USAID
FROM THE AMERICAN PEOPLE

SECTOR ENVIRONMENTAL GUIDELINES

LIVESTOCK

Partial Update 2015 | Last Full Update: Prior to 2003

This document was prepared by The Cadmus Group, Inc. under USAID's Global Environmental Management Support Program, Contract Number GS-10F-0105J. The contents are the sole responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.

Cover Photo: USAID/Afghanistan has supported and provided veterinary health programs to improve livestock production. Photo credit: M. Lueders (2008).

About this document and the *Sector Environmental Guidelines*

This document presents one sector of the *Sector Environmental Guidelines* prepared for USAID under the Agency's Global Environmental Management Support Project (GEMS). All sectors are accessible at www.usaidgems.org/bestPractice.htm.

Purpose. The purpose of this document and the *Sector Environmental Guidelines* overall is to support environmentally sound design and management (ESDM) of common USAID sectoral development activities by providing concise, plain-language information regarding:

- the typical, potential adverse impacts of activities in these sectors;
- how to prevent or otherwise mitigate these impacts, both in the form of general activity design guidance and specific design, construction and operating measures;
- how to minimize vulnerability of activities to climate change; and
- more detailed resources for further exploration of these issues.

Environmental Compliance Applications. USAID's mandatory life-of-project environmental procedures require that the potential adverse impacts of USAID-funded and managed activities be assessed prior to implementation via the Environmental Impact Assessment (EIA) process defined by 22 CFR 216 (Reg. 216). They also require that the environmental management/mitigation measures ("conditions") identified by this process be written into award documents, implemented over life of project, and monitored for compliance and sufficiency.

The procedures are USAID's principal mechanism to assure ESDM of USAID-funded Activities—and thus to protect environmental resources, ecosystems, and the health and livelihoods of beneficiaries and other groups. They strengthen development outcomes and help safeguard the good name and reputation of USAID.

The Sector Environmental Guidelines directly support environmental compliance by providing: information essential to assessing the potential impacts of activities, and to the identification and detailed design of appropriate mitigation and monitoring measures.

However, the Sector Environmental Guidelines *are* ***not*** *specific to USAID's environmental procedures. They are generally written, and are intended to support ESDM of these activities by all actors, regardless of the specific environmental requirements, regulations, or processes that apply, if any.*

Region-Specific Guidelines Superseded. The *Sector Environmental Guidelines* replace the following region-specific guidance: (1) *Environmental Guidelines for Small Scale Activities in Africa* ; (2) *Environmental Guidelines for Development Activities in Latin America and the Caribbean*; and (3) Asia/Middle East: *Sectoral Environmental Guidelines.* With the exception of some more recent Africa sectors, all were developed over 1999–2004.

Development Process & Limitations. In developing this document, regional-specific content in these predecessor guidelines has been retained. Statistics have been updated, and references verified and some new references added. However, this document is not the result of a comprehensive technical update.

Further, *The Guidelines* are not a substitute for detailed sources of technical information or design manuals. Users are expected to refer to the accompanying list of references for additional information.

Comments and corrections. Each sector of these guidelines is a work in progress. Comments, corrections, and suggested additions are welcome. Email: gems@cadmusgroup.com.

Advisory. *The Guidelines are advisory only. They are not official USAID regulatory guidance or policy. Following the practices and approaches outlined in the Guidelines does not necessarily assure compliance with USAID Environmental Procedures or host country environmental requirements.*

CONTENTS

LIVESTOCK

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 grains for livestock feed, primarily for industrial systems.

A student of animal husbandry at the University Catholique du Graben in Butembo, Democratic Republic of the Congo. Photo Credit: L. Rose

BRIEF DESCRIPTION OF THE SECTOR

The use of livestock such as cattle, sheep, goats, pigs and poultry offer many benefits to the growing global population and millions of farmers in the developing world. These animals are integral to rural livelihoods and local cultures, providing food (meat, eggs and other dairy products), materials (wool, hide, horns, etc.), income, and mechanical power for pulling carts, drawing water or plowing fields. Livestock manure can serve as a source of fertilizer. Grazing can help sustain vegetation and promote biodiversity by dispersing seeds, controlling shrub growth, stimulating grass growth and improving seed germination. Livestock may also represent savings and currency or have cultural value. 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, 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. Although it might increase the costs, adding livestock to their farms helps farmers to minimize risk through more diversified production systems 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.

Grazing systems are most favored in arid, semi-arid, or other areas of marginal value for crop-based agricultural production, with about 25 percent of the world's total land area used for grazing livestock and about 20-30 percent of arable land used for production of cereals for livestock feed.[1] Extensive grazing systems cover the dry areas of Africa, Asia, Australia, and North America, and are characterized by grazing livestock in communal, sparsely populated areas, while the high-quality grassland temperate zones of Europe, North America, and South America support intensive grazing systems. In intensive grazing systems, large groups of cattle graze smaller areas amongst a medium to high population density.[2] Mixed farming systems flourish in temperate, subhumid, humid, and some highland climates and can be rain-fed (mainly in Europe and the Americas) or irrigated (eastern and southern Asia). Animal Feed Operations (AFOs) use feed, so they do not depend on local forage, and therefore, can be practiced in any climate and near areas of high consumer demand, such as urban centers. However, AFOs are only practical where fodder, either cereal feed or natural fodder, can be transported to the facilities. Industrial systems are common in Europe, North America, southeast Asia, and Latin America and are becoming more prevalent in developing nations as a response to growing livestock demand[3].

In response to growing demand for livestock products, livestock production is increasing throughout the developing world, with highest production growth exhibited in China and Brazil between 1980 and 2007.[4] This increase is driven by increasing urbanization, rising incomes, globalization, and to a lesser

A boy watches over a small herd of cattle. Livestock can enhance land quality and socio-economic well-being, but producers must guard against potential environmental and economic damage.

Photograph: K. Burns

[1] FAO. 1997. Livestock and the Environment – Meeting the Challenge. http://www.fao.org/docrep/x5304e/x5304e00.htm and FAO. 2006. Livestock impacts on the environment. Spotlight http://www.fao.org/ag/magazine/0612sp1.htm.
[2] FAO. 2009. The State of Food and Agriculture. Part 1: Livestock in the Balance. http://www.fao.org/docrep/012/i0680e/i0680e02.pdf.
[3] Otte, J. Roland-Holst, D. Soares-Magalhaes, R., Rushton, J., Graham, J., Silbergeld, E. 2007. Industrial Livestock Production and Global Health Risks. Pro-Poor Livestock Policy Initiative. http://www.fao.org/ag/againfo/programmes/en/pplpi/docarc/rep-hpai_industrialisationrisks.pdf.
[4] The State of Food and Agriculture. Part 1: Livestock in the Balance. 2009. FAO. http://www.fao.org/docrep/012/i0680e/i0680e02.pdf

extent growing population.[5] This situation is expected to continue throughout the next decade, and will be a major contributor to emission of greenhouse gases (GHGs) and climate change from the agriculture sector. A shift towards industrial production—farming of monogastric species (pigs, poultry) fed with grain—seems a trend likely to continue in areas with rapidly growing demand for animal food products, absent policy interventions or business initiatives that guide behavior and diets in other directions.

