
Chapter 11

Livestock Production

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Brief Description of the Sector

The use of cattle, sheep, goats, pigs, poultry, and other livestock offers many benefits to millions of farmers in the developing world. These animals are integral to rural livelihoods and culture, providing food (meat, blood, eggs and dairy products), materials (wool, hide, horns, etc.), income, and mechanical power for pulling carts or plowing fields. Asia has been identified as the developing region in which the demand for livestock products is expected to rise most rapidly. Livestock manure can serve as a source of fertilizer. Grazing can help sustain vegetation and promote biodiversity by dispersing seeds, controlling shrub growth, breaking soil crusts, stimulating grass growth and improving seed germination. Livestock also may represent savings and currency, and have cultural value as well. For example, gifts of livestock may serve to resolve conflicts or cement marriages.

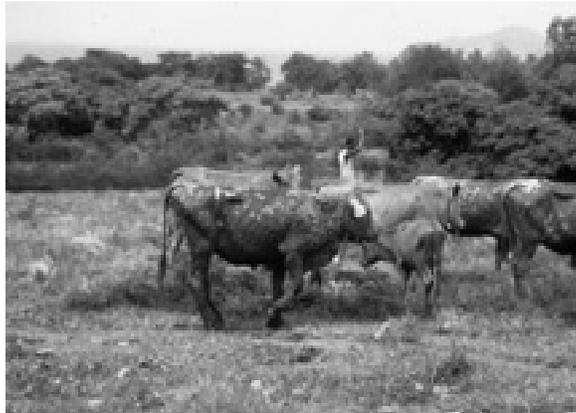
Livestock production can be categorized under three main systems: grazing, mixed farming and industrial.

- **Grazing** systems generally rely on native grassland or forests for fodder, with little or no use of crops or imported inputs, and are traditionally managed by pastoralist communities.
- **Mixed farming** systems integrate livestock and crop production. Adding livestock to their farms helps farmers diversify risk and extract value from otherwise valueless or low-value by-products of each activity: crop residue becomes feed, manure becomes fertilizer. Soil nutrients can be further replenished by rotating leguminous (nitrogen-fixing) fodder crops with food crops. These systems are managed by settled farmers.
- **Industrial production** systems concentrate livestock populations in special facilities and separate their feeding and waste processing from the land on which they live. Feed is provided directly instead of being acquired through grazing, and manure is transported off-site. Generally, these systems are owned by relatively wealthy individuals and managed by local employees.

More than a quarter of the world's land area is used for livestock as part of grazing or mixed farming systems. Another fifth of the world's arable land is used to grow livestock feed grains, primarily for industrial production systems.

Grazing systems are most favored in arid, semi-arid, or other areas of marginal value for crop-based agricultural production, while mixed farming systems flourish in temperate, subhumid, humid, and some highland climates. Industrial production, because it does not depend on local fodder supplies, can be conducted in any climate and generally occurs near the urban centers it supplies, sometimes even in peri-urban areas.

Livestock production is increasing throughout the developing world,



Livestock can enhance water and land quality, but producers must guard against potential environmental and economic damage.

Although more slowly in sub-Saharan Africa than in most other regions. This increase is driven by growing population, increasing urbanization and rising incomes. This situation is expected to continue throughout the next decade. A shift towards industrial production—farming of monogastric species (pigs, poultry) fed with grain—may be an unavoidable trend in areas with rapidly growing demand for animal food products.

Properly managed, livestock production can enhance land and water quality, biodiversity, and social and economic well-being. However, when improperly managed, livestock production may cause significant economic, social and environmental damage. Increasing livestock production has the potential to increase environmental harm. This guideline is intended to help identify potential adverse environmental impacts and to suggest mitigation and monitoring options, as well as “best management practices” to address them.

Potential Environmental Impacts in the Livestock Sector and Their Causes

Large areas of land degraded

Overgrazing

Overgrazing of rangeland reduces the density of vegetation and the amount of organic matter generated. This, in turn, increases soil erosion from wind and water and decreases soil fertility through loss of nutrients. In arid and

semi-arid areas these impacts may also contribute to desertification. Fortunately, ecosystems in these areas demonstrate considerable resilience and often recover when grazing pressure is reduced, either through traditional methods or through modern management practices.

Policy and Legal Problems

In areas that traditionally rely on grazing, the health of rangeland is generally best maintained by traditional pastoralist practices, which regulate grazing location and herd size in accordance with drought cycles and the supply of fodder. In fact, government policies or donor interventions that disrupt or discourage these practices may be a root cause of degradation. A variety of government policies may restrict the movement of livestock within a range area and prevent livestock managers from moving stock from areas that have been depleted of fodder to better supplied areas.

