



# Environmental, Health, and Safety Guidelines for Mammalian Livestock Production

## Introduction

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)<sup>1</sup>. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the **General EHS Guidelines** document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. A complete list of industry-sector guidelines can be found at: [www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines](http://www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines)

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account.

<sup>1</sup> Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment

## Applicability

The EHS Guidelines for Mammalian Livestock Production includes information relevant to cattle ranching and farming, dairy farming, and hog and pig farming. Sheep and goat farming operations, while not explicitly discussed, are similar to the operations included in this document, and the recommendations presented here are also generally applicable. This document does not address feed production, dairy processing, or meat processing, which are covered under other EHS Guidelines. For guidance on animal welfare, see the IFC Good Practice Note "Animal Welfare in Livestock Operations."<sup>2</sup> This document has the following sections:

Section 1.0 — Industry-Specific Impacts and Management  
Section 2.0 — Performance Indicators and Monitoring  
Section 3.0 — References and Additional Sources  
Annex A — General Description of Industry Activities

<sup>2</sup> [http://www.ifc.org/ifcext/enviro.nsf/Content/Publications\\_GoodPractice](http://www.ifc.org/ifcext/enviro.nsf/Content/Publications_GoodPractice). An additional source for animal welfare guidance is the Farm Animal Welfare Council available at [www.fawc.org.uk](http://www.fawc.org.uk)

## 1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with mammalian livestock production that occur during the operational phase, along with recommendations for their management. Recommendations for the management of EHS issues common to most large projects during the construction and decommissioning phases are provided in the **General EHS Guidelines**.

### 1.1 Environment

Environmental issues in mammalian livestock production primarily include the following:

- Waste management
- Wastewater
- Air emissions
- Hazardous Materials Management
- Ecological impacts
- Animal diseases

#### Waste Management

Solid waste generated during mammalian livestock production includes waste feed, animal waste, and carcasses. Other wastes include various kinds of packaging (e.g. for feed and pesticides), used ventilation filters, unused / spoilt medications, used cleaning materials, and sludges from wastewater treatment if present (which may contain residual amounts of growth enhancers and antibiotics, among other hazardous constituents). In addition to the following sector specific guidance, wastes should be managed and disposed of according to the guidance for hazardous and non-hazardous waste provided in the **General EHS Guidelines**.

#### Waste Feed

Livestock feed includes hay, grain (sometimes supplemented with protein, amino acids, enzymes, vitamins, mineral supplements, hormones, heavy metals, and antibiotics), and silage. Livestock operations may produce all, a portion, or none of the feed used. Feeding can take place in buildings, feedlots, and pastureland. Feed can become unusable waste material if spilled during storage, loading, and unloading or during animal feeding. Waste feed, including additives, may contribute to the contamination of stormwater runoff, primarily because of its organic matter content.

To maximize the efficiency of the operation and minimize wasted feed, the following measures are recommended:

- Promote efficient storage, handling and use of feed by maintaining records of feed purchases and livestock feed use;
- Use covered or protected feeders to prevent feed from exposure to rain and wind;
- Maintain feeding systems in good working condition to prevent spills and feed contact with the ground;
- Consider mixing of waste feed with other recyclable materials destined for use as fertilizer, or else consider incineration or land disposal options, based on an assessment of potential impacts of each option to air, soils, and surface water / groundwater.<sup>3</sup>

#### Animal Waste

Mammalian livestock production operations generate significant quantities of animal waste, mainly in the form of un-metabolized nutrients excreted as manure. A mature pig, for example,

<sup>3</sup> Since some of the growth promoters used in livestock feed contain heavy metals (with the type and concentration of the metals determined by the type of livestock), the environmental impacts of the treatment and disposal options should be assessed (e.g. metals emissions to air from incineration, metals accumulation in soils, or migration into surface water or groundwater media from land application) and mitigated accordingly.

excretes on average 67 percent of the protein in feed via its urine and feces.<sup>4</sup>

Manure contains nitrogen, phosphorus, and other excreted substances which may result in air emissions of ammonia and other gases and may pose a potential risk of contamination to surface or groundwater resources through leaching and runoff. Manure also contains disease-causing agents such as bacteria, pathogens, viruses, parasites, and prions which may also potentially affect soil, water, and plant resources (for human, livestock, or wildlife consumption). Most of the animal waste is generated at housing, feeding, and watering locations. Animal wastes can be either liquid, slurry, or solid, depending on the solids content. Animal waste management systems involve the collection, transport, storage, treatment, and utilization (rather than disposal) of the waste to reduce such adverse impacts.

Manure collection systems include slotted floors that allow manure to drop into a storage area located beneath the floor; scraping of solid floors; and water flushing. The most common manure storage methods are belowground tanks, aboveground circular tanks and earth-banked lagoons, and weeping wall stores (aboveground concrete paneled stores with slots to allow liquid seepage to a collection tank). Lagoons should be fenced to prevent access by wildlife and nearby communities.

Manure may be used as a fertilizer on agricultural land after careful assessment of potential impacts due to the presence of hazardous chemical and biological constituents. The results of the assessment may indicate the need to some level of treatment and preparation prior to its application as a fertilizer as well as the application rates.<sup>5</sup>

The following management measures are recommended to minimize the amount of manure produced, to facilitate handling

<sup>4</sup> EC (2003).

<sup>5</sup> Additional information on the application of crop nutrients is provided in the Annual Crops and Plantation Crops EHS Guidelines.

of animal wastes, and to reduce migration of contaminants to surface water, groundwater, and air:

- Implement a comprehensive nutrient and waste management plan that takes into account the potentially harmful constituents of this waste including potential phytotoxicity levels, potential concentration of hazardous substances in soils and vegetation, as well as nutrient limits and groundwater pollutant limits;<sup>6</sup>
- Observe internationally recognized guidance, such as that published by FAO, on land requirements for livestock production for livestock units (LU) per hectare (ha) to ensure an appropriate amount of land for manure deposition;<sup>7</sup>
- Match feed content to the specific nutritional requirements of the animals in their different production and growth stages;<sup>8</sup>
- Use low-protein, amino acid-supplemented diets (e.g. a 1 percent reduction in the protein content of pig feed may result in a 10 percent reduction in the amount of nitrogen excreted);<sup>9</sup>
- Grind feed to increase utilization efficiency by the animals, allowing the use of less feed and thereby reducing the amount of manure generated (as well as increasing the production efficiency);
- Use low-phosphorus diets with highly digestible inorganic phosphates;
- Use quality, uncontaminated feed materials (e.g. concentrations of pesticides, dioxins, and so on are known

<sup>6</sup> A source for good practice includes Roy et al. (2006) Plant Nutrition for Food Security, A Guide for Integrated Nutrient Management, FAO, available at <ftp://ftp.fao.org/agl/agll/docs/fpnb16.pdf>

<sup>7</sup> A livestock unit is a term used to express the generic production of nitrogen (N) from livestock; one livestock unit produces 100 kg of N per year. Guidance regarding land areas for manure deposition is discussed in Roy et al. (2006).

<sup>8</sup> Further information is available from Animal Feed Resources Information System AFRIS Publisher by the FAO and available at <http://www.fao.org/AGA/AGAP/FRG/afri/tree/cat.htm> and in EC (2003).

<sup>9</sup> Ibid.

and do not exceed acceptable levels) that contain no more copper, zinc, and other additives than is necessary for animal health;<sup>10</sup>

- Ensure production and manure storage facilities<sup>