

# livestock's long shadow

environmental issues and options



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# Preface

The in-depth assessment presented in this document of the various significant impacts of the world's livestock sector on the environment is deliberately termed *Livestock's long shadow* so as to help raise the attention of both the technical and the general public to the very substantial contribution of animal agriculture to climate change and air pollution, to land, soil and water degradation and to the reduction of biodiversity. This is not done simply to blame the rapidly growing and intensifying global livestock sector for severely damaging the environment but to encourage decisive measures at the technical and political levels for mitigating such damage. The detailed assessment of the various environmental impacts of the sector is therefore associated with the outline of technical and policy-related action to address these impacts.

The assessment builds on the work of the Livestock, Environment and Development (LEAD) Initiative. This multi-stakeholder Initiative, coordinated by FAO's Animal Production and Health Division, was formed to address the environmental consequences of livestock production, particularly in the light of rising demand for food products of animal origin and the increasing pressure on natural resources. The LEAD Initiative brought together a broad range of research and development institutions and individuals interested in livestock–environment interactions; it has been active in a number of areas of particular concern, i.e. in land and water pollution from intensive livestock production in land degradation from overgrazing in dry lands and in livestock-induced deforestation in the humid and subhumid tropics.

While previous assessments of the livestock–environment interactions by LEAD have adopted a livestock sector perspective, i.e. investigated the impacts of the sector on the natural resources used in animal production, the current assessment sets off from the environment and determines the contribution of livestock to changes to the environment (land use and climate change, soil, water and biodiversity depletion). The benefit of this change in perspective is substantial in that it provides the framework for gauging the significant and dynamic role of the livestock sector in driving global environmental change. This in turn should assist and enhance decision-making on necessary action at all levels, from local to global, from private to public, from individual to corporate and from non-governmental to intergovernmental. Action is required: if, as predicted, the production of meat will double from now to 2050, we need to halve impacts per unit of output to achieve a mere status quo in overall impact.

LEAD has been catalysing such action, supported by the Global Environment Facility (GEF) and other donors, in a range of livestock-induced environmental “hotspots”, such as in East and Southeast Asia where solutions are designed for the sustainable management of the very large quantities of livestock waste in intensive animal production, such as in Central America where new procedures are introduced for the payment of environmental services in livestock-based land use, and such as in the United Republic of Tanzania where

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sustainable wildlife–livestock interactions are designed. Such efforts require decisions on, and enforcement of, suitable policy instruments for enabling stakeholder engagement in economically sustainable resource use that addresses the environmental concerns at stake.

It is obvious that the responsibility for the necessary action to address the environmental damage by the livestock sector goes far beyond the sector; it also goes beyond agriculture. While the sector, and agriculture as a whole, have to live up to the challenge of finding suitable technical solutions for more environmentally sustainable resource use in animal agriculture, the decisions concerning their use clearly transcend agriculture; multisector and multiobjective decision-making is required.

It is hoped that this assessment contributes to such decision-making and to thus shrink “*Livestock’s long shadow*”.



Samuel Jutzi

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# Abbreviations and acronyms

<b>A/R</b>	Afforestation or reforestation
<b>AET</b>	Actual evapotranspiration
<b>ASA</b>	American Soybean Association
<b>AU-IBAR</b>	African Union – Inter-African Bureau for Animal Resources
<b>BMWS</b>	Barley, maize, wheat and soybean
<b>BNF</b>	Biological nitrogen fixation
<b>BOD</b>	Biological oxygen demand
<b>BSE</b>	Bovine spongiform encephalopathy
<b>CALPI</b>	Capitalisation of Livestock Programme Experiences in India
<b>CAP</b>	Common Agricultural Policy
<b>CATIE</b>	Tropical Agricultural Research and Higher Education Centre
<b>CBD</b>	Convention on Biological Diversity
<b>CDM</b>	Clean development mechanism
<b>CEMAGREF</b>	Recherche et expertise sur la multifonctionnalité de l'agriculture
<b>CERs</b>	Certified emissions reductions
<b>CIRAD</b>	Centre de coopération en recherche agronomique pour le développement
<b>CIS</b>	Commonwealth of Independent States
<b>COD</b>	Chemical oxygen demand
<b>CSA</b>	Central and South America
<b>DANIDA</b>	Danish International Development Agency
<b>Embrapa</b>	Empresa Brasileira de Pesquisa Agropecuária – Ministério da Agricultura, Pecuária e Abastecimento
<b>EU</b>	European Union
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>FAOSTAT</b>	FAO statistical databases
<b>FRA</b>	Global Forest Resource Assessment
<b>GATT</b>	General Agreement on Tariffs and Trade
<b>GDP</b>	Gross domestic product
<b>GEF</b>	Global Environmental Facility
<b>GHG</b>	Greenhouse gases
<b>GMO</b>	Genetically modified organisms