Two particular policy-based problems are:

- *Land tenure insecurity.* Lack of confidence in secure title to rangeland (especially on communal lands) has been shown to reduce the incentive to manage the land sustainably. Many national governments have either implicitly or explicitly claimed ownership of range and wildlands and ignored traditional or customary claims.
- *Privatization of communal resources.* Where national governments have privatized, or are privatizing, formerly state-owned or communal lands, new owners may erect fencing or prevent herds from crossing or grazing on their property.

Wells and boreholes

Traditionally, access to water on critical grazing lands has been controlled to limit livestock populations and prevent herds from outgrowing the forage supply in dry areas. Thus, new wells or boreholes, generally sponsored by donors or governments, may undermine traditional livestock management systems practices by allowing herds to grow beyond sustainable levels for surrounding areas. Overgrazing and degradation are most noticeable in the immediate vicinity of the boreholes or wells, but their effects can extend (in gradually decreasing severity) over a considerable radius. Boreholes also reduce pressure on livestock owners to decrease herd size during drought and may discourage movement of herds to other rangelands, disrupting historic wet season/dry season grazing patterns. Larger herd sizes and reductions in pastoral movement may prove to be a recipe for severe degradation of soil and vegetation.

Wet-Season Grazing

Poor timing in the use of rangeland can also damage the soil. Wet-season grazing can compact the moist earth, reducing its ability to absorb moisture. This increases erosion from water runoff.

Poor Balance of Livestock Species

Each species or breed of livestock has foraging preferences and will graze favored areas and plants while neglecting others. Browsing animals, such as

goats and camels, prefer the leafy tops of shrubs. By contrast, grazers tend to consume ground-level grasses and leafy plants. A poor balance between browsers and grazers can change the mix of plants in ways that degrade the area. For example, too many grazers can diminish the number and populations of herbaceous plant species and allow woody plants to become dominant, changing, possibly irreversibly, the character and utility of the ecosystem.

Damaged habitat and reduced biodiversity

Livestock production can damage habitats and reduce biodiversity in wildlife and domestic stock, in vegetation, and in aquatic and wetland ecosystems.

Harm to wildlife and domestic stock and loss of wildlife habitat.

The loss of habitat caused by livestock production in grazing and mixed farming systems may be one of the greatest threats to wildlife. Human population growth and density, and the accompanying increase in livestock, often leads producers to expand livestock grazing ranges into wild lands and the conversion of wild lands to mixed farming use.

Slaughter of wildlife by livestock managers.

Another danger to wildlife is intentional slaughter by livestock managers. Fear that the wildlife will prey on livestock and damage crops is a common motivation, as is the belief that the wildlife are competing with livestock for fodder, the desire to prevent spread of disease to livestock, and concern for human safety.

Extinction of local livestock breeds.

Systematic livestock production may result in loss of genetic diversity in livestock species. This is unfortunate because genetic diversity is a measure of a species' robustness. Local breeds may have traits conferring resistance to emergent or future pathogens, or have other favorable adaptations to local environments. The consistent replacement of local breeds with more productive imported ones can contribute to the extinction of that breed and of all the genetic diversity harbored within its population.

Harm to Vegetation

Clearing of forest and wild lands.

(See "Widely degraded land areas" above.) Vegetation is typically altered or



Livestock can cause serious harm to a variety of environments by overgrazing vegetation and compacting soil.

destroyed when forests/wild lands are cleared or are burned to promote new growth. This changes local ecosystems and may contribute to global warming. Fires to burn vegetation are dangerous and degrade air quality.

Loss of rangeland fertility.

Ironically, mixed farming systems may reduce the fertility of rangeland while helping to solve a farmland problem. Traditional farming practices cause a net loss of nutrients in farm soils; that is, when crops are harvested and sold (or even when human waste is deposited in a latrine) nutrients that make the soil fertile may be lost. Mixed farming reduces the extent of this loss, by transferring nutrients from the range to the farm in the form of manure. The gain in fertility for the farm is, of course, a net loss for rangeland. Over time, the altered nutrient balance can reduce the productive capacity of the range and/or lead to changes in the composition and density of plant species.

Loss of farm fertility.

Damage from mixed farming often occurs when poverty and population growth pressure change the crop/grazing land ratio, where other nutrient sources are not available. As the land area available for each grazing animal shrinks, overgrazing becomes prevalent leading to soil erosion and nutrient loss. Harvesting livestock further reduces nutrients available for crop production.

Damage to riparian soil and vegetation.

Livestock in grazing and mixed farming systems often graze very heavily in riparian areas along streams and lakes. Results include trampling, loss of vegetation, soil disturbance, and soil compaction, erosion and/or sedimentation which can severely damage riparian habitats, increase siltation and adversely affect watersheds.

Pesticide contamination from treatments to protect livestock from insect-borne infections (e.g., livestock “dipping”) may ultimately reach the aquatic environment. Here it can be toxic to aquatic organisms, as well as people or animals who depend on these sources for drinking water.

Introduction of invasive plants.

