# Livestock's Long Shadow

## Environmental Issues and Options

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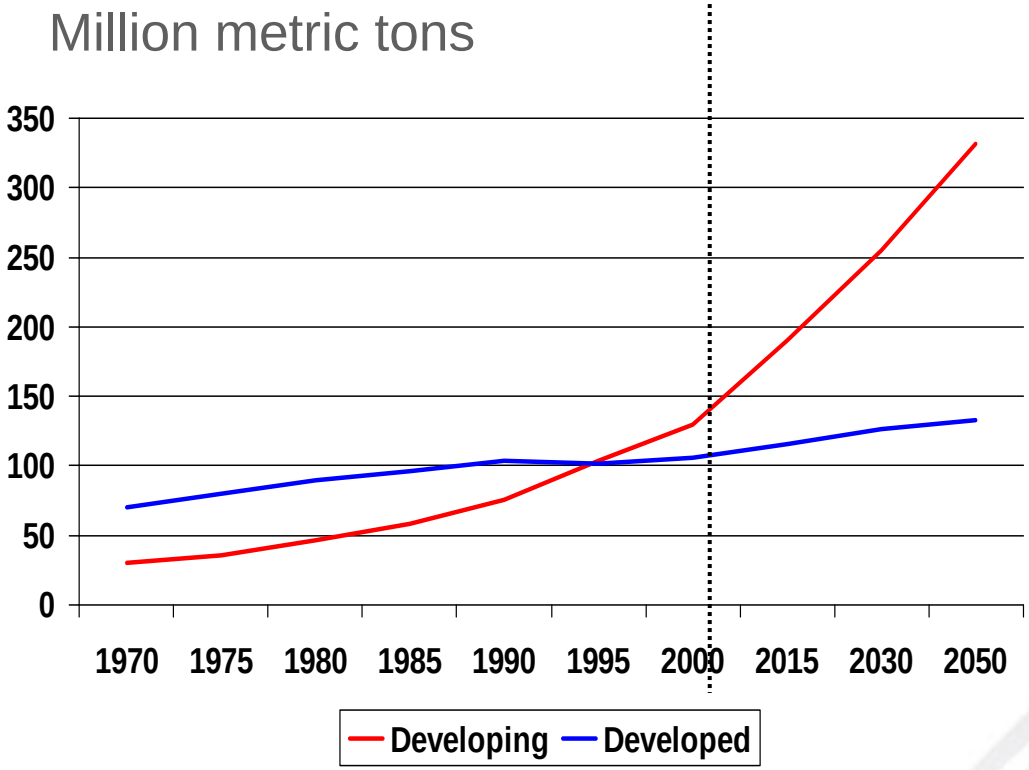
# Drivers of the Livestock Sector

- Demand Drivers
  - Population growth: + 50 % by 2050 globally; slowing down in East Asia, still strong elsewhere in developing countries
  - Income growth: strong in E and S Asia, NENA and SS Africa picking up
  - Urbanization: more than 80 % of population growth occurs in cities of developing countries