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<b>GWP</b>	Global warming potential
<b>HPAI</b>	Highly pathogenic avian influenza
<b>IFA</b>	International Fertilizer Industry Association
<b>IFAD</b>	International Fund for Agricultural Development
<b>IFPRI</b>	International Food Policy Research Institute
<b>IIASA</b>	Institute for Applied Systems Analysis
<b>IOM</b>	Institute of Medicine
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>IUCN</b>	The World Conservation Union (formerly the International Union for the Conservation of Nature and Natural Resources)
<b>IWMI</b>	International Water Management Institute
<b>LEAD</b>	Livestock, Environment and Development (Initiative)
<b>LPS</b>	Livestock production system
<b>LULUCF</b>	Land use, land-use change and forestry
<b>LWMEAP</b>	Livestock Waste Management in East Asia Project
<b>MAFF–UK</b>	Ministry of Agriculture, Fisheries and Food, United Kingdom of Great Britain and Northern Ireland
<b>MAF–NZ</b>	Ministry of Agriculture and Forestry – New Zealand
<b>MEA</b>	Millennium Ecosystem Assessment
<b>NASA</b>	National Aeronautics and Space Administration
<b>NEC</b>	National Emission Ceiling (directive)
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>OIE</b>	World Organization for Animal Health
<b>PES</b>	Payment for environmental services
<b>ppb</b>	Parts per billion
<b>ppm</b>	Parts per million
<b>RCRE</b>	Rutgers Cooperative research and extension
<b>SAfMA</b>	South African Millennium Ecosystem Assessment
<b>SCOPE</b>	Scientific Committee on Problems of the Environment
<b>SOC</b>	Soil organic carbon
<b>SSA</b>	Sub-Saharan Africa
<b>TOC</b>	Total organic carbon
<b>UNCCD</b>	United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa.
<b>UNCED</b>	United Nations Conference on Environment and Development
<b>UNDP</b>	United Nations Development Programme

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<b>UNEP</b>	United Nations Environment Programme
<b>UNEP-WCMC</b>	UNEP World Conservation Monitoring Centre
<b>UNESCO</b>	United Nations Educational, Scientific and Cultural Organization
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>USDA/FAS</b>	United States Department of Agriculture: Foreign Agricultural Service
<b>USDA-NRCS</b>	United States Department of Agriculture–National Resources Conservation Service
<b>USEPA</b>	United States Environmental Protection Agency
<b>WANA</b>	West Asia and North Africa
<b>WHO</b>	World Health Organization
<b>WMAs</b>	Wildlife Management Areas
<b>WRI</b>	World Resources Institute
<b>WTO</b>	World Trade Organization
<b>WWF</b>	World Wide Fund for Nature

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# Executive summary

This report aims to assess the full impact of the livestock sector on environmental problems, along with potential technical and policy approaches to mitigation. The assessment is based on the most recent and complete data available, taking into account direct impacts, along with the impacts of feedcrop agriculture required for livestock production.

The livestock sector emerges as one of the top two or three most significant contributors to the most serious environmental problems, at every scale from local to global. The findings of this report suggest that it should be a major policy focus when dealing with problems of land degradation, climate change and air pollution, water shortage and water pollution and loss of biodiversity.

Livestock's contribution to environmental problems is on a massive scale and its potential contribution to their solution is equally large. The impact is so significant that it needs to be addressed with urgency. Major reductions in impact could be achieved at reasonable cost.

## **Global importance of the sector**

Although economically not a major global player, the livestock sector is socially and politically very significant. It accounts for 40 percent of agricultural gross domestic product (GDP). It employs 1.3 billion people and creates livelihoods for one billion of the world's poor. Livestock products provide one-third of humanity's protein intake, and are a contributing cause of obesity and a potential remedy for undernourishment.

Growing populations and incomes, along with changing food preferences, are rapidly increasing demand for livestock products, while globalization is boosting trade in livestock inputs and products. Global production of meat is projected to more than double from 229 million tonnes in 1999/01 to 465 million tonnes in 2050, and that of milk to grow from 580 to 1 043 million tonnes. The environmental impact per unit of livestock production must be cut by half, just to avoid increasing the level of damage beyond its present level.

## **Structural changes and their impact**

The livestock sector is undergoing a complex process of technical and geographical change, which is shifting the balance of environmental problems caused by the sector.