New breeds or fodder crops can introduce invasive non-native plants into a region. The manure, coats and hooves of newly introduced breeds can carry plant seeds. Most non-native plants are not invasive, but when they are, the results can be devastating.

Contamination from manure.

Livestock manure contains relatively high concentrations of nutrients, solids, enteric bacteria and other microorganisms, and organic material. The manure from industrial livestock operations is often discharged or “leaked” into lakes or streams, because it cannot be economically transported to replenish crop fields. When this occurs, the nutrients can cause eutrophication (rapid plant growth in water bodies), solids can create sedimentation, and organic material leads to oxygen depletion (BOD) of the water. Manure from mixed farming, if applied in a concentrated fashion, can lead to similar problems.

Degrade water quality and reduce water supplies.

Where water is scarce, either chronically or seasonally, the diversion of water to sustain livestock potentially limits its availability for other purposes. This is of particular concern in arid and semi-arid regions, where the construction of boreholes to supply livestock can lead to unsustainable withdrawal rates and the dangerous depletion of aquifer reserves.

As noted above, stockpiled manure can contaminate bodies of water, causing myriad adverse effects. These include eutrophication, oxygen depletion, sedimentation, contamination with enteric bacteria and possibly other pathogenic organisms, toxic pollution from pesticides, and contamination of groundwater and aquifers with both nitrates and pesticides. Moreover, high concentrations of nitrate in potable water supplies represent a potential health hazard, especially for children.

Harm to human health.

Using water for farm animals may make it less available for the many uses that influence health, such as bathing, washing, cooking, and drinking. Moreover, as mentioned above, excessive contamination by enteric microorganisms, toxic pesticides or nitrates in may render water unfit for human consumption and may be especially dangerous to children. Pesticides or other vector control treatments used on livestock represent threats to the health of livestock managers, their families, and others exposed directly or through water use. These substances may be toxic, cause birth defects, alter children's proper development, promote cancer, or slowly poison one or more organ systems.

Climate change/global warming.

Approximately 17% of global methane is produced by livestock digestion and manure. Methane is a greenhouse gas that has 56 times more global warming potential than carbon dioxide over a 20-year time horizon. Furthermore, clearing wild or forest land for new fields reduces the land's ability to act as a carbon sink. As noted above, setting fire to vegetation to clear land or promote new growth for livestock to graze on may also contribute to global warming.

Odor.

Concentrated manure stored at industrial livestock facilities can generate strong and unpleasant odors, damaging the quality of life of nearby residents. This problem is most evident when facilities are located in densely populated areas.

Sector Program Design—Some Specific Guidance

The following questions and suggestions are intended to help project designers and managers identify factors and practices that may cause—or prevent—adverse environmental impacts. Bear in mind that the first priority of most livestock managers and farmers is household food security and family welfare. Sustainable practices must always be balanced against these immediate demands.

Consider climate, terrain, and ecosystem

Since environmental impacts from livestock production vary, depending on the specific climates, terrains and ecosystems involved, project designers need to address these characteristics during the initial design phase:

- What is the climate in the project area (arid, semi-arid, temperate, subhumid, humid)? What do historical records of rainfall patterns and flooding indicate? Is the proposed livestock management practice compatible with this climate?

- What terrains are found in the project area(s) (alluvial plain, highland, rocky desert, wetland, etc.)? Do they have any known vulnerabilities to livestock grazing? For example, are there many unprotected streams or rivers? Are there slopes with limited topsoil sensitive to erosion?
- Will the project encompass or border on protected or ecologically sensitive areas? Are there any threatened or endangered species in the



Soil and climate must be considered when planning livestock management projects. Semi-arid lands, for example, pose unique challenges and problems for program designers.

area? Would the proposed project directly or indirectly threaten wildlife or native vegetation? For example, does the project require expansion of grazing into protected areas or make livestock more vulnerable to wildlife predators, triggering reprisals by farmers?

Evaluate policy, legal, customary and cultural context

The policy, legal, and cultural contexts of a project merit attention, since, as illustrated above, these factors may limit program options or erect substantial barriers to success.

Policy/legal

- Do livestock owners and managers have legal and recognized ownership and responsibility for land and grazing resources? What are the current or proposed national land tenure policies, and how are they implemented at the local level? Are they effective in encouraging sustainable management of grazing land and resources?
- What is the tenure status of current or proposed rangeland—Is it owned by individuals or the community? Does the government have claims?
- What wildlife protection laws exist and how are they implemented in the region?

Culture/custom

- What role does livestock play in local culture and customs, and how might the proposed project affect these practices? Would the proposed project disrupt traditional grazing patterns?
- If there are customary land tenure arrangements, what are they and how would the proposed livestock management system work within these arrangements? For example, will livestock herders—who often come into conflict with farmers, particularly during droughts—have a means of working out disputes with farmers?
- If livestock management arrangements are communal, how would these be affected by and/or affect the proposed development activities?