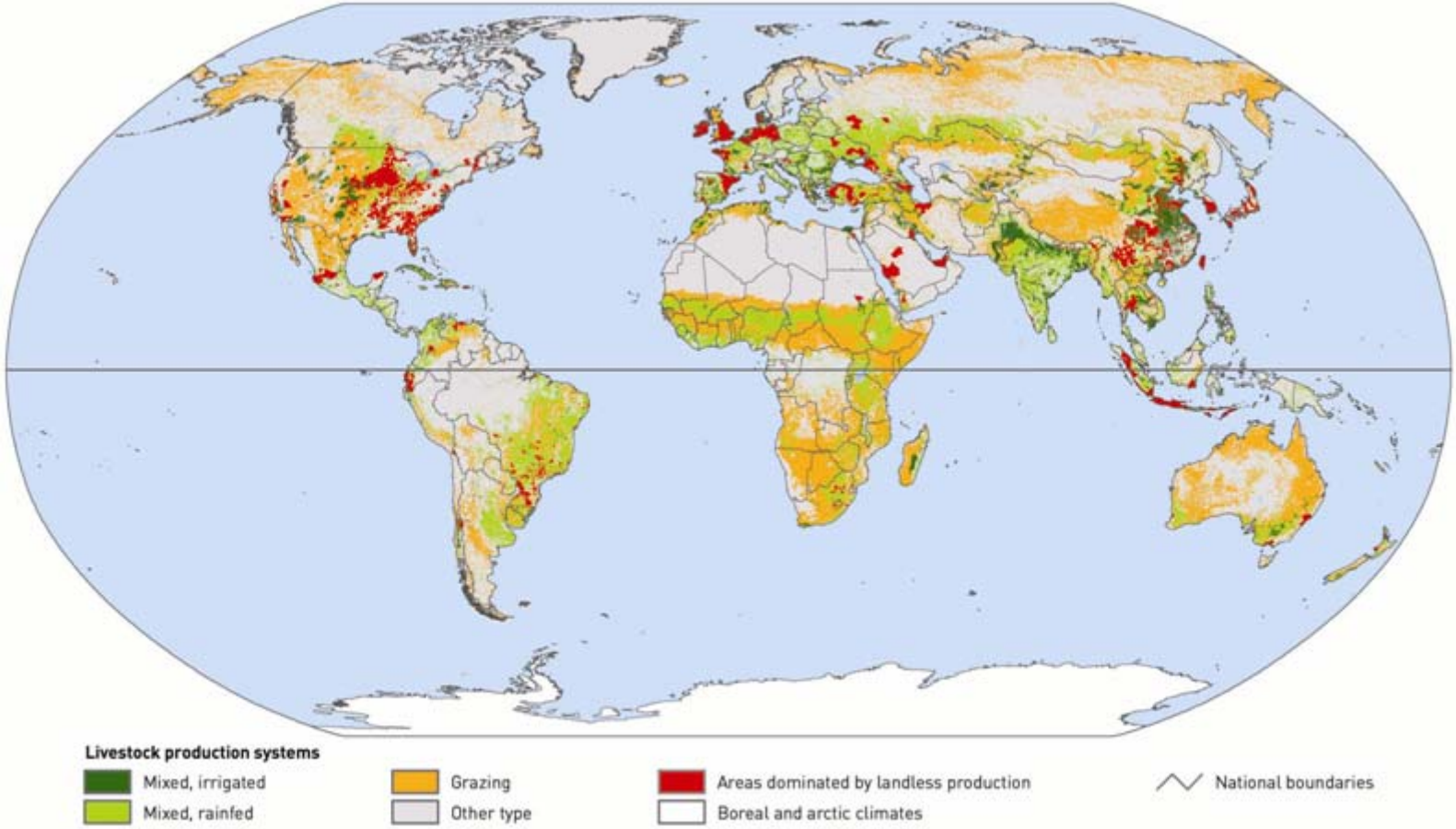
- Supply Drivers
  - Cheap grain: decreasing prices over the past four decades
  - Technological change: genetics, feeding, transport
  - Cheap energy: substantial externalities
  - Policy environment: incentive frameworks, market and credit regulation, sanitary standards, labour and environmental policies

# Broad trends: soaring output and underlying structural changes




- Growing intensities
- Increasing scales
- Vertical integration/longer food chains
- Geographic shifts / geographic concentration

# Estimated distribution of livestock production systems



# Quantification of environmental impacts: approach

- Global issues:
  - land use
  - climate change
  - water resources
  - biodiversity

- Analysis of impacts using a food chain approach (from feed production to product)