Extensive grazing still occupies and degrades vast areas of land; though there is an increasing trend towards intensification and industrialization. Livestock production is shifting geographically, first from rural areas to urban and peri-urban, to get closer to consumers, then towards the sources of feedstuff, whether these are feedcrop areas, or transport and trade hubs where feed is imported. There is also a shift of species, with production of monogastric species (pigs and poultry, mostly produced in industrial units) growing rapidly, while the growth of ruminant production (cattle, sheep and goats, often

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raised extensively) slows. Through these shifts, the livestock sector enters into more and direct competition for scarce land, water and other natural resources.

These changes are pushing towards improved efficiency, thus reducing the land area required for livestock production. At the same time, they are marginalizing smallholders and pastoralists, increasing inputs and wastes and increasing and concentrating the pollution created. Widely dispersed non-point sources of pollution are ceding importance to point sources that create more local damage but are more easily regulated.

## **Land degradation**

The livestock sector is by far the single largest anthropogenic user of land. The total area occupied by grazing is equivalent to 26 percent of the ice-free terrestrial surface of the planet. In addition, the total area dedicated to feedcrop production amounts to 33 percent of total arable land. In all, livestock production accounts for 70 percent of all agricultural land and 30 percent of the land surface of the planet.

Expansion of livestock production is a key factor in deforestation, especially in Latin America where the greatest amount of deforestation is occurring – 70 percent of previous forested land in the Amazon is occupied by pastures, and feedcrops cover a large part of the remainder. About 20 percent of the world's pastures and rangelands, with 73 percent of rangelands in dry areas, have been degraded to some extent, mostly through overgrazing, compaction and erosion created by livestock action. The dry lands in particular are affected by these trends, as livestock are often the only source of livelihoods for the people living in these areas.

Overgrazing can be reduced by grazing fees and by removing obstacles to mobility on common property pastures. Land degradation can be limited and reversed through soil conservation methods, silvopastoralism, better management of grazing systems, limits to uncontrolled burning by pastoralists and controlled exclusion from sensitive areas.

## **Atmosphere and climate**

With rising temperatures, rising sea levels, melting icecaps and glaciers, shifting ocean currents and weather patterns, climate change is the most serious challenge facing the human race.

The livestock sector is a major player, responsible for 18 percent of greenhouse gas emissions measured in CO<sub>2</sub> equivalent. This is a higher share than transport.

The livestock sector accounts for 9 percent of anthropogenic CO<sub>2</sub> emissions. The largest share of this derives from land-use changes – especially deforestation – caused by expansion of pastures and arable land for feedcrops. Livestock are responsible for much larger shares of some gases with far higher potential to warm the atmosphere. The sector emits 37 percent of anthropogenic methane (with 23 times the global warming potential (GWP) of CO<sub>2</sub>) most of that from enteric fermentation by ruminants. It emits 65 percent of anthropogenic nitrous oxide (with 296 times the GWP of CO<sub>2</sub>), the great majority from manure. Livestock are also responsible for almost two-thirds (64 percent) of anthropogenic ammonia emissions, which contribute significantly to acid rain and acidification of ecosystems.

This high level of emissions opens up large opportunities for climate change mitigation through livestock actions. Intensification – in terms of increased productivity both in

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livestock production and in feedcrop agriculture – can reduce greenhouse gas emissions from deforestation and pasture degradation. In addition, restoring historical losses of soil carbon through conservation tillage, cover crops, agroforestry and other measures could sequester up to 1.3 tonnes of carbon per hectare per year, with additional amounts available through restoration of desertified pastures. Methane emissions can be reduced through improved diets to reduce enteric fermentation, improved manure management and biogas – which also provide renewable energy. Nitrogen emissions can be reduced through improved diets and manure management.

The Kyoto Protocol's clean development mechanism (CDM) can be used to finance the spread of biogas and silvopastoral initiatives involving afforestation and reforestation. Methodologies should be developed so that the CDM can finance other livestock-related options such as soil carbon sequestration through rehabilitation of degraded pastures.

## **Water**

The world is moving towards increasing problems of freshwater shortage, scarcity and depletion, with 64 percent of the world's population expected to live in water-stressed basins by 2025.

The livestock sector is a key player in increasing water use, accounting for over 8 percent of global human water use, mostly for the irrigation of feedcrops. It is probably the largest sectoral source of water pollution, contributing to eutrophication, "dead" zones in coastal areas, degradation of coral reefs, human health problems, emergence of antibiotic resistance and many others. The major sources of pollution are from animal wastes, antibiotics and hormones, chemicals from tanneries, fertilizers and pesticides used for feedcrops, and sediments from eroded pastures. Global figures are not available but in the United States, with the world's fourth largest land area, livestock are responsible for an estimated 55 percent of erosion and sediment, 37 percent of pesticide use, 50 percent of antibiotic use, and a third of the loads of nitrogen and phosphorus into freshwater resources.