Assess current and proposed species and breeds

Introduction of a new breed into an area should be approached with caution. The new breed may bring with it diseases that can decimate local livestock herds and wildlife. In addition, the foraging habits of a new breed may lead to a sharp decline in available forage and biodiversity. A new breed's reproductive habits can lead to a herd's uncontrolled growth. Weeds can be accidentally introduced along with a new animal species, and they may displace desirable vegetation.

The long term full costs and benefits of introducing a given new livestock species into a particular environment should be assessed. For example, large animals roam over extensive areas in search of food, often require a greater financial investment, can be more difficult to control, and have lower reproductive potential than small animals. It is important not to underestimate the value of breeds that are well adapted to the environment.

Livestock tend to overgraze favored areas and plants while neglecting others. Native plants may not be able to survive heavy grazing. While unforaged plants tend to lose vigor and nutritional value as they mature. The introduction of new plant species (whether accidentally or intentionally) may quickly result in replacement of native plants. Even when grazing pressure is reduced, exotic plant species sometimes retain their dominance.

Ask the following questions when introduction of a new breed or species is proposed:

About current species and breeds

- Which wild and domestic species are already present in the area, and in what numbers?
- How have they been used in local farming systems and traditions?
- What are the feeding preferences of local livestock and wildlife? What is the balance between browsers and grazers? Do domestic species compete for resources with one another and with wildlife?
- Have population sizes of wild or domestic species changed recently?
- Could local breeds satisfy the project's needs?

About proposed species and breeds

- If new species or breeds are being considered, how will their production complement or conflict with local species or breeds, wildlife, and other local resource users?

- How would they fit in local herding systems?
- Are they well suited to the local climate and environment?
- Are they resistant to local livestock diseases?
- Have alternative species or breeds been considered for possible introduction?

Evaluate current and proposed livestock management practices

To maximize forage productivity, it is best to combine or alternate various livestock breeds on a range. Their differing food preferences can help to keep plants productive by minimizing overgrazing of a particular favored area and allowing less preferred plant species time to mature. It is prudent to make superior forage available to those animals with the highest needs. When forage is limited, livestock managers may decide that young and milk-producing animals must have first access to new pastures and ranges with a wide variety of abundant forage.

Managers should investigate the value of various systems of rotating livestock. Rotation allows land to be grazed continuously throughout the year. Livestock can be rotated between fields or ranges to prevent the buildup of disease and to vary grazing pressures. Through either fencing or herding, they can be relocated into croplands to consume crop residues.

Assessment of seasonal grazing patterns should include potential impact on soils. Dry-season grazing can benefit the land by breaking up crusted soil and working seeds into the ground. By contrast, as mentioned above, grazing on moist soil can cause considerable soil compaction, which reduces the soils ability to absorb moisture and can result in increased erosion from runoff during the rainy season.

Many of the environmental impacts from livestock production are associated with particular practices of livestock managers. Thus it is critical to understand current practices and how the proposed project might alter these practices or promote new ones.

- Who are the local community's livestock managers?
- What practices do a family or community use to control the size and composition of livestock herds?
- How do livestock managers currently control livestock movement? Will the proposed project change these movements in a way that might harm the environment?
- Does the proposed project require the construction of fences? If so, will they interfere with wildlife migration or transit of livestock belonging to other communities? Could the fences lead to overgrazing and land degradation? Will the fences be built with local materials? Would living fencing be practical? Would solar-powered electric fencing be technically and economically feasible?
- Are streams and riverbanks currently protected from livestock damage? If the proposed project will open new areas to grazing, will water supplies need to be protected?

- Must steps be taken to prevent new livestock and associated animals (e.g., dogs) from transmitting disease to wildlife? Is there a vaccination/animal disease control program available for this purpose?
- Will the project involve construction of improvements (e.g., boreholes or other infrastructure)? Could these lead to unplanned changes in herding patterns and overgrazing?

Assess demand and use of livestock products

- Who is marketing livestock and livestock products?
- Is the demand for livestock products coming from local or outside populations? How rapidly is it increasing or decreasing? How stable is the demand?
- In preparing livestock products, are people using technologies which reduce impacts on the environment, open additional markets, or improve health and nutrition (of people and animals.)

Assess livestock ectoparasite management

Epidemic and endemic diseases continue to be a major constraint to livestock productivity in large parts of the developing world. Although vaccines have controlled many of the epidemic diseases, they continue to cause severe economic losses through morbidity and mortality. These diseases include the infections caused by vector-borne haemoparasites and helminths. Existing technologies, such as chemotherapeutic agents and live vaccines that were previously successful in controlling these diseases, are no longer effective—because of acquired resistance or weakened delivery services. Appropriately designed alternatives are often lacking.