Properly managed in terms of number and kinds of species, livestock production can enhance land, 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. Cattle, in particular, have a large carbon footprint as a major emitter of GHGs. This guideline will help identify potential adverse environmental impacts and suggest mitigation and monitoring options, as well as "best management practices," to address them.

CLIMATE CHANGE

ADAPTATION

Global climate change is resulting in changes in temperatures, rainfall patterns, sea levels, and extreme weather events that are putting stress on many communities and challenging development efforts. It is becoming more difficult to predict future climate based on historical baseline conditions or trends. This uncertainty is increasing project design risks and community vulnerabilities. In response, project designers should now include a focus on climate change adaptation — defined as adjustment to natural or human systems in response to actual or expected climate change effects. Successful livestock projects include efforts to moderate climate-related risks and vulnerabilities and to take advantage of potential benefits to improve the likelihood of long-term project success. This guideline provides information on the relationship between climate change and livestock activities (farmed fisheries are not included in here).

When making use of climate change scenarios, those involved in livestock projects need to take adequate account of the associated uncertainties around climate change and plan for robustness. Risk management frameworks can be used to understand the implications of uncertainties about climate change impacts when informing planning, investment and operation decisions.

MITIGATION

Globally, livestock production is a major contributor to greenhouse gas (GHG) emissions. GHG emissions associated with livestock supply chains add up to 14.5 percent of all human-caused GHG releases, but the FAO estimates that the sectors' emissions could be cut by as much as 30 percent through the wider use of existing best practices and technologies.[6] Project selection and design should also assess the potential contribution of a proposed project or projects to greenhouse gas emissions, and reduce contributions by selecting low-emission options and cost-effective strategies and actions that minimize GHG emissions. Emissions from the livestock sector come both from the animals themselves and from land management and land use change associated used for these animals. Historically, livestock production has been associated with land clearing for pasture, so mitigating the expansion of pasturelands at the expense of forests should be considered and avoided in project design.

---

[5] DeFries, R. Rudel, T., Uriarte, M., and M. Hansen. 2010. Deforestation driven by urban population growth and agricultural trade in the twenty-first century. Nature Geoscience. 3(3): 178-181. Boucher, D., P. Elias, K. Mulik, and E. Davis. 2013. Climate-Friendly Land Use. Union of Concerned Scientists. Washington, DC. 36 pp.

[6] FAO. 2013. Major cuts of greenhouse gas emissions from livestock within reach. http://www.fao.org/news/story/en/item/197608/icode/.

Methane dominates emissions from the livestock sector, but N_2O emissions and carbon storage are also important. Four major opportunities to reduce GHG emissions from the livestock sector are: (1) avoid deforestation and forest degradation associated with opening new land for grazing; (2) support a transition away from cattle -- which accounts for 41% of livestock-related GHG emissions but only 5% of calories -- towards other animals; (3) exclude grazing from marginal lands and place them under fodder production for fattening operations as alternative livelihoods coinciding with livestock production; and (4) Because livestock production generally has a larger carbon footprint than plant production, increase the efficiency with which livestock is not only produced but used by reducing food waste in the livestock sector.

Additional opportunities to reduce GHG emissions from livestock do exist but potential benefits are more modest. These take advantage of existing best practices within any particular livestock production system and include practices such as manure and pasture management.

POTENTIAL ENVIRONMENTAL IMPACTS IN THE LIVESTOCK SECTOR AND THEIR CAUSES

LARGE AREAS OF LAND DEGRADED

OVERGRAZING

Overgrazing of rangeland—including cleared or converted land—reduces the density of vegetation and the amount of organic matter produced via plant growth. The decrease in vegetation, in turn, when bare ground starts to appear, 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. Higher temperatures, more variable rainfall and stronger storms associated with climate change can exacerbate damage caused by overgrazing or further constrain the number and type of livestock that rangeland can support.

USE OF MARGINAL LANDS

Growing population pressures have led many smallholder farm families to eke out a subsistence livelihood on more and more marginal lands, such as the uplands of Latin America and Caribbean. There are some indications that the trend is beginning to reverse itself in the region as a result of more robust economies and off-farm employment opportunities. At the same time, climate change is causing many areas to be less productive and lands that were once productive may become more marginal. Land degradation is perhaps the most widespread example of an environmental issue having a direct impact on human beings. Livestock grazing on environmentally fragile sites causes soil erosion and disrupts the hydrological cycle, contributing to a decline in productivity and undermining food security. Higher temperatures, more variable rainfall and stronger storms associated with climate change can also further exacerbate damage. As land degradation becomes more severe, farmers, especially those using rainfed systems, often have few options other than to expand their farms to another piece of land on which they can earn a livelihood or to cope by migrating to tropical lowlands or already overburdened urban areas. The consequences of degrading marginal lands, such as flooding and siltation, undermine other promising water-related development initiatives in irrigation, potable water supply and hydropower. Farming on these marginal lands is also a higher risk activity in the face of erratic and variable rainfall associated with climate change because the expanded farmlands are often located on steep slopes with little vegetative cover and thin soils that are prone to erosion and landslides.

POLICY AND LEGAL ISSUES

National Government policies or donor interventions have the potential to disrupt or discourage good practices and may become a root cause of degradation. For example, some government policies may restrict the movement of livestock within a range area or prevent livestock managers from moving stock from areas that have been depleted of fodder to better supplied areas. The health of rangelands are generally best maintained by traditional pastoralist practices which regulate grazing location and herd size in accordance with drought cycles and the supply of fodder. Regardless of the ownership system livestock owners seek assurance that they will be able to conduct their activities without disruptions. Two particular policy-based problems are:

Land tenure insecurity. In many developing countries across the globe, lack of confidence in secure title to rangeland (especially on communal lands) has been shown to reduce the incentive to manage the land sustainably. Often, pastoralists who have lost land to the government or degradation will clear forests in order to acquire new pastures or land for growing feed contributing to deforestation. 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 and boreholes - 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. In addition, higher temperatures, more variable rainfall and more frequent or severe extreme events, such as drought and floods, associated with climate change can exacerbate water availability and quality. Expected climate impacts should be considered before new wells and boreholes are installed.

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. Note that climate change may impact the timing and severity of wet seasons and this should also be taken into account.

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, 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 significantly alters the ecosystem dynamics in the area. For example, dense bush encroach on cattle pastures, making them unproductive for cattle ranching. If cattle are allowed to graze alone without browsing animals present. In Zimbabwe, small-scale commercial

ranchers pasture goats with cattle to prevent bush encroachment, which also serves as a risk mitigation strategy for years with drought since goat tend to do better in low water conditions than cattle.[7]

DAMAGED HABITAT AND REDUCED BIODIVERSITY

Livestock production can damage habitats and reduce biodiversity of wildlife and domestic stock, vegetation, and 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 convert wild lands to mixed farming use.