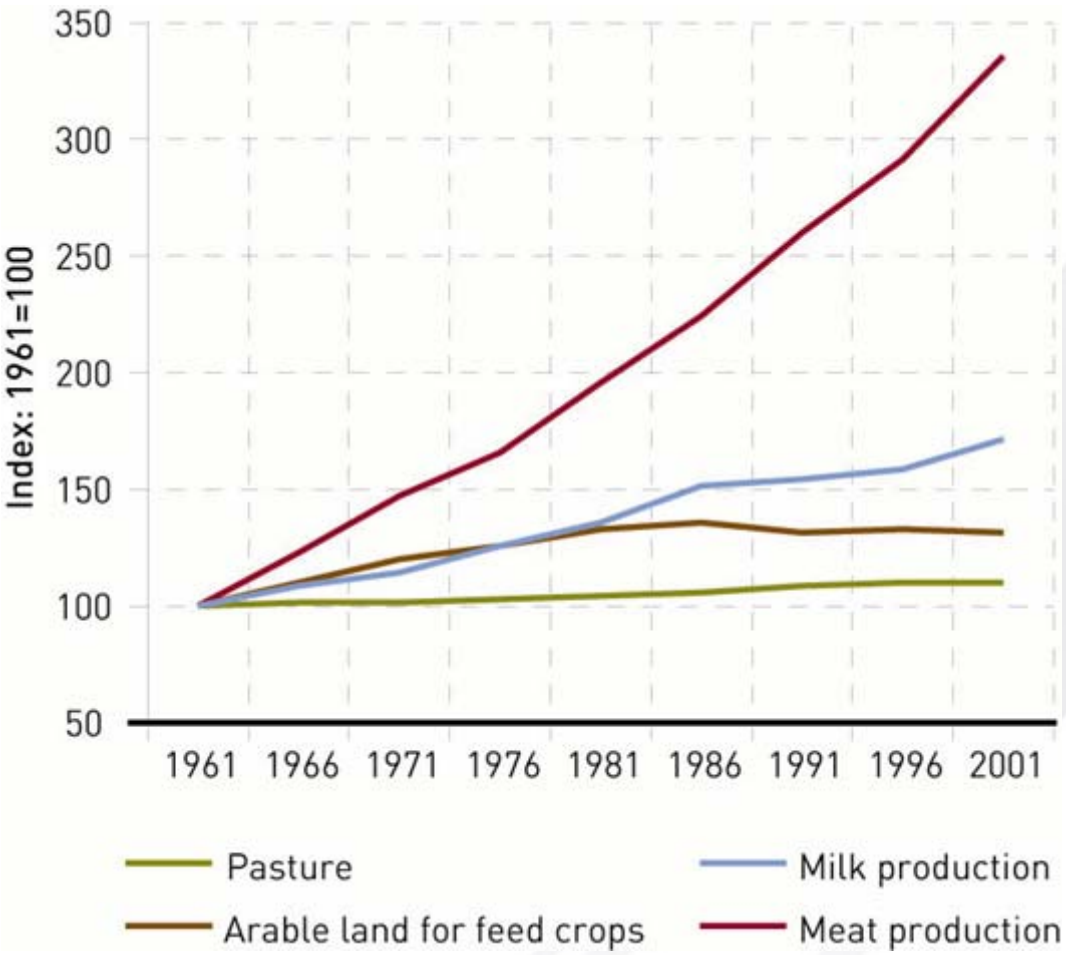
- Identification of technical and policy mitigation options

