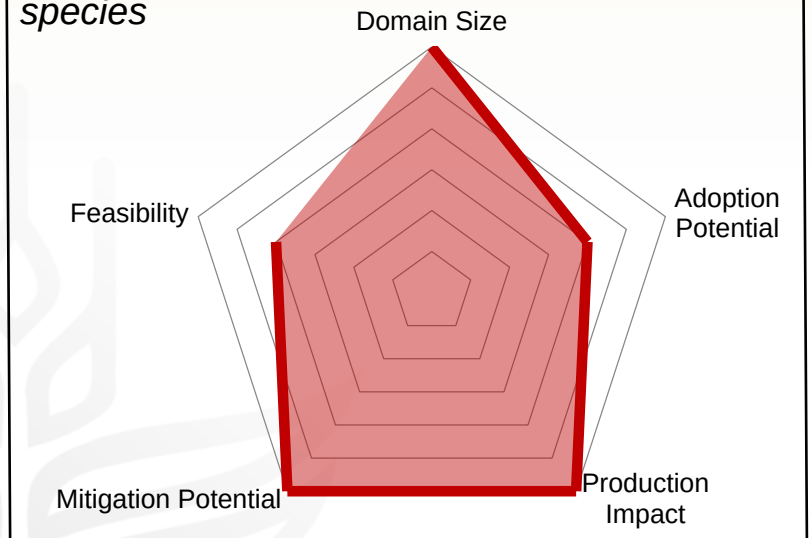
1 Diet intensification: stover digestibility improvement



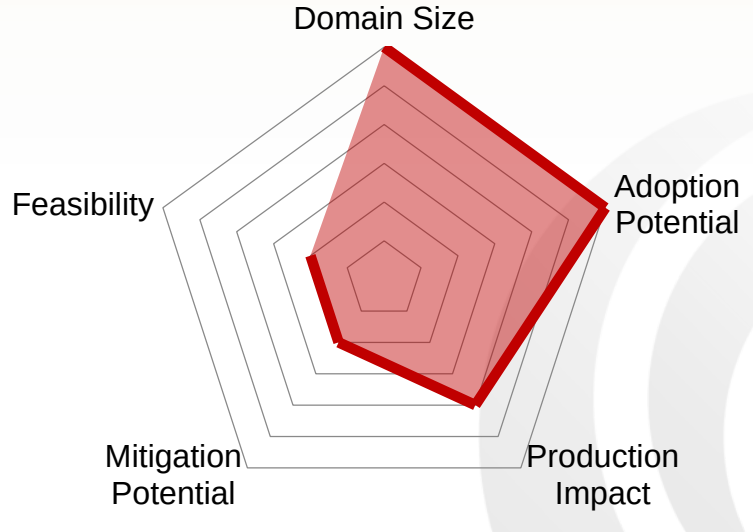
2 Diet intensification: grain supplementation



3 Diet intensification: use of agroforestry species



4 Use of cross-bred dairy animals



Yes, in several (often additive) ways, including:

2 Reducing losses and waste in livestock product value chains

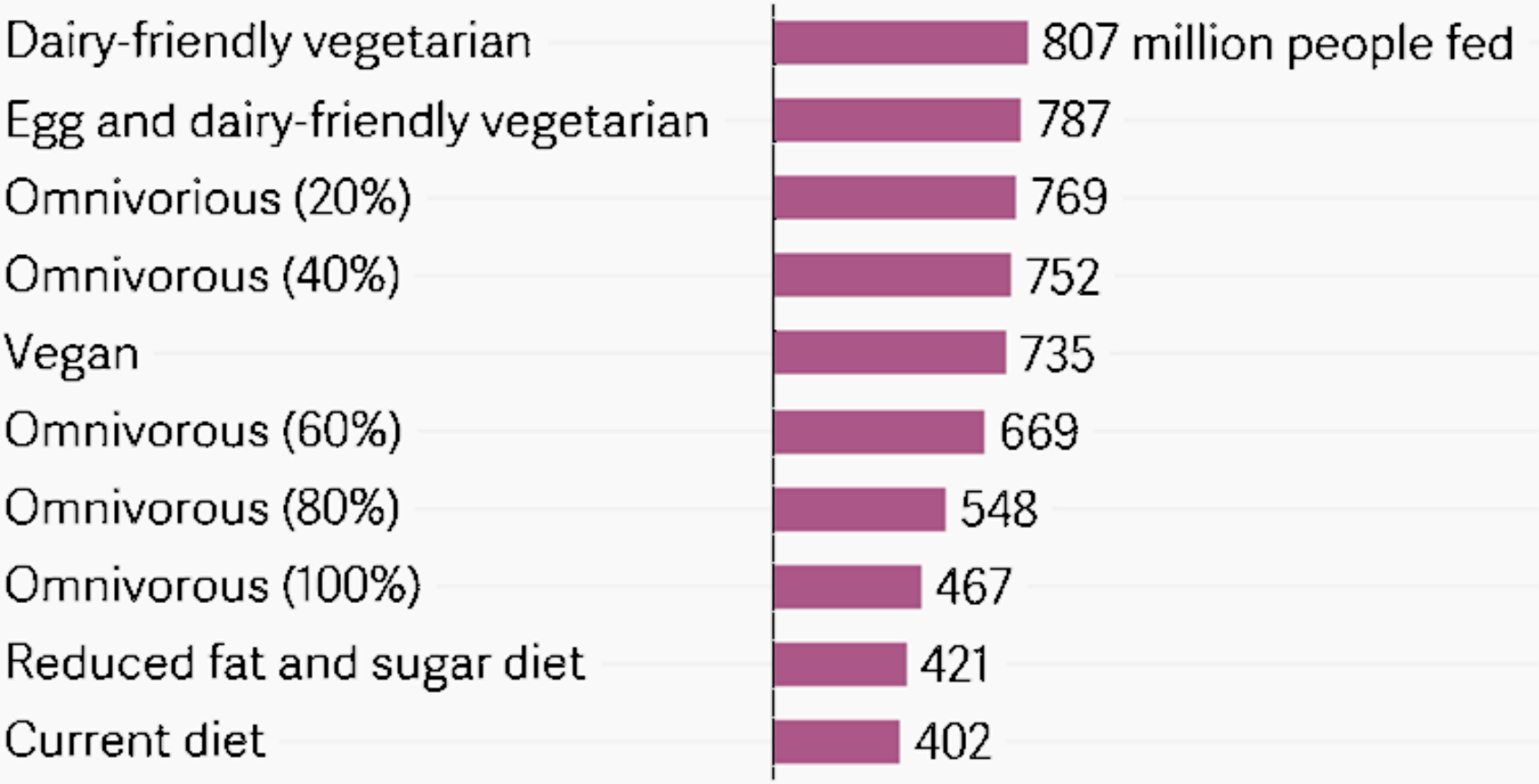
- Markets, packaging, labelling, avoiding waste
- Methane from liquid waste can be captured and used as a source of energy (large-scale pig and dairy units)

3 Consuming more sustainable diets (managing the demand side)

- Modifying what we eat could reduce resource use, reduce GHG emissions, and have important health and nutritional benefits
- Double burden of malnutrition