These habitat losses occur most frequently through overgrazing, the installation of fencing that impedes or prevents migration and conversion of wild lands or forests to fodder crops. Fencing can exclude a species' subpopulations from their traditional range, thereby reducing their habitat, increasing their vulnerability, and potentially leading to local "extinctions" of species or subspecies. In addition, when livestock and wildlife share the use of rangeland and forests, the potential exists for competition over water and fodder, depending on their fodder preferences. Research suggests, however, that in some cases the fodder preference overlap may be small and that coexistence is possible if livestock managers restrict herd size to some degree.

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.

For decades thousands of wild animals in Africa were killed to prevent contact with livestock, under the belief that they served as reservoirs for diseases deadly to livestock. This practice has diminished as the tourist value of wildlife has grown. However, the rationale was correct in principle—wildlife do serve as reservoirs for some of the most harmful diseases that affect cattle: malignant catarrhal fever, theileriosis/East Coast fever, and trypanosomiasis (sleeping sickness). Now livestock themselves are reservoirs for these diseases, and obliteration of wild species would be pointless. Nevertheless, wildlife remain at risk from farmers anxious to protect their livestock and farming investments.

POTENTIAL SPREAD OF DISEASE TO WILDLIFE

Wildlife contribute significantly to the economies of many countries, particularly those with an eco-tourism industry. Wildlife may be at risk of contracting diseases from imported livestock. The controlled or uncontrolled movements of livestock within countries or across national borders in search of grazing lands or markets may results in frequent contact between livestock and wildlife, and create opportunities for pathogen transmission and transboundary diseases,

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

[7] Sikosana, J.L.N. and Gambiza, J. 1994. Goat production in a mixed cattle-goat system: Effect of stocking and substitution rate on redsoil thornveld stability. In Lebbie, S.H.B., Rey, B., and Irungu, E.K. (editors), Small ruminant research and development in Africa. Proceedings of the Second Bienniel Conference of the African Small Ruminant Research Network. http://www.fao.org/wairdocs/ilri/x5472b/x5472b00.htm#Contents.

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 Livestock practices are currently resulting in a loss of livestock breeds that are essential to the overall wellbeing of the sector. In just the last 15 years, 190 breeds listed in FAO's Global Databank for Farm Animal Genetic Resources have disappeared from a total of 7,600 breeds. Since 2002, it is believed that 60 breeds of cattle, goats, horses, pigs, and poultry have become extinct. The increasing demand for livestock meat products favors high-output breeds over local species.[8] Traditional breeds, while not as productive under optimal conditions, sometimes produce more reliable growth under a wider range of circumstances. This characteristic has particular advantages in the face of climate change.

HARM TO VEGETATION

CLEARING OF FOREST AND WILD LANDS

(See "Large Areas of Land Degraded" above.) Vegetation is typically altered or destroyed when forests/wild lands are cleared or are burned to promote new growth. This changes local ecosystems and contributes to the loss of biodiversity and the loss of ecosystem function and associated ecosystem services, including water and climate regulation services. Fires to burn vegetation are dangerous, degrade air quality, and release carbon stored in woody vegetation to the atmosphere, adding carbon dioxide to the atmosphere and increasing the rate of climate warming.

LOSS OF RANGELAND FERTILITY

Ironically, mixed farming systems may reduce the fertility of rangeland while helping to solve a farmland problem. Grazing systems cause a net loss of nutrients in farm soils; that is, when crops are harvested and sold 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.

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, soil compaction, erosion and/or sedimentation which can severely damage riparian habitats, decrease biodiversity, and increase siltation. Riparian zones often filter surface water and groundwater as it passes from uplands by trapping soil particles and reducing the amount of sediment and phosphorous entering streams. A damaged riparian soil can lead to higher phosphorous levels in streams resulting in high rates of algal growth and reduced water quality.

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

[8] Nierenberg, D. 2013. Protecting livestock biodiversity. http://www.worldwatch.org/node/5128

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 that depend on these sources for drinking water.

These impacts may be exacerbated by climate change in cases where increased precipitation and more severe storms can lead to increased water flows in riparian areas.

INTRODUCTION OF INVASIVE PLANT SPECIES

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 and will not cause environmental or economic harm, but when they are, the results can be devastating.

DECREASED WATER QUALITY AND SUPPLY

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. The absence of regulation and/or effective enforcement increases the likelihood of these impacts.

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. Rules or norms for limiting use of the water resources tend to be much less common for groundwater than for surface water. As a result, in many cases, groundwater resources are overused and aquifers become depleted over time. The same aquifers that supply water for animal agriculture often supply water for human consumption, so water shortages that result from overpumping for livestock have consequences for drinking water supply and crop irrigation. These impacts may be exacerbated in areas made drier or hotter by climate change.

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.

One of the most common examples of unsustainable agriculture is over-grazing on sloping lands, which leads to soil erosion and uncontrolled rainfall run-off. These consequences can be far-reaching, leading to both minor and major environmental impacts, including landslides, earth slumps, gully formation, siltation and sedimentation of water courses, and downstream flooding with significant loss of life and property. Slope, topsoil depth, and soil type all affect the potential for erosion and dictate the appropriate conservation measures essential for controlling it.

HARM TO HUMAN HEALTH

Excessive contamination by enteric microorganisms, toxic pesticides or nitrates 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.

In CAFOs (confined animal feeding operations), routine use of antibiotics to prevent healthy animals from contracting disease has led to the growth of microbes that resist these antibiotics, creating a major challenge for medical treatment of people.[9]

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.

CLIMATE CHANGE

PLANNING FOR A CHANGING CLIMATE: ADAPTATION

In recent years, many communities have also been stressed by changing temperatures, rainfall patterns, and extreme weather events—abnormal weather patterns indicative of a changing climate. Adaptation is a process through which societies make themselves better able to cope with these changes. Adapting to climate change entails taking appropriate measures to mitigate the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. The definition of adaptation applies to short-term climate variability as well as long-term changes.

Adaptation to man-made climate change varies from traditional coping and adaptation strategies in that: climatic shocks are likely to be increasingly severe and frequent; and climate change forecasting provides the capacity to adapt proactively, instead of just reactively. Adaptation is necessary because at least some degree of climate change is inevitable even with strong mitigation measures. Because climate change is inevitable, it is important to look for ways to reduce the severity of these impacts, especially on vulnerable populations.

Planning for climate change requires an understanding of how climate is currently affecting land, livestock feed growing operations, hydrologic cycles, and the economy of the livestock sector, and how climate change is likely to affect these factors in the future. With the exception of indoor feeding operations, planning also requires considering the unique climate sensitivities of livestock species. Due to climate change, locations can also be affected by higher temperatures, more variable rainfall, sea level rise, salt water intrusion, or increased intensity and frequency of extreme events such as floods, storms, and drought. Climate change impacts may be more severe if other non-climate stressors—like increased water withdrawal, and erosion—make livestock and agriculture environments more sensitive. As climate shifts, the livestock sector may face drought, water scarcity, and decreased productivity of forage crops. With higher temperatures, livestock may suffer from heat distress, leading to illness, decreases in food uptake, reduced productivity, and poor growth. Some species require very narrow temperature ranges while others can tolerate higher or lower temperatures. For example, non-native dairy breeds developed for colder climates introduced into the tropics may be particularly sensitive to increasing temperatures, which will likely stress animals and reduce productivity. Therefore, some livestock may be more resilient than others when facing a changing climate while other species may no longer be economically viable.