Consider population pressure and disease burden

Two factors that may affect the outcome and impact of projects population growth and fatal or debilitating epidemic diseases. Population growth may lead to conflicting uses of grazing lands or reduce individual farms or rangeland to sizes that cannot sustain livestock. Fatal or debilitating epidemic diseases may weaken effective dissemination or replication of proper livestock management techniques.

- What is the current and projected population growth rate in the project area? How might this affect project sustainability in the future?
- What is the current extent of the HIV/AIDS epidemic in the region? How might this affect the composition of the population (size, ethnic makeup, age/gender distribution) and family structures necessary for project sustainability? How will development and livestock technical support services be affected?
- Are there other epidemic diseases in the region, such as sleeping sickness, that might adversely affect project implementation?

Mitigation and Monitoring Issues

Environmental Mitigation and Monitoring Issues for Livestock Projects

Activity	Impact	Mitigation
<p>Introduction of a new grazing livestock production or of mixed farming</p>	<p><i>The activity may. . .</i></p> <p>Degrade large areas by:</p> <ul style="list-style-type: none"> - overgrazing - imbalanced foraging - dominance by low-utility plant species - soil compaction - soil erosion <p>Damage habitat and reduce biodiversity by:</p> <ul style="list-style-type: none"> - overgrazing - imbalanced foraging - competition with wildlife for fodder or water - increased killing of wildlife to “protect herds” -spreading disease to wildlife 	<p>To prevent overgrazing and soil compaction, ensure that pastoralists and livestock managers/farmers have secure tenure rights. Monitor implementation of tenure policy.</p> <p>Develop decision-makers’ awareness of the long-term economic importance of maintaining balanced ecosystems and resilience, including maintenance of biodiversity and wildlife. Provide similar knowledge to pastoralists and livestock managers/farmers.</p> <p>For grazing systems, guarantee managers and pastoralists sufficient mobility and flexibility to manage grazing areas sustainably, use water and biomass efficiently, destock rapidly in times of drought and restock when rains return.</p> <p>For mixed farming systems, determine farmer/livestock manager’s ability to match livestock requirements to available rangeland and fodder crops for long-term sustainability. Strengthen capabilities through education and incentives where needed.</p> <p>To avoid killing of wildlife that is thought to be infecting or preying on livestock, provide livestock managers with financial incentives to maintain ecosystem balance. Explore possible community-based natural resource management (CBNRM) approaches. (See “Community-based Natural Resource Management” in this volume for more information), or other successful integrated wildlife and livestock management methods, such as combined wildlife and livestock ranching.</p> <p>To maintain rangeland and mixed farming system sustainability, ensure a balanced mix of foraging and grazing species, including wildlife where appropriate. Determine fodder preferences of domestic and wildlife species.</p> <p>To ensure balanced use of fodder and water, determine baseline carrying capacity for livestock and wildlife (where appropriate). Establish quota systems for domestic species and wildlife to ensure that carrying capacity is not exceeded. Change domestic species and breeds to minimize overlap between their preferred fodder and that of local wildlife, and/or ensure a sufficient supply of fodder for domestic species and wildlife. Monitor management of the quota system.</p> <p>Establish historical baselines for climate and precipitation, taking into account seasonal and geographic variations. Establish historical baselines for soils, water quality and quantity, flora and fauna, and select indicators to measure deviation from baseline. Monitor indicators to gauge whether long-term resilience of range and mixed farming systems is being maintained. Train herders, pastoralists and farmers as resource monitors.</p>