# Review of impacts

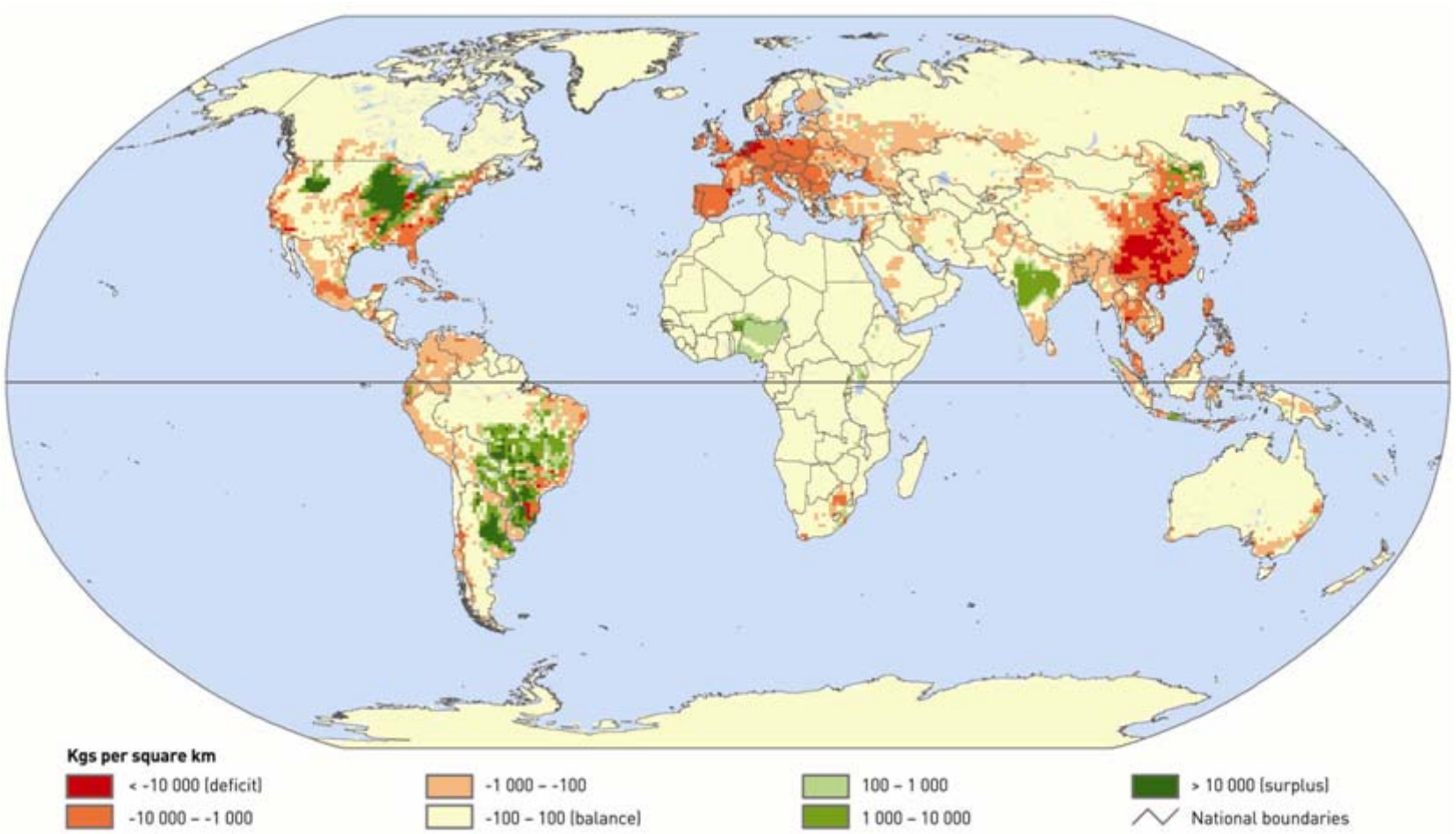
## Land use

- Pastures: 3.4 billion hectares (26% of emerged lands)
  - wide range of production intensities
  - marginal land frontier is exhausted
  - 20% of rangeland are estimated to be degraded – UNEP (up to 73% in the drylands)
- 470 million hectares of arable land dedicated to animal feed production (ca. 33% of overall arable land)
- Geographical trends:
  - Intensification
  - geographical concentration
  - Increased reliance on transport

# Trends in land-use area for livestock production and total production of meat and milk



# Estimated feed surplus/deficit – soymeal (pig and poultry)



# Review of impacts

## Green House Gas Emissions

- **How large is the livestock sector's contribution?**
- **What are the options to mitigate GHG emissions?**