Issues to be resolved 1: complexity of quantifying impacts, costs, benefits

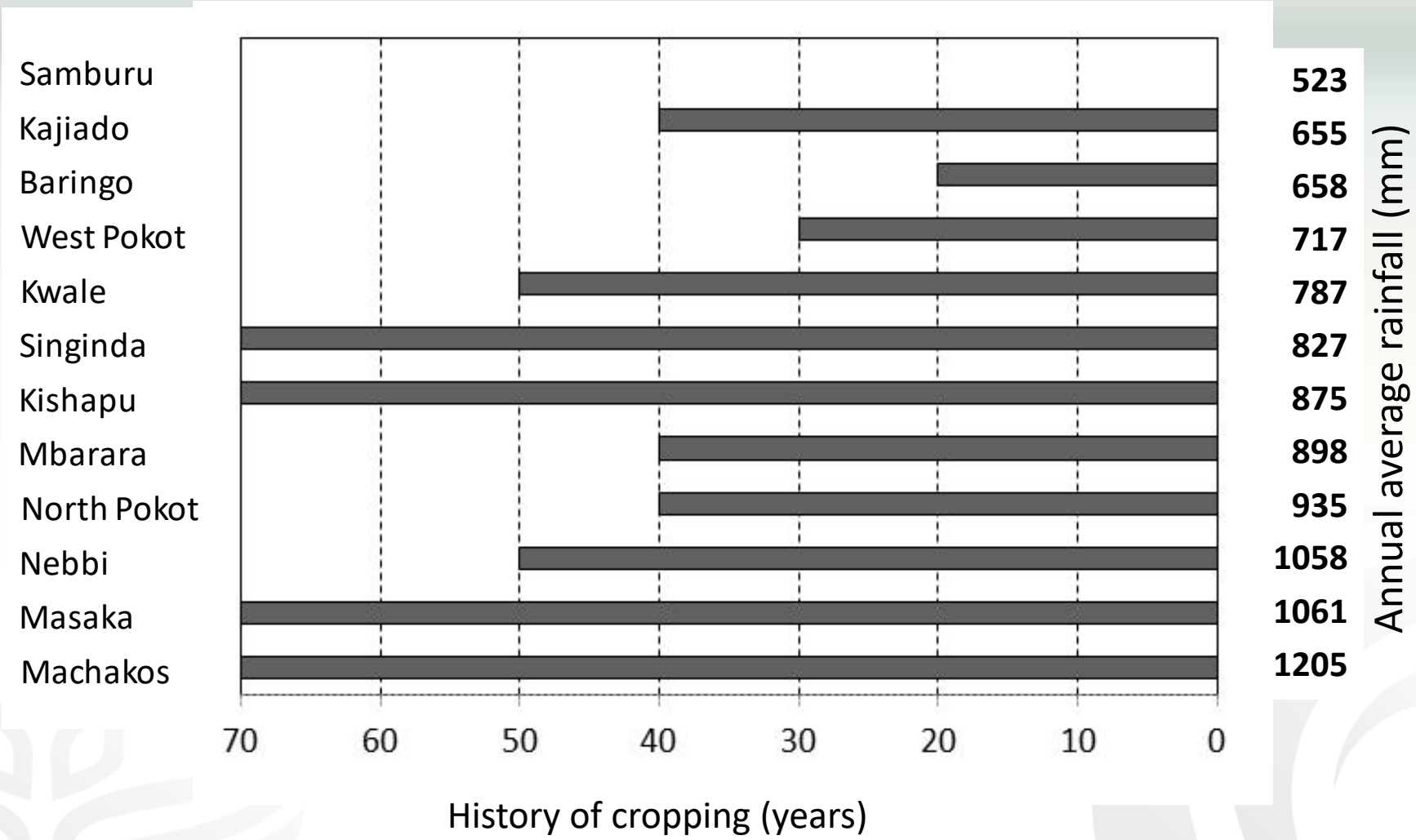
Carrying capacity of different diets in the US



Peters et al. (2016), Carrying capacity of U.S. agricultural land: Ten diet scenarios. Elementa