Climate change may have a number of other direct and indirect effects on livestock production:

- *Increased animal feed costs.* Climate change is likely to impact production of crops. For example, changes in precipitation patterns, such as shorter growing seasons or more severe droughts,

[9] Schneider , K. and L. Garrett. 2009. Non-therapeutic Use of Antibiotics in Animal Agriculture, Corresponding Resistance Rates, and What Can be Done About It. Center for Global Development. http://www.cgdev.org/article/non-therapeutic-use-antibiotics-animal-agriculture-corresponding-resistance-rates-and-what.

may decrease overall crop productivity and lead to increased prices. Additionally, if there is a decrease in production of crops that can be fed to both animals and humans, such as maize, prices are likely to increase in places where people do not have food substitutes. More extreme weather events, such as floods and stronger storms, may also interrupt supply chains and lead to increased prices or at least temporary price spikes. Droughts and floods may also decrease the productivity of agriculture and grazing lands.

- *Increased incidence of disease outbreaks as disease vectors change and grow.* Climate change will change the way vector-borne diseases (vectors include ticks and mosquitoes) and animal parasites are spread. With higher temperatures and more variable precipitation, new diseases will emerge or diseases will occur in places where they formerly did not.
- *Increased milk spoilage due to higher average temperatures*. Many farmers are already under pressure to get milk to chilling and processing centers where it can be cooled and preserved before it spoils. Higher average temperatures and increased frequency of heat waves will make this task even more difficult.
- *Changing water systems increases the difficulty of maintaining healthy animals in a sanitary environment.* Changing precipitation patterns and warmer temperatures may impact water availability on local and regional scales. On-farm demand for water will increase as farmers try to meet each animal's increasing need for water as well as normal demands for animal, kraal, and milking equipment hygiene. Flooding increases unsanitary environments (water-logged kraals and milking areas) and contaminated water supplies. For example, recent typhoons in the Philippines resulted in unsanitary animal keeping conditions, raising the risk of mastitis.

Best practices for climate change adaptation, both generally and specifically for livestock and agricultural adaptation, include:

- Understand the main climate change threats facing a specific country or region. It is important to understand what climate change impacts are predicted for a given country or region to design appropriate responses. It also important to understand which communities or groups of people (for example, women or poor families) are most vulnerable to climate change impacts and why.
- Integrate planning for climate change adaptation into the project planning cycle. This starts with analyzing how climatic events might impact the project and its beneficiaries and what steps the project can take to minimize the impacts and build resilience. Any interventions that can help beneficiaries deal with their immediate challenges while preparing for future climate change impacts can be win-wins for all involved. For example, if more severe droughts and floods are predicted for the project area, responses might include rain water harvesting to ensure water supplies, introduction of drought resistant seeds, and more robust cow sheds and manure storage areas.
- Include project participants as part of the planning process to increase awareness about potential climate change issues and encourage sustainable, long-term community-driven responses. USAID has developed a set of guidelines for integrating climate change into the project planning cycle (see Resources and References).Make sure that the promoted crop and livestock species are those best suited for both current and potential future climate conditions. For livestock, this may mean strengthening local breeds, which are already adapted to local climate stress and feed sources and/or more cross-breeding of exotic species with heat- and disease-tolerant breeds. USAID projects can help livestock owners strategically reduce herd sizes so that resources can be focused on the most robust and productive animals. For agriculture, introduction of drought resistant or flood tolerant species or promotion of alternative crops better suited to changing climatic conditions could increase farmer resiliency

to climate change. Project technical staff need to stay abreast of climatic conditions at the field level, so they can advise farmers on the best options.

- Improve access to credit, insurance, and markets so that beneficiaries have options and safety nets in case of climate-related events. This involves either linking existing insurance programs and markets to partner producer groups/beneficiaries or collaborating with financial and insurance companies to design products best-suited to the financial limitations of crop and livestock production.
- Improve dissemination of information from crop and livestock early-warning systems as well as other forecasting and crisis preparedness systems. One such source of information is USAID's Famine Early Warning Systems Network (FEWS NET) which covers most countries in sub-Saharan Africa and Central America (www.fews.net). Projects should ensure that beneficiaries are able to access this information easily in a format they can understand and act on to make better decisions.
- Consider alternative livelihoods to compliment livestock sector activities which are sensitive to the local climate. In some programs, overgrazed lands and marginal agricultural land have been excluded from grazing and instead designated for fodder production, which not only provides alternative livelihoods but also improves vegetative cover locally.

POTENTIAL CLIMATE CHANGE IMPACTS THAT COULD AFFECT LIVESTOCK PROJECTS

Direct Impacts (illustrative examples)	**Indirect Impacts** (illustrative examples)	**Possible Adaptation Responses** (illustrative examples; adaptation responses should be tailored to local circumstances)
• More crop pests & livestock disease • Heat stress for livestock and human workers • Decrease in the available water resources • Reduced access to markets	• Reduced nutrition • Reduced incomes • Food insecurity • Migration	• Herder managed natural regeneration of trees and grasslands • Rangeland-based rainfall capture and infiltration • Commodity-based trade approach to livestock disease management, allowing removal of wildlife migration-inhibiting fences • Restoration of pastoral migration rights-of-way and protection of grassbanks • Heat management techniques for workers and livestock

ADAPTING TO CLIMATE CHANGE BY MINIMIZING VULNERABILITY THROUGH PROJECT DESIGN

Adapting planning, design, and project execution to climate change involves ensuring that existing livestock operations, fodder production, and associated facilities are able to withstand variations in climatic conditions and especially extreme weather events. The vulnerability of livestock to climate change is the degree to which species may be unable to cope with a changed climate. Vulnerability is a function of exposure, sensitivity, and adaptive capacity. Designers and project managers should

incorporate information on climate from past baseline trends, as well as future projections for the expected life expectancy of the investment. They should also ensure that workers in the industry have access to these resources. In many cases managing for greater uncertainty and risk associated with potential extreme conditions rather than past historical trends emphasizes the **precautionary principle** over "**business as usual**." This type of focus on risk analysis and management is commonly applied by the financial and insurance industries and can also be used in assessing potential development activities.

For example, design and siting for livestock projects in coastal communities should take into account projected sea level rises and storm surges. Operations in or near flood plains, rivers, and wetlands should be avoided whenever possible. In locations where drought conditions are becoming more frequent, livestock project managers should ensure that a reliable source of water can be sustained to supply the operation and that livestock can withstand the projected increase in temperature and arid climate. If livestock operations in coastal communities rely on groundwater, excessive pumping may lead to saltwater intrusion, contaminating supplies used for drinking water as well as for livestock.