Activity	Impact <i>The activity may . . .</i>	Mitigation
<p>In highland areas</p> <p>Near rivers and streams</p>	<p>Generate conflict between livestock managers and other groups, such as farmers</p> <p>Cause erosion</p> <p>Damage riparian habitat</p> <p>Degrade water quality</p> <p>Damage aquatic and wetland habitat and biodiversity</p>	<p>Assure pastoralists' access to seasonal grazing and water.</p> <p>Strengthen systems for wildlife management and for control of problem animals to minimize adverse interactions with pastoral and mixed farming systems (such as disease transmission, predation and crop damage).</p> <p>To prevent the spread of disease from livestock to wildlife, carefully research any new breeds and associated diseases.</p> <p>To prevent conflict between livestock managers, farmers, pastoralists and other groups, ensure that the customary or legal rights and responsibilities of all parties are harmonized and accepted. Agreements should cover how each resource will be used, who will use it, when it is to be used, utilization rates and quotas, management costs, and monitoring responsibilities. If such rights and responsibilities are not yet established, work with policymakers to create a respected legal framework.</p> <p>To minimize erosion caused by livestock raised in highland areas, avoid overgrazing through the use of quota systems matched to carrying capacity. Ensure that terracing and paths are well constructed, and reduce soil compaction by providing incentives to avoid wet season grazing.</p> <p>To prevent erosion, sedimentation, degradation of water quality, and damage to aquatic habitats and biodiversity, protect stream and riverbanks from browsing or grazing through fencing or herding techniques.</p>
Introduction of industrial livestock production	<p>Improper management and/or treatment of manure from industrial facilities may</p> <ul style="list-style-type: none"> -degrade water quality -damage aquatic and wetland habitat and biodiversity -harm human health -create odor 	<p>Preferably, apply manure to crop fields. If the expense of transport makes this uneconomical, treat the manure. Options for treating animal manure are like those for treating human waste. These include construction of artificial wetlands, detention ponds, composting, and biogas generation. Site these treatment systems with care to minimize adverse impacts on water bodies and communities. (See section on "Water Supply and Sanitation" in this volume for more information.)</p>
Introduction of new livestock and breeds	<p>Degrade land</p> <p>Reduce biodiversity and harm habitat</p> <p>Reduce genetic diversity of domestic species</p> <p>Transmit disease to wildlife</p> <p>Introduce invasive non-native plant species</p>	<p>Thoroughly research new species of livestock. Determine their grazing/browsing preferences and compare them to those of current livestock species/breeds and wildlife to minimize overlap and prevent unbalanced feeding. Pilot-test new breeds and species before introducing them in a broad program, and monitor their impacts over time.</p> <p>If local breeds can meet specified needs, strongly consider their use. In particular, even if local breed is a relatively low producer, weigh this drawback against the breed's disease resistance and hardiness in the local environment.</p> <p>Introduce entirely new species or breeds to a region with great care Evaluate the risks of introducing new diseases that might be transferred to wildlife.</p> <p>If breeds or species from other parts of the world are to be introduced, wash and comb their hooves and coats to remove plant seeds. Feed livestock on grain or other crop feed in transit to minimize the risk of accidentally introducing new plant species.</p>

Activity	Impact <i>The activity may . . .</i>	Mitigation
Construction of new fencing	<p>Cause conflict with pastoralists or communities</p> <p>Disruption of migratory patterns and ecosystem balance</p> <p>Damage natural resources viewed and aesthetics</p>	<p>If the project calls for constructing new fencing, ensure that such fencing is consistent with local customary property and resource-use arrangements and will not interfere with the movement of livestock belonging to traditional pastoralists.</p> <p>Site fencing to minimize impacts on migratory species. Fully research impacts on migratory animals, their role in the ecosystem and the potential effects of fencing on reproduction. Provide corridors which ensure that migratory patterns are not jeopardized. Monitor migration patterns against baseline conditions.</p> <p>Avoid cutting living trees for fence posts in areas where wood is scarce. Investigate the potential for live fences as barriers. Assess the cost-effectiveness of solar powered electric fencing.</p> <p>In or near protected areas, or areas of unique scenic value, make efforts to construct fencing which is hidden from view or which minimizes impact on aesthetics.</p>
Installation of new/improved water supply	<p>Degrade large land areas from overgrazing</p> <p>Compact soil</p> <p>Reduce biodiversity and harm ecosystem and habitat</p> <p>Reduce water availability</p> <p>Degrade water quality</p>	<p>When installing new water supplies, consider how access to water will affect geographical and seasonal grazing patterns. In some cases, such as in a semi-arid climate, it may be best not to construct water supply improvements for livestock, since these will almost certainly lead to environmental degradation.</p> <p>If the improvements are essential, ensure that a mechanism for regulating water use is in place to prevent exhaustion of the water resources and to help restrict the number of livestock dependent on these sources. Water supply improvements should also be designed so that they minimize the risks of water supply contamination by animals and humans.</p> <p>Monitor water supply quantity and quality.</p> <p>(See section on “Water Supply and Sanitation” in this volume for more information).</p>
Control of livestock disease vectors	<p>Harm human health</p> <p>Damage plant and animal biodiversity</p>	<p>Evaluate latest information on integrated vector management (IVM) and integrated pest management (IPM) alternatives to pesticides for control of livestock diseases.</p> <p>If pesticides are to be used to control ectoparasites, such as ticks and tsetse flies, consider alternatives to cattle dipping and area treatment (e.g., vaccines for tick-borne diseases and bait traps for tsetse).</p> <p>Where cattle dipping and/or area treatment are used, ensure that those handling and applying pesticides are fully aware of the hazards, use appropriate equipment and protective clothing, and receive proper training in correct handling, storage, application and disposal. Use only pesticides approved by the U.S. Environmental Protection Agency.</p> <p>Ensure that cattle dips are designed to avoid potential contamination of ground or surface water with pesticide. Be especially aware of the potential for underground migration of chemicals over distance to nearby wells and streams used for potable water, and the potential effects on aquatic organisms.</p> <p>Monitor handling, storage, application and disposal of pesticides. Monitor potential effects on non-target organisms (both terrestrial and aquatic) and human health. Be aware of the potential for bio-accumulation.</p> <p>(See section on “Integrated Pest Management/Pesticides” in this volume for more information)</p>
Increased population and disease burdens		<p>Design projects with attention to mechanisms to maintain human and livestock populations at sustainable levels below the upper limits of the ecosystem’s carrying capacity, including the provision of health and family planning services and incentives. Consider use of permits and quota systems to limit in-migration</p>

