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
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 $\rightarrow \sim 18$ million tons CO$_2$
- Soil liming in tropical areas $\rightarrow \sim 10$ million tons CO$_2$
- Pasture desertification in drylands $\rightarrow \sim 100$ 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

<table>
<thead>
<tr>
<th>Source of N emissions</th>
<th>N$_2$O million tons N</th>
<th>NH$_3$ million tons N</th>
</tr>
</thead>
<tbody>
<tr>
<td>from feed-crop related fertilizer</td>
<td>0.2</td>
<td>3.1</td>
</tr>
<tr>
<td>from leguminous feed crops</td>
<td>&gt;0.5</td>
<td>-</td>
</tr>
<tr>
<td>from aquatic sources following fertilizer use</td>
<td>0.2</td>
<td>-</td>
</tr>
<tr>
<td>from stored manure</td>
<td>0.7</td>
<td>2</td>
</tr>
<tr>
<td>from applied or deposited manure</td>
<td>1.7</td>
<td>20</td>
</tr>
<tr>
<td>following application/deposition</td>
<td>0.4</td>
<td>-</td>
</tr>
</tbody>
</table>

**Resulting Overall Contribution**

- About 2.2 billion tons CO$_2$ equivalent:
  - 65% of total anthropogenic N$_2$O emissions
- 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 N₂O 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

<table>
<thead>
<tr>
<th>Pasture and feedcrop expansion into natural ecosystems</th>
<th>Climate</th>
<th>Water</th>
<th>Biodiversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasture and feedcrop expansion into natural ecosystems</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Rangeland degradation</td>
<td>+++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Contamination in intensive production areas</td>
<td>+</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Intensive feedcrop agriculture</td>
<td>++</td>
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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 diversity 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
Livestock’s Long Shadow

Download from: www.virtualcentre.org

Order a hard copy from FAO’s Animal Production and Health Division website

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