Climate change adaptation also includes integrating renewable and/or back up energy systems to maintain operations in the event systems are overwhelmed by climatic events. From a **risk management** perspective, it is less costly to design for the potential direct and indirect impacts of climate change on livestock operations, than to than to risk major losses or damage to livestock systems. Doing so reduces vulnerability, maximizes the chance of successful livestock production, facilitates community adaptation to climate change, and can increase community resilience.

MINIMIZING GREENHOUSE GAS EMISSIONS (GHG) AND MAXIMIZING SEQUESTRATION

MAJOR IMPACT ACTIVITIES

Worldwide, the livestock sector contributes 14.5 percent of total global greenhouse gas emissions, mostly in the forms of methane and nitrous oxide.[10] Methane in particular has 25 times the global warming potential (GWP) of carbon dioxide over a 100-year time horizon and 72 times CO_2's GWP on a 20-year time horizon. Therefore, while reducing emissions of methane into the atmosphere matters on both short and long time scales, it is particularly important for mitigating climate change consequences in the short term, and for reducing the peak concentrations of atmospheric GHGs.

In the practice of EIA, mitigation is the implementation of measures designed to eliminate, reduce or offset the potential adverse effects of a proposed action on the environment.

In the practice of climate change, mitigation is defined as human interventions to reduce GHG emissions or enhance carbon sinks (e.g., forests and soil), which store CO_2.

Livestock vary tremendously in their climate impact. Ruminants -- and cattle in particular -- contribute much more to climate change than other livestock such as poultry or goats; even sheep, another ruminant, have significantly smaller GHG emissions than cattle. Compared to other agricultural GHG sources, ruminant production is the largest source of anthropogenic CH_4 and globally occupies more area than any other land use.[11] Cattle production stands out as an opportunity for reducing GHG emissions because alone it contributes 41 percent of emissions from the livestock sector and uses the

[10] Gerber, P. Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & G. Tempio. 2013. Tackling Climate Change Through Livestock — A Global Assessment of Emissions and Mitigation Opportunities. FAO. 139 pp.
[11] Ripple, W., P. Smith, H. Haberl, S. Montzka, C. McAlpine, and D. Boucher. 2014. Ruminants, climate change, and climate policy. Nature Climate Change. 4: 2-5.

majority of the world's agricultural land, but contributes only about 5 percent of the world's protein. To maximize climate change mitigation, in those areas where cattle is not vital culturally or economically, projects should support poultry or even sheep (a ruminant) rather than cattle.

In addition, livestock production can drive land use change including deforestation and forest degradation, which accounts for approximately 15 percent of global GHG emissions and should be avoided. Clearing of wilderness or forests for new pasture removes important carbon stores, thus contributing to climate change.

Because livestock production generally has a larger carbon footprint than plant production, increasing the efficiency with which livestock is not only produced but used can increase mitigation of climate change. Approximately 30 percent, and perhaps as much as 50 percent, of all food is lost between harvest and table.[12] Post-harvest losses from livestock translate into needless GHG emissions associated with grain production, such as N_2O resulting from synthetic fertilizer application (for intensive operations) and methane from enteric fermentation (for ruminants) as well as CO_2 produced during any fossil-fuel powered transportation. Hence, incorporating project elements designed to reduce food waste into any livestock project has large climate change mitigation benefits. Minimizing food waste also contributes to increased food security.

MODERATE IMPACT ACTIVITIES

Manure management contributes approximately 10 percent of global methane emissions. Therefore, improved manure management can reduce these emissions. One approach is to use an anaerobic digester, which converts the methane to CO_2 by combustion. Ideally, energy produced during combustion is captured and used, but even in the absence of energy capture this practice reduces the GWP of the emitted gas. Alternatively, composting manure or spreading it on fields at agronomically appropriate rates avoids decomposition in a largely oxygen-free environment, minimizes the amount of methane produced, and increases the potential for building soil organic matter and increasing soil carbon storage. Increasing soil organic matter also results in increased productivity and improved moisture-management. Incorporating manure into soil needs to be evaluated on a case-by-case basis; incorporating manure into the soil can increase soil carbon storage but could disturb soil and leave it vulnerable to decomposition and erosion depending upon time of year and when the next crop will be sown.

In pasture-based systems, there are opportunities to reduce emissions from grazers and increase soil carbon storage. Birdsfoot trefoil, for example, has appropriate levels of protein and fixes nitrogen. It also produces condensed tannins. While these compounds can reduce feed efficiency at higher concentrations, in small amounts they reduce methane production in the guts of ruminants and increase the efficiency of protein absorption by moving it from the rumen to the hindgut.[13] Consequently, more nitrogen occurs in dung and less in urine. Nitrous oxide emissions from urine patches can be extremely high, so reducing nitrogen concentrations in urine may also reduce N_2O emissions. Perennial plants have deeper roots and much higher rates of carbon storage than annual plants. Active pasture management can balance the need for aboveground plant production to support animal growth with belowground growth to increase soil carbon and water-holding capacity. There is considerable room to improve understanding of how and where birdsfoot trefoil and other species could be used to improve pasture, reduce GHG emissions from livestock, and increase soil carbon storage on grazing land.

[12] Foley, J., N. Ramankutty, K. Brauman, E. Cassidy, J. Gerber, M. Johnston, M. Mueller, C. O'Connell, D. Ray, P. West, C. Balzer, E. Bennett, S. Carpenter, J. Hill, C. Monfreda, S. Polasky, J. Rockstrom, J. Sheehan, S. Siebert, D. Tilman, and D. Zaks. 2011. Solutions for a cultivated planet. Nature. 478: 337-442.

[13] Macadam, J.W. and T. C. Griggs. 2010. Performance of birdsfoot trefoil, white clover, and other legume-grass mixtures under irrigation in the Intermountain West USA. Proceedings of the New Zealand Grassland Association. 68: 355-359.

Activity	Main Sources of GHGs	Mitigation Strategies
Zero and semi-zero grazing livestock and dairy production	Enteric Fermentation (CH_4)	Better animal nutrition (more concentrate feed and nutritional supplements) and genetics. Switch from ruminant species to monogastrics (e.g. chickens, pigs).
	Manure Management (CH_4)	Avoid anaerobic manure decomposition by applying manure directly as fertilizer. Biogas digesters to reduce CH_4 emissions and produce usable fuel for cooking and lighting (see Annex 6 for more info).
	Manure Management (N_2O)	Proper storage and application of manure to fields.
	Land use change and deforestation to produce feed and fodder crops (CO_2)	Promote agriculture intensification instead of clearing new land or deforestation. Conservation agriculture practices to promote soil carbon sequestration.
	Transportation and processing of feed and milk or meat (CO_2)	Build sustainable value chains at regional, national, or sub-national levels.
Extensive livestock production	Pasture degradation (CO_2)	Better grazing practices, such as rotational grazing and optimization of livestock numbers.
Agriculture Production	Land use change and deforestation and degradation (CO_2)	Promote agriculture intensification instead of clearing new land or deforestation. Conservation agriculture practices such as no till, strip-till, and use of cover crops promotes soil carbon sequestration.
	Inorganic fertilizer production, transport, and use (CO_2 and N_2O)	Use organic fertilizer if possible. Optimal application of inorganic fertilizer.
	Mechanized agriculture (CO_2)	Use efficient, appropriate, and well maintained equipment.