# Approach

## Emissions from feed production

- Fertilizer manufacturing and application
- On-farm fossil fuel use
- Livestock-related land use changes
- C release from soils

[Savannah burning]

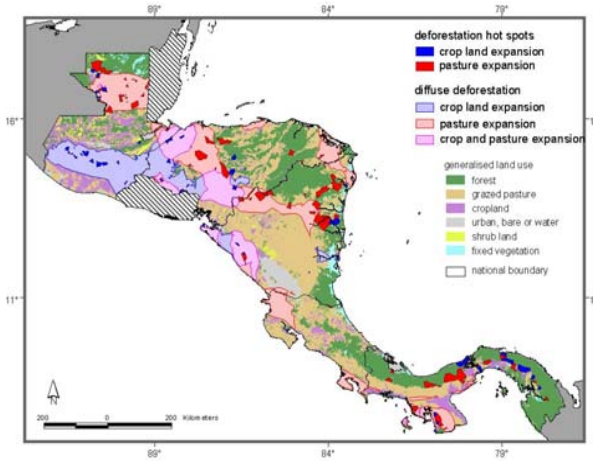
## Emissions from livestock rearing

- Methane from enteric fermentation
- Methane from animal manure
- Nitrous oxide

[Respiration by livestock]

## Emissions from livestock processing, refrigeration and transport

# Livestock related land use change:
## Deforestation in the Neotropics





~2.4 million ha/year
Forest → Pasture

~0.5 million ha/year
Forest → Feed crops

↓

**~2.4 billion tons $CO_2$**

## Carbon release from soils

- Conventional tillage of land for intensive feed cropping → ~18 million tons $CO_2$
- Soil liming in tropical areas → ~10 million tons $CO_2$
- Pasture desertification in drylands → ~100 million tons $CO_2$

## $CO_2$ emissions from processing and refrigerated transport

- Emissions from processing are in the order of several tens of million tons $CO_2$
- Emissions from meat transport estimated at 0.8 – 1 million ton $CO_2$

# Resulting Overall Contribution

About 2.7 billion tons $CO_2$:
9% of total anthropogenic $CO_2$ emissions

## Methane released from enteric fermentation

Assessment per region and livestock production system

Resulting total of 86 million tons $CH_4$ per year

## Methane released from animal manure

Assessment per region and livestock production system, using updated emissions factors

Resulting total of 18 million tons $CH_4$ per year

# Resulting Overall Contribution

About 2.2 billion tons $CO_2$ equivalent:
37% of total anthropogenic $CH_4$ emissions

## N emissions

| | $N_2O$ million tons N | $NH_3$ million tons N |
|---|---|---|
| from feed-crop related fertilizer | 0.2 | 3.1 |
| from leguminous feed crops | >0.5 | - |
| from aquatic sources following fertilizer use | 0.2 | - |
| from stored manure | 0.7 | 2 |
| from applied or deposited manure | 1.7 | 20 |
| following application/deposition | 0.4 | - |

# Resulting Overall Contribution

$N_2O$ — About 2.2 billion tons $CO_2$ equivalent:
65% of total anthropogenic $N_2O$ emissions

$NH_3$ — 64% of total anthropogenic $NH_3$ emissions

# Relative contributions along the food chain

About 7.1 billion tonnes $CO_2$ equivalent
or
18% of total anthropogenic GHG emissions
(2/3 from extensive systems and 1/3 from intensive systems)

…but variable across the world (eg. 60% of Brazil's emissions)

- Land use and Land Use Change : 36%
- Feed Production: 7%
- Animals: 25%
- Manure Management: 31%
- Processing and Transport: 1%

# Mitigation Options (1)

Control LUC :

agricultural intensification, avoiding change

adoption of more sustainable practices, mitigating the impact
(silvo-pastoral systems, conservation agriculture)