Livestock also affect the replenishment of freshwater by compacting soil, reducing infiltration, degrading the banks of watercourses, drying up floodplains and lowering water tables. Livestock's contribution to deforestation also increases runoff and reduces dry season flows.

Water use can be reduced through improving the efficiency of irrigation systems. Livestock's impact on erosion, sedimentation and water regulation can be addressed by measures against land degradation. Pollution can be tackled through better management of animal waste in industrial production units, better diets to improve nutrient absorption, improved manure management (including biogas) and better use of processed manure on croplands. Industrial livestock production should be decentralized to accessible croplands where wastes can be recycled without overloading soils and freshwater.

Policy measures that would help in reducing water use and pollution include full cost pricing of water (to cover supply costs, as well as economic and environmental externalities), regulatory frameworks for limiting inputs and scale, specifying required equipment and discharge levels, zoning regulations and taxes to discourage large-scale concentrations close to cities, as well as the development of secure water rights and water markets, and participatory management of watersheds.



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## **Biodiversity**

We are in an era of unprecedented threats to biodiversity. The loss of species is estimated to be running 50 to 500 times higher than background rates found in the fossil record. Fifteen out of 24 important ecosystem services are assessed to be in decline.

Livestock now account for about 20 percent of the total terrestrial animal biomass, and the 30 percent of the earth's land surface that they now pre-empt was once habitat for wildlife. Indeed, the livestock sector may well be the leading player in the reduction of biodiversity, since it is the major driver of deforestation, as well as one of the leading drivers of land degradation, pollution, climate change, overfishing, sedimentation of coastal areas and facilitation of invasions by alien species. In addition, resource conflicts with pastoralists threaten species of wild predators and also protected areas close to pastures. Meanwhile in developed regions, especially Europe, pastures had become a location of diverse long-established types of ecosystem, many of which are now threatened by pasture abandonment.

Some 306 of the 825 terrestrial ecoregions identified by the Worldwide Fund for Nature (WWF) – ranged across all biomes and all biogeographical realms, reported livestock as one of the current threats. Conservation International has identified 35 global hotspots for biodiversity, characterized by exceptional levels of plant endemism and serious levels of habitat loss. Of these, 23 are reported to be affected by livestock production. An analysis of the authoritative World Conservation Union (IUCN) Red List of Threatened Species shows that most of the world's threatened species are suffering habitat loss where livestock are a factor.

Since many of livestock's threats to biodiversity arise from their impact on the main resource sectors (climate, air and water pollution, land degradation and deforestation), major options for mitigation are detailed in those sections. There is also scope for improving pastoralists' interactions with wildlife and parks and raising wildlife species in livestock enterprises.

Reduction of the wildlife area pre-empted by livestock can be achieved by intensification. Protection of wild areas, buffer zones, conservation easements, tax credits and penalties can increase the amount of land where biodiversity conservation is prioritized. Efforts should extend more widely to integrate livestock production and producers into landscape management.

## **Cross-cutting policy frameworks**

Certain general policy approaches cut across all the above fields. A general conclusion is that improving the resource use efficiency of livestock production can reduce environmental impacts.

While regulating about scale, inputs, wastes and so on can help, a crucial element in achieving greater efficiency is the correct pricing of natural resources such as land, water and use of waste sinks. Most frequently natural resources are free or underpriced, which leads to overexploitation and pollution. Often perverse subsidies directly encourage livestock producers to engage in environmentally damaging activities.

A top priority is to achieve prices and fees that reflect the full economic and environmental costs, including all externalities. One requirement for prices to influence behaviour is

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that there should be secure and if possible tradable rights to water, land, use of common land and waste sinks.

Damaging subsidies should be removed, and economic and environmental externalities should be built into prices by selective taxing of and/or fees for resource use, inputs and wastes. In some cases direct incentives may be needed.

Payment for environmental services is an important framework, especially in relation to extensive grazing systems: herders, producers and landowners can be paid for specific environmental services such as regulation of water flows, soil conservation, conservation of natural landscape and wildlife habitats, or carbon sequestration. Provision of environmental services may emerge as a major purpose of extensive grassland-based production systems.

An important general lesson is that the livestock sector has such deep and wide-ranging environmental impacts that it should rank as one of the leading focuses for environmental policy: efforts here can produce large and multiple payoffs. Indeed, as societies develop, it is likely that environmental considerations, along with human health issues, will become the dominant policy considerations for the sector.

Finally, there is an urgent need to develop suitable institutional and policy frameworks, at local, national and international levels, for the suggested changes to occur. This will require strong political commitment, and increased knowledge and awareness of the environmental risks of continuing “business as usual” and the environmental benefits of actions in the livestock sector.