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 is the recent history regarding rainfall patterns and flooding patterns? Is the proposed livestock management practice compatible with current and potential future climatic trends? Will climate change impacts such as higher temperatures and more variable weather events reduce potential availability of fodder and grazing areas?

- 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 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?

- Is fodder and forage productivity in the project communities appropriate from an availability and nutrition standpoint for the livestock being promoted? Does fodder management require burning? Can production and promotion of fodder and forage serve to mitigate climate change and prevent desertification by contributing to improved grassland management?

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

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? Are local land tenure practices and traditions respected through relevant land tenure policies including at a national level? Are they effective in reassuring farmers and 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 does spell out what farmers can and cannot do in terms of protecting livestock from the threat of wildlife?

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?

LIVESTOCK PROJECT CAPACITY AND ONGOING SUPPORT

- Is capacity in the livestock sector a concern? What is the project able to do to ameliorate this situation?

- Is the project assuring adequate technical support for livestock herders? Can this support be provided by the project's technical team, or a third party such as the local agricultural extension service?

- Are appropriate veterinary services available?

- Will the project have an effective follow up system in place to monitor the well-being of livestock and impacts on the local environment?

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 disrupt 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 who 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. Selecting breeds that are well adapted to the environment is vital to successful livestock management—the value of appropriate breed selection should not be underestimated.

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. Heavily grazed native plants may be additionally impacted by transfer of invasive species, as discussed above. 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 are there concerns regarding the interaction of different breeds? ,
- 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? How will future climate change affect these species?
- Which species/breeds will have the smallest impact on climate change (note that cattle, in particular, contribute significantly to greenhouse gas emissions)?
- 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.

Within reason, managers should investigate the value of different 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 management. 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?
- Is there currently adequate fodder and forage for livestock? What are the expectations in fodder/forage availability with climate change predictions?
- 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, overgrazing or overallocation of groundwater? Will water demand be met in the context of climate change?
- With predicted climate change, are there breeds or types of livestock that may perform better (e.g., cattle that are smaller or grow slower, and therefore, have lower feed requirements)? Will there be enough rainfall for fodder production to meet needs?

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.)

MARKET LINKAGES AND PROCESSING

- Are agrovets and extension agents available to provide technical support and products at the community level, especially on issues that may significantly impact the environment such as vaccinations, pesticides, and veterinary pharmaceutical use and disposal?

- Are processing facilities (e.g., milk cold storage, abattoirs, auction houses) accessible to producers and are the facilities responsive to environmental impacts? Processing facilities can generate large amounts of solid waste (both manure and carcasses) or liquid waste (e.g., milk processing, cleaning, bottling facilities).

DISEASE 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.

Bloodsucking ticks and flies

Bloodsucking ticks and flies transmit several fatal or seriously debilitating diseases to cattle. In Africa, examples include tick-borne East Coast fever and African animal trypanosomiasis (nagana), transmitted by the tsetse fly. Cattle dipping and area treatment with pesticides are often used to control the carriers of such diseases. Although drugs have been used to prevent and treat typanosomiasis, they are expensive, effective for only a few months, and trypanosomes rapidly develop resistance to them. Promising alternatives to such control methods are being researched, including vaccines for tick-borne diseases and highly effective tsetse traps using baits.

CONSIDER POPULATION PRESSURE AND DISEASE BURDEN

Two factors that may affect the outcome and impact of livestock projects worldwide—but particularly in sub-Saharan Africa, Asia, and the Near East—are population growth and fatal or debilitating epidemic diseases. Population growth increases pressure on herds and may lead to conflict over grazing lands, reduction of the size of individual farms or rangelands so that they cannot sustain livestock, severe immobility of the herd, and environmental degradation. Fatal or debilitating epidemic diseases may weaken effective dissemination or replication of proper livestock management techniques. HIV/AIDS is a particular concern, but so are geographically restricted diseases such as sleeping sickness and malaria.

- 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?

- Will climate change affect the disease patterns in the region? How will this affect the project?

MITIGATION AND MONITORING ISSUES

ACTIVITY	IMPACT *The activity may. . .*	MITIGATION
Introduction of a new grazing livestock production or of mixed farming	Degrade large areas by: • Opening new areas to grazing • overgrazing • imbalanced foraging • dominance by low-utility plant species • soil compaction • soil erosion Damage habitat and reduce biodiversity by: • overgrazing • imbalanced foraging Contribute to GHG emissions	• To prevent overgrazing and soil compaction, ensure that pastoralists and livestock managers/farmers have secure tenure rights. Monitor implementation of tenure policy. • 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. • 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 and provide access to timely climate information to help them make those decisions. • Consider expected climate impacts and ensure land will be able to support new livestock population • Choose species/breeds that are well suited to the local ecology and current and future climate. Choose species that produce less GHG emissions.
	Damage habitat and reduce biodiversity by: • competition with wildlife for fodder or water • increased killing of wildlife to "protect herds" • spreading disease to wildlife	• 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. • 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. • 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,

ACTIVITY	IMPACT *The activity may. . .*	MITIGATION
Introduction of a new grazing livestock production or of mixed farming (continued)	Damage habitat and reduce biodiversity by: • competition with wildlife for fodder or water • increased killing of wildlife to "protect herds" • spreading disease to wildlife (continued)	and/or ensure a sufficient supply of fodder for domestic species and wildlife. Monitor management of the quota system. • 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. • Assure pastoralists' access to seasonal grazing and water. • 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). • 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. • To prevent the spread of disease from livestock to wildlife, carefully research any new breeds and associated diseases.
	Generate conflict between livestock managers and other groups, such as farmers	• 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.

ACTIVITY	IMPACT *The activity may. . .*	MITIGATION
		• If such rights and responsibilities are not yet established, work with policymakers to create a respected legal framework. • Provide timely, access to climate information so that groups can optimally manage the resource.
Introduction of a new grazing livestock production or of mixed farming in highland areas or marginal lands	Cause erosion	To minimize erosion caused by livestock raised in highland areas or marginal lands: • Avoid overgrazing through the use of quota systems matched to carrying capacity. • Construct side hill ditches or similar diversion structures—Very typically separating higher, non-arable land from cultivated land below. • Construct terraces—radical conversion of sloped land into a series of graded steps approximating flat conditions. • Plant living barriers—planted along the contour to trap or filter run-off and retain soil, such as contour hedgerows or grass strips. In some circumstances, fencing is necessary to keep animals and waste out of riparian areas. • Ensure that terracing and paths are well constructed, and • Reduce soil compaction by providing incentives to avoid wet season grazing.
Introduction of a new grazing livestock production or of mixed farming near rivers and streams	Cause erosion and sedimentation, thereby potentially: • Damaging riparian habitat • Degrading water quality • Damaging aquatic and wetland habitat and biodiversity	• Protect stream and riverbanks from browsing or grazing through fencing or herding techniques.
Introduction of industrial livestock production	Improper management and/or treatment of manure from industrial facilities may: • Degrade water quality • Damage aquatic and wetland habitat and biodiversity • Harm human health • Create odor • Increased GHG emissions	• Preferably, apply manure to crop fields. • Use an anaerobic digester • If the expense of transport makes this uneconomical, treat the manure. o Options for treating animal manure are like those for treating human waste. These include construction of artificial wetlands, detention ponds, composting, and biogas generation. o Site these treatment systems with care to minimize adverse impacts on water bodies and communities.