Activity	Impact <i>The activity may . . .</i>	Mitigation
		<p>and population growth in sensitive or threatened rangelands or mixed farming areas, as well as other areas of special value. Use pollution permits to control pollution from industrial livestock operations, especially near communities and water resources. Monitor growth in population against a historical baseline.</p> <p>Assess the medium- to long-term implications of epidemic diseases (e.g., HIV/AIDs, tuberculosis, sleeping sickness) on livestock managers, pastoralists and farmers, as well as on provision of technical assistance and support. Institute local health and HIV/AIDs education programs in conjunction with technical assistance and training in livestock management.</p>

Resources and references

LEAD Virtual Research and Development Center: The LEAD (Livestock, Environment And Development) Initiative, an inter-institutional project with the secretariat in FAO supported by the World Bank, the European Union (EU), FAO and many donor countries. In English, Spanish and French. <http://www.virtualcentre.org/selector.htm>

The project's main goals are to increase awareness, knowledge and understanding of livestock and environment interactions; to identify appropriate options for livestock and environment management at regional and national levels, and to help build sound livestock management and environmental concepts into government and donor policies and projects.

The LEAD Virtual Research and Development Center provides access to decision support tools, electronic conferences, online discussion forums, a digital library, expert consultations, a who's who, a directory, newsletters, and information on project research centers.

Decision support tools include: the Livestock and Environment Toolbox, Livestock Development Planning Systems, Fossil Fuel in Livestock Systems computer models and planning tools, the Digital Library, and the Livestock Environment Policy Dialog.

LEAD Livestock and Environment Toolbox. Part of LEAD Virtual Research and Development Center (see above) <http://www.virtualcentre.org/en/dec/toolbox/homepage.htm>.

The Livestock and Environment Toolbox is an electronic decision support tool for policymakers, planners and project leaders less familiar with livestock environment interactions, to help them identify which ones should be encouraged (beneficial) or mitigated (adverse). The toolbox offers technical and policy or institutional development options, together with suggestions for increasing awareness of the issues among policymakers, planners and extension officers.

CGIAR System-wide Livestock Programme (SLP): Annual Report 1997–98, International Livestock Research Institute, Consultative Group on International Agricultural Research (CGIAR), USAID, 1999, 53 pages. Available at http://www.dec.org/pdf_docs/PNACH705.pdf

Poverty, food insecurity and a deteriorating environment threaten the livelihoods and even the lives of millions of rural people in developing countries. Smallholder farmers in these countries have few resources or opportunities to improve their situation, but one widely available option is to integrate crop and livestock production. These systems help farmers improve farm productivity while protecting natural resources. CGIAR' SLP combines crop-livestock research with research on the management of natural resources.

P.J. Brandjes, J. de Wit, H.G van der Meer and H. Van Keulen, 1996. *Environmental Impact of Animal Manure Management*. FAO/World Bank/USAID, Rome. Working Document: Livestock and the Environment: Finding a Balance. <http://www.virtualcentre.org/en/dec/toolbox/Refer/IACman.PDF>

ILRI and USAID, 2000. *ILRI (International Livestock Research Institute) 1999 Annual Report: Making the Livestock Revolution Work for the Poor*. 86 pages. Available at www.dec.org/pdf_docs/PNACK019.pdf.

This report focuses on a farm in central Ethiopia, whose mixed crop–livestock producers were just beginning to participate in the expanding dairy market of the country’s capital, Addis Ababa. The study also explores what has happened and what may likely happen to supply and demand for different livestock products in different parts of the world. It discusses the implications for equity, the environment and human health, and then briefly reviews some of the policy, institutional and technological interventions needed to ensure benign outcomes. Many of the suggested interventions are part of the research program of ILRI and its partners around the world.

ILRI and USAID, 2000. *ILRI Strategy to 2010: Making the Livestock Revolution Work for the Poor*. 107 pages. Available at www.dec.org/pdf_docs/PNACK021.pdf.

Major implications for livestock research are identified from analysis of the major factors expected to influence livestock development over the next decade. This framework is based on ex ante, or preventive, assessment of probable economic surplus from different research investments, taking into account five criteria: contribution to poverty reduction; expected economic impact; expected environmental impact; international relevance of recommendations under consideration; and expected impact on research capacity in developing countries.

ILRI and USAID, 1998. *ILRI 1997: Livestock, People and the Environment*. 73 pages <http://www.cgiar.org/ilri/pubs/a-report/ar97.cfm>.