Conserve/restore C and N in cultivated soils:

agricultural intensification – conservation tillage – erosion reduction

Mitigate C loss from pasture soils:

silvo-pastoral and agro-forestry systems in the humid tropics

improved grazing management in drylands
(and also fire management, grass production enhancement, …)

# Mitigation Options (2)

Enteric fermentation:

improved efficiency and diets

Manure:

balanced feeding, reducing methane emissions and lowering the N content

anaerobic digestion:

reducing methane emissions (>50%),
near elimination of ammonia volatilization,
reducing $N_2O$ emissions from subsequent application

fine tuning of waste application to land

# Review of impacts

## Water resources

- Livestock sector represents 8% of all entropic water use, 90% of which for feed production.
- Feed production: 15% of evapotranspiration in agriculture (irrigated)
- Overall pollution: hardly quantifiable but substantial at feed production, animal production and processing levels (nutrients, organic matter, antibiotics, pesticides)
- impact on water cycles

# Livestock and Water: Technical Mitigation Options

- Improved water use efficiency
  - Irrigation efficiency
  - Water productivity
- Enhance waste management
  - Production stage: balance feed, phase feeding, supplements
  - Improved manure collection process
  - Manure storage and processing
  - Improved utilization of waste
- Land management
  - Adapted grazing systems, range improvements, critical periods
  - Improving livestock distribution

# Review of impacts

## Biodiversity

- Main mechanism habitats degradation/destruction:
  - deforestation
  - pollution
  - desertification
  - intensive agriculture
- Fishmeal production causing over fishing

→ IUCN identifies livestock as one of the threats to 1699 endangered species (red list)

# Livestock and Biodiversity: Technical Mitigation Options

Biodiversity loss often results from environmental degradation
→ Many options previously presented apply

- Intensify land use to reduction of pressure on natural land and habitat

- Improve land and pest management practices
  - Integrated agriculture: response to excessive chemical use
  - Conservation agriculture: restore habitats

- Combine field level improvements with ecological infrastructure conservation/restoration at landscape level

# Hotspots of environmental impact

| | Climate | Water | Biodiversity |
|---|---|---|---|
| Pasture and feedcrop expansion into natural ecosystems | +++ | + | +++ |
| Rangeland degradation | +++ | ++ | ++ |
| Contamination in intensive production areas | + | +++ | ++ |
| Intensive feedcrop agriculture | ++ | ++ | ++ |

# Underlying causes (i)

- Neglect of externalities
  - negative externalities, e.g. water and soil pollution, climate change, biodiversity losses, etc.
  - positive externalities, e.g. carbon sequestration, ecosystem diversitybiodiversity gains

- Inadequate pricing
  - At input level, e.g. land water
  - At output level, e.g. subsidies

# Underlying causes (ii)

- Livestock production concentrates
  - The clustering of livestock close to feed outlets, consumption centres leads to nutrient overloads
  - Disruption of nutrient cycling
- Mismanaged grazing
  - lack of stewardship in marginal and remote areas
- The multiple objectives pursued with livestock

# Principles for policy intervention (i)

- Get prices right: Inefficiencies in resource use, often increasing use and leads to misallocation of resources among competing uses (within and outside agriculture)

- Apply "Polluter pays, provider gets" principles

  Payment for environmental services could be a major tools to shift to " service-oriented" grazing (making carbon sequestration, water and biodiversity protection a major purpose of extensive systems)

# Principles for policy intervention (ii)

- Seek livestock/ecosystem balances: Bring livestock in balance with surrounding land. The need for intensification of production (without concentration)
- Develop institutions for environmental stewardship
- The importance of liability
- The need to educate and inform

# The social and health dimensions

Environmental policies should be designed and implemented in the context of social and health objectives:

- 1.3 billion people depend (partially or entirely) on livestock for their livelihoods
- The cultural dimension of livestock
- Livestock provide protein and micro-nutrients to many of the 830 million food insecure people
- Livestock contributes to health problems of the affluent (obesity, cancers, cardio-vascular diseases

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