ACTIVITY	IMPACT *The activity may. . .*	MITIGATION
		See section on "Water Supply and Sanitation" in this volume for more information.
Introduction of new livestock and breeds	• Degrade land • Reduce biodiversity and harm habitat • Reduce genetic diversity of domestic species • Transmit disease to wildlife • Introduce invasive non-native plant species	• 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. • If local breeds can meet specified needs, strongly consider their use. Even if a local breed is a relatively low producer, weigh this drawback against the breed's disease resistance and hardiness in the local environment. Consider whether the breed will be well-suited to expected climate changes. • 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. • If breeds or species from other parts of the country, region, or 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.
Conversion of forest and other ecosystems to grazing land	• Increase GHG emissions/decrease carbon sinks	• Avoid conversion of existing forests or other ecosystems when possible • Generate clean energy from biodigesters of by-products including manure and residues • Employ sustainable feed management practices to reduce methane emissions from livestock
Installation of new/improved water supply	• Degrade large land areas from overgrazing • Compact soil • Reduce biodiversity and harm ecosystem and habitat • Reduce water availability • Degrade water quality	• 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. • Ensure adequate water supply for livestock as well as other local uses (human and ecosystem). Consider recent as well as expected future climatic conditions.

ACTIVITY	IMPACT *The activity may. . .*	MITIGATION
		• 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. • Monitor water supply quantity and quality. See section on "Water Supply and Sanitation" in this volume for more information.
Increased population and disease burdens		• 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 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. • 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

RESOURCES AND REFERENCES

REFERENCES

- Pica-Ciamarra, U., J. Otte, and C. Martini. *Pro-Poor Livestock Policy Initiative. Livestock Sector Policies and Programmes in Developing Countries: A Menu for Practitioners*. FAO. 2010. http://www.fao.org/docrep/012/i1520e/i1520e00.pdf

- Mandleni, B. and F.D.K. Anim. *Climate Change and Adaptation of Small-Scale Cattle and Sheep Farmers*. African Journal of Agricultural Research. 2012. http://www.academicjournals.org/ajar/PDF/pdf2012/5%20May/Mandleni%20and%20Anim.pdf

CLIMATE CHANGE RESOURCES

Note: USAID's Global Climate Change (GCC) Office can provide support on the climate change aspects of this Guideline. To contact the GCC office, please email: climatechange@usaid.gov

- USAID. 2007. Adapting to Climate Variability and Change: A Guidance Manual for Development Planning. http://pdf.usaid.gov/pdf_docs/PNADJ990.pdf

  The Adaptation Guidance Manual provides guidance to assist planners and stakeholders as they cope with a changing climate. It provides guidance on adaptation and the project cycle. USAID is currently preparing updated Adaptation Guidance to be released in 2013.

- USAID. 2009. Adapting to Coastal Climate Change: A Guidebook for Development Planners. http://pdf.usaid.gov/pdf_docs/PNADO614.pdf

- Food and Agricultural Organization (FAO). 2013. Climate Change Website. http://www.fao.org/climatechange/en/

  Provides publications, resources, case studies, and other information on climate change, and climate-smart agriculture, including:

- FAO. Mainstreaming Climate-Smart Agriculture into a Broader Landscape Approach. 2012. http://www.fao.org/docrep/016/ap402e/ap402e.pdf
- FAO. Developing a Climate-Smart Agriculture Strategy At The Country Level: Lessons from Recent Experience. 2012. http://www.fao.org/docrep/016/ap401e/ap401e.pdf
- Achieving Food Security in the Face of Climate Change: Final Report from the Commission on Sustainable Agriculture and Climate Change. 2012. http://ccafs.cgiar.org/sites/default/files/assets/docs/climate_food_commission-final-mar2012.pdf
- World Watch. 2009. Livestock and Climate Change. http://www.worldwatch.org/files/pdf/Livestock%20and%20Climate%20Change.pdf
- Feed the Future Collaborative Research Innovation Lab: Adapting Livestock Systems to Climate Change. 2013. http://lcccrsp.org/wp-content/uploads/2013/06/RB-12-2013.pdf
- IFAD. Livestock and Climate Change. http://www.ifad.org/lrkm/factsheet/cc.pdf
- Punsalmaa Batima Institute of Meteorology and Hydrology. 2006. Climate Change Vulnerability and Adaptation in the Livestock Sector of Mongolia. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CC8QFjAA&url=http%3A%2F%2Fipcc-

wg2.gov%2Fnjlite_download.php%3Fid%3D5854&ei=EAn8UaT0I4jB4AOj8YCgDg&usg=AFQjCNHsspctRKQ_T3M2wUG-JucT3uqMw&sig2=Qk_YiTil8dglz3HGjrMPFg&bvm=bv.50165853,d.dmg

- **National Communications** are submitted by countries to the UNFCCC and include information on country context, broad priority development and climate objectives, overviews of key sectors, historic climate conditions, projected changes in the climate and impacts on key sectors, potential priority adaptation measures, limitations, challenges and needs. http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

- **The World Bank's Climate Change Knowledge Portal** is intended to provide quick and readily accessible climate and climate-related data to policy makers and development practitioners. The site also includes a mapping visualization tool (webGIS) that displays key climate variables and climate-related data. http://sdwebx.worldbank.org/climateportal/

- **National climate change policies and plans.** Many countries have policies and plans for addressing climate change adaptation.

DOCUMENTS

- Boyd, C., R. Blench, D. Bourn, E. Drake, and P. Stevenson. 1999. *Reconciling Interests among Wildlife, Livestock and People in Eastern Africa: A Sustainable Livelihood Approach.* Overseas Development Institute, Natural Resource Perspectives Number 45. :London, UK. http://www.odi.org.uk/resources/details.asp?id=2109&title=reconciling-interests-wildlife-livestock-people-eastern-africa-sustainable-livelihoods-approach

  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.

- *The State of Food and Agriculture. Part 1: Livestock in the Balance*. FAO. 2009. http://www.fao.org/docrep/012/i0680e/i0680e00.htm

  This report is part of a comprehensive study on 'Interactions between Livestock Production Systems and the Environment - Global Perspectives and Prospects'. The study examines management of waste from animal product processing, and environmental impact of animal manure management, landless monogastric production systems, landless livestock ruminant systems, and mixed irrigated systems in the (sub-) humid zones.