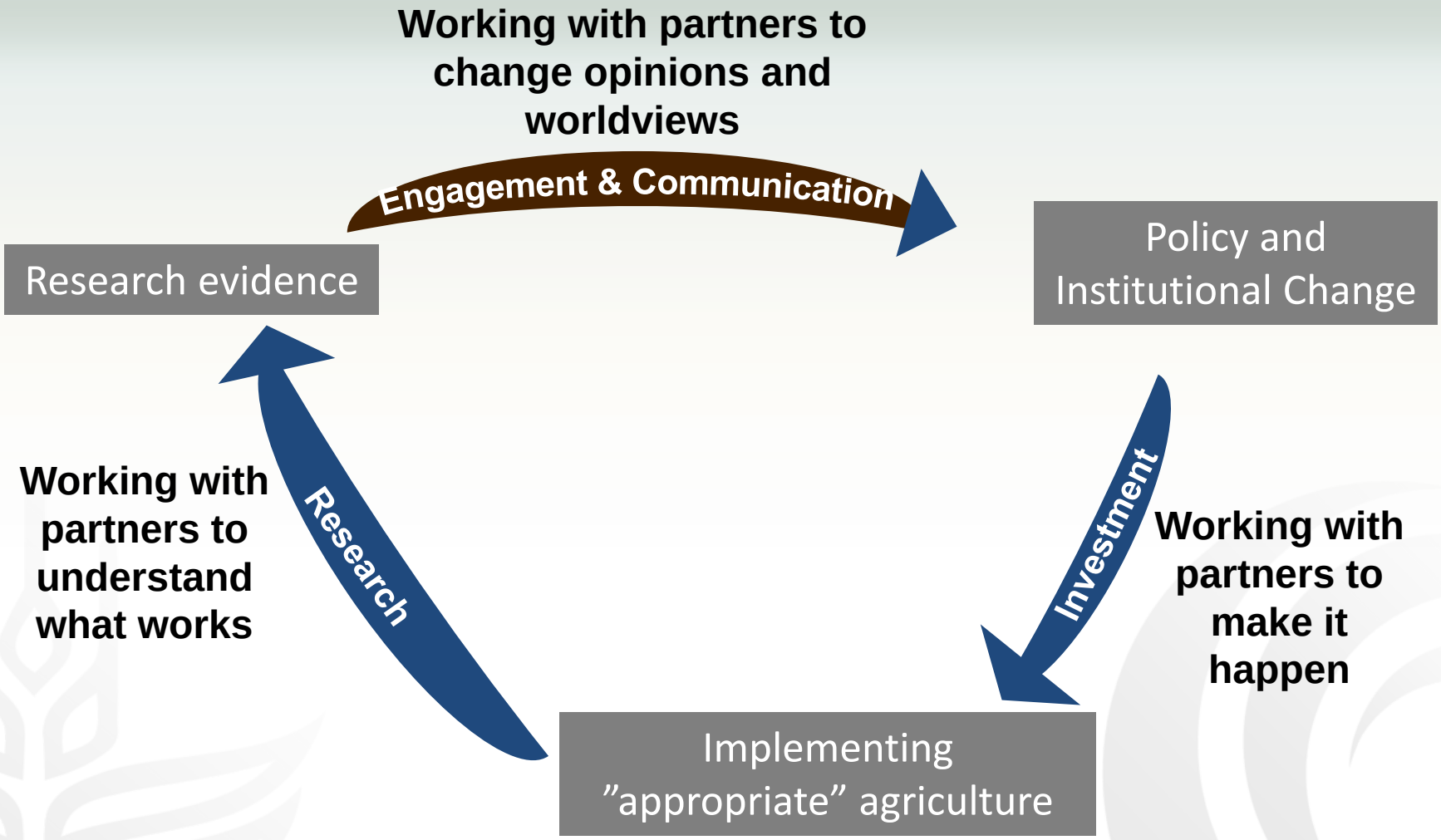
Issues to be resolved 2: the future of livestock systems in different places

Cropping history in 12 agro-pastoral systems in East Africa



Rufino et al. (2014)

Issues to be resolved 3: how to provide appropriate incentives for change for institutions, governance, the private sector?