The Institute’s Annual Report including a collection of articles on topics highlighting different facets of livestock-human-environment interactions and relationships. Articles include:

- livestock and nutrient cycling: maintaining a balance showing how livestock support intensified agricultural production systems;
- making sense—and use—of genetic diversity: highlighting the role for indigenous animal genetic resources in the low—external—input production systems used by the vast majority of the world's smallholder farmers;
- aspects of biotechnology research at ILRI;
- diagnostics and the environment: demonstrating approaches to alleviating the disease constraints facing smallholder livestock production;
- smallholder dairying—intimate links between people and livestock; and
- articles on the impact and control of trypanosomiasis and other livestock diseases

David John Pratt, Francois Le Gall and Cornelis de Haan, 1997. *Investing in Pastoralism: Sustainable Natural Resource Use in Arid Africa and the Middle East*. World Bank Technical Paper No. 365. 174 pages Available at www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2000/02/24/000009265_3971110141434/Rendered/PDF/multi_page.pdf

This document offers guidelines for development in arid lands where pastoralism is practiced. It focuses on natural resource management (NRM) on arid rangelands used by pastoralists in Africa and Middle East. Chapter 2 introduces NRM.

Part One provides advice on preparing for project interventions. Effective pastoral development has four basic requirements: (a) to differentiate the type of pastoral system(s) (chapter 2 and annex D); (b) to assess population pressure and societal coping mechanisms in order to establish whether present population pressure seriously impedes progress (chapter 3); (c) ensure that enabling policies and infrastructure are in place to support pastoral development (chapters 4 and 5); and (d) ensure a project design that combines participation, flexibility and the prospect of sustainability (chapter 6 and Annex E).

Part Two provides guidelines for specific project components, addressing five essentials of pastoral development projects: (a) herder organizations (chapter 7), (b) support systems (chapter 8), (c) drought management (chapter 9), (d) phasing of technical inputs (chapter 10), (e) process monitor (chapter 11). A concluding chapter considers the broader implications for international agencies such as the World Bank. Eight annexes provide additional background information and advice, and a user's guide.

Cornelis de Haan et al, 2001. *Livestock Development: Implications on Rural Poverty, the Environment, and Global Food Security*. World Bank, 80 pages. Price: \$15.00.

This book argues for a people-focused approach to livestock development, giving high priority to the public-goods aspect of poverty reduction, environmental sustainability, food security and safety, and animal welfare. It outlines the primary policy/technology framework for the main production systems and concludes with an eleven-point action plan for the sector.

Timothy O. Williams, 1998. *Multiple Uses of Common Pool Resources in Semi-arid West Africa: A Survey of Existing Practices and Options for Sustainable Resource Management*. Overseas Development Institute, Natural Resources Perspectives Number 38. Available at www.odi.org.uk/nrp/38.html.

Common pool resources such as rangeland, forests, fallow fields and ponds provide an array of social and economic benefits for a wide variety of users in semi-arid West Africa. However, poor definition and enforcement of the institutional arrangements governing the use of these resources sometimes lead to social conflicts and resource degradation. This paper examines why institutional arrangements are at times weak, and suggests what action can be taken.

M.A. Jabbar, J. Pender and S.K. Ehui (eds), 2000. *Policies for Sustainable Land Management in the Highlands of Ethiopia: Summary of Papers and Proceedings of a Seminar Held at ILRI, Addis Ababa, Ethiopia, 22–23 May 2000*. International Livestock Research Institute, Nairobi, Socio-economics and Policy Research Working Paper 30. 68 pages. Available at <http://www.cgiar.org/ilri/InfoServ/Webpub/Fulldocs/Workp30/Contents.htm>

The papers presented at this seminar provided information about the interrelated problems of land degradation, low agricultural productivity and poverty in the Ethiopian highlands (emphasizing the administrative regions of Tigray, Amhara and Oromiya);

- the proximate and underlying causes of those problems;
- the responses of individuals, communities and governments to the problems;
- the impacts of some of those responses; and
- the constraints and opportunities affecting the potential in the future for more productive, sustainable and poverty-reducing development pathways in the Ethiopian highlands.

Charlotte Boyd with Roger Blench, David Bourn, Liz Drake and Peter Stevenson, 1999. *Reconciling Interests among Wildlife, Livestock and People in Eastern Africa: A Sustainable Livelihood Approach*. Overseas Development Institute, Natural Resource Perspectives Number 45. Available at www.odi.org.uk/nrp/45.html.

From the perspective of local livelihoods this paper explores the complex interactions between wildlife, livestock and people, and options for integrated wildlife and livestock management in the semi-arid rangelands of eastern Africa. The paper draws on the sustainable livelihoods approach which explicitly considers whether households have access to the assets required to engage in an activity, and how that activity fits with existing livelihood activities.

Joshua Ramisch. 1999 *The Long Dry Season: Crop-livestock Linkages in Southern Mali*. Agricultural Ecosystems Research Group, Agronomy Department, University of Wisconsin, Madison, WI. Available at http://www.iied.org/pdf/dry_ip88english.pdf.