- *CGIAR Annual Report 2008: Global Recommitment to Agriculture*. Consultative Group on International Agricultural Research. http://library.cgiar.org/bitstream/handle/10947/5262/2008_CGIAR_Annual_Report_low_res.pdf?sequence=1

  This annual report highlights communities adopting new ways of doing livestock business that are creating pathways out of poverty. The main chapters of this document present three case studies of how livestock systems are helping poor people meet the challenges of agricultural intensification in developing countries. The research activities in China, India and Nigeria outlined in this annual report is providing ILRI and partners and donor agencies with lessons for producing global public goods.

- de Haan, C. et al. 2001. *Livestock Development: Implications on Rural Poverty, the Environment, and Global Food Security.* World Bank, Washington D.C. http://www.ruta.org:8180/xmlui/bitstream/handle/123456789/523/RN62.pdf?sequence=1

  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.

- Heffernan, C. 1998. *Livestock, Destitution and Drought: The impact of restocking on food security post-disaster.* Pastoral Development Network, Overseas Development Network, FAO. Rome, Italy. http://www.odi.org.uk/pdn/drought/heffernan.html

  This paper examines concepts of food security in relation to pastoralists and attempts to quantify the impact of restocking on pastoralist households in Northern Kenya. The first section of the paper, analysis how food security can be both theoretically defined and practically applied. Whereas, the second section examines the impact of restocking projects on food security at both the household and project level. Food security parameters such as capital, investments and stores were evaluated. Household economic conditions were utilised as a proxy to measure food security. At the project level, the influence of the size of the restocking package on present and future food security was evaluated.

- ILRI and USAID. 2000. *Livestock Strategy to 2010: Making the Livestock Revolution Work for the Poor.* Nairobi, Kenya. http://mahider.ilri.org/bitstream/handle/10568/587/ILRIStrategy2010.pdf?sequence=1

  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.

- Jabbar, M.A., 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. http://www.ifpri.org/divs/eptd/ws/papers/eptws09.pdf

  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.

- Osofsky, Steve (ed). 2005. *Proceedings of the Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock and Human Health, AHEAD (Animal Health for the Environment And Development) Forum, IUCN Vth World Parks Congress, Durban, South Africa, 14th and 15th September, 2003.* IUCN Occasional Paper 30, IUCN - The World Conservation Union, UK. http://ilrinet.ilri.cgiar.org/inrm/InvestingFeb2006.pdf

The "Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock and Human Health" forum brought together nearly 80 veterinarians, ecologists, economists, wildlife managers, and other experts from Botswana, Kenya, Malawi, Mozambique, Namibia, South Africa, Tanzania, Uganda, Zambia, Zimbabwe, France, the United States, and the United Kingdom to develop ways to tackle the immense health-related conservation and development challenges at the wildlife/domestic animal/human interface facing Africa today, and tomorrow. This volume attempts to capture invitees' uniquely grounded insights, and their ideas for making the long-overdue "one health" perspective a reality in practice.

- Peden, D., A. Freeman, A. Astatke, A. Notenbaert. 2006. *Investment Options for Integrated Water-Livestockcrop Production in sub-Saharan Africa.* Working Paper 1, International Livestock Research Institute, Kenya. ISBN 92-9146-183-0 http://ilrinet.ilri.cgiar.org/inrm/InvestingFeb2006.pdf

  This paper focuses on opportunities to enhance investment returns in agricultural water through integration of livestock into production systems by considering three issues. The first is the development context of the dynamic livestock sector including the anticipated rapid growth in demand for animal products that are transforming the livestock sector and placing increased demand on agricultural water resources. The second is a continent-wide spatial analysis of the current and projected distribution of livestock with implications for related pressure on water resources and investment options that better integrate agricultural water and livestock development. Thirdly, this paper suggests a set of water-livestock investment strategies and options that can help guide planners toward more effective use of water and more beneficial animal production.

- Pratt, D. J., F. Le Gall and C. de Haan. 1997. *Investing in Pastoralism: Sustainable Natural* Resource *Use in Arid Africa and the Middle East.* World Bank Technical Paper No. 365. World Bank, Washington D.C. http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000009265_3971110141434

  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. Part One provides advice on preparing for project interventions. Part Two provides guidelines for specific project components, addressing five essentials of pastoral development projects: herder organizations, support systems, drought management, phasing of technical inputs, and process monitoring.

- Ramisch, Joshua. 1999. *The Long Dry Season: Crop-livestock Linkages in Southern Mali.* Agricultural Ecosystems Research Group, Agronomy Department, University of Wisconsin, Madison, WI. http://pubs.iied.org/pdfs/7413IIED.pdf

  This article discusses agro-pastoralist exchanges in Mali. This has increase following the Sahelian droughts of the 1970s and 1980s, in which pastoralists have moved southwards with their herds, into wetter, more productive environments; cultivators are increasingly investing in livestock as the plough replaces the hoe. This paper investigates the interactions brought about by the co-existence of herds and agriculture in a village setting.

- Sheng, T.C. 1989. "*Soil Conservation for Small Farmers in the Humid Tropics*." FAO Soils Bulletin 60: 104.

  Although somewhat dated, considered by many as the most useful guide for a practical understanding and application of soil and water conservation practices.

- Williams, Timothy O. 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. London, UK. http://www.odi.org.uk/resources/docs/2885.pdf;

  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.

DOCUMENTOS DISPONIBLES EN ESPAÑOL

- Evaluación del impacto ambiental Directrices para los Proyectos de Campo de la FAO. Roma 2011. http://www.fao.org/docrep/016/i2802s/i2802s.pdf.

- Evaluación Ambiental Ganadería Colombiana Sostenible. Mainstreaming Biodiversity is Sustainable Cattle Ranching. Documento de trabajo elaborado por La Fundación Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria – CIPAV. http://www.cipav.org.co/

- Las Guías sobre medio ambiente, salud y seguridad para *la* producción de ganado, Corporación financiera internacional Abril 2007. http://www1.ifc.org/wps/wcm/connect/5fe02880488657f9b3aaf36a6515bb18/Mammalian%2BLivestock%2BProd%2B-%2BSpanish%2B-%2BFinal-%2Brev%2Bcc.pdf?MOD=AJPERES

DOCUMENTS DISPONIBLES EN FRANÇAIS

- Directives environnementales, sanitaires et sécuritaires pour la production animale (Bétail) Société Financière Internationale. Avril 2007. http://www1.ifc.org/wps/wcm/connect/0105de004885523baaf4fa6a6515bb18/018_Mammalian_Livestock_Production.pdf?MOD=AJPERES

- Lignes Directrices pour l'Évaluation Intégrée des Impacts Environnementaux et Sociaux, Banque Africain de Développement. Novembre 2003. http://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/Lignes%20Directrices%20pour%20L%27evaluation%20Integree%20des%20Impacts%20Envitonmetal%20aux%20et%20Socieux.pdf

- Manuel en environnement - Ressources complémentaires — Élevage d'animaux. Outils pour l'identification des effets environnementaux de secteurs d'activités spécifiques, des mesures d'atténuation appropriées et lignes directrices ACDI. http://www.acdi-cida.gc.ca/acdi-cida/acdi-cida.nsf/fra/EMA-218123620-NNV