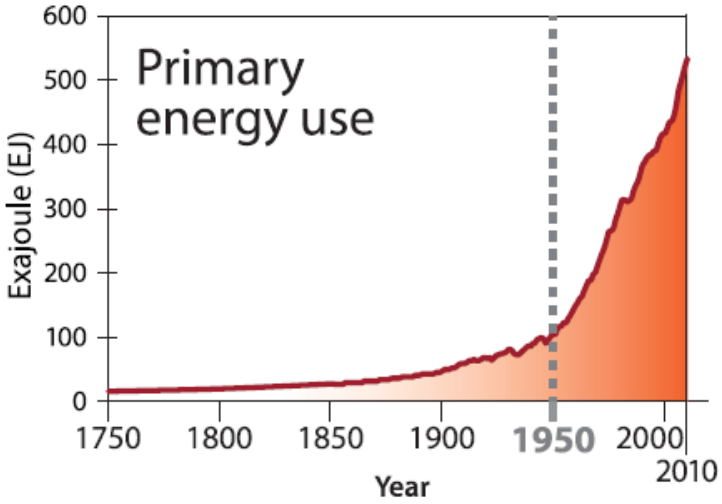


Issues to be resolved 4: modifying discourses around climate change and livestock

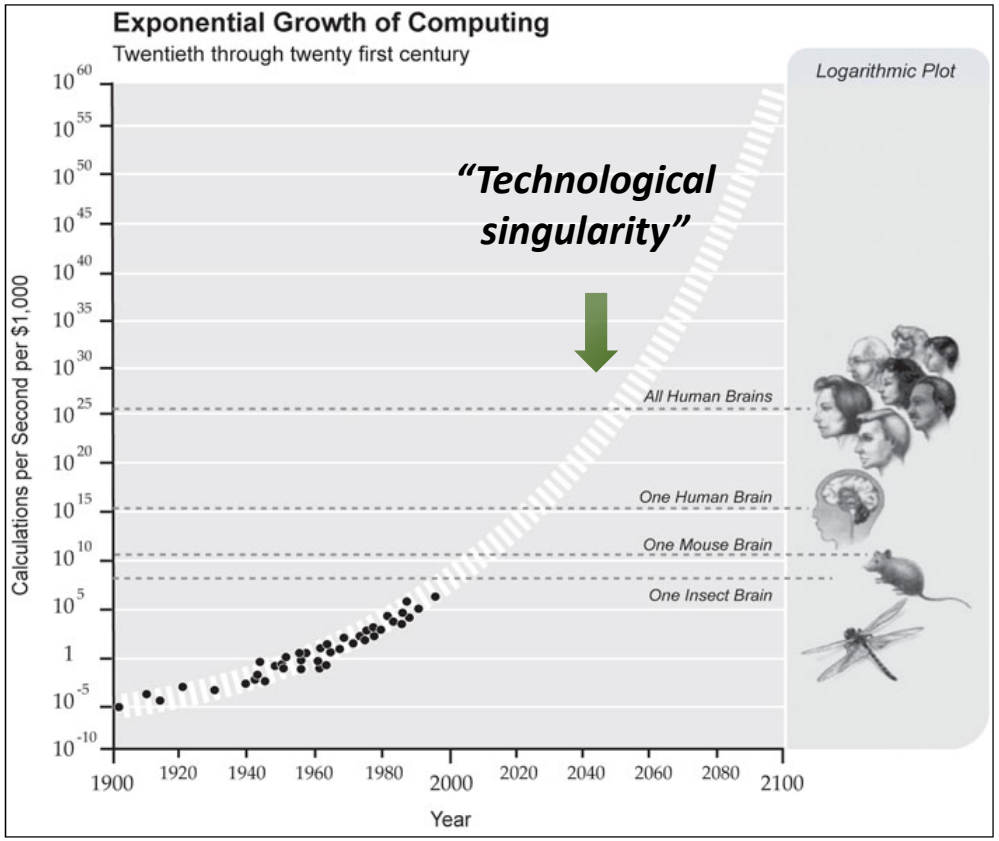
- Burgeoning literature on global change communications: framing, psychology, values, attitudes, beliefs, political ideologies, …
- Tap in to new skills in discourse analysis and understanding gender norms, addressing beliefs, values, worldviews (both individual and shared)
- Backed up by appropriate engagement and communications: getting the message right for different stakeholders
- This will involve combining “softer” social science with “harder” biophysical science in effective ways (importance of process and buy-in)

And what about technological game-changers?

- Artificial meat
- N-fixing cereals
- Ruminants producing less methane
- …



Steffen et al. (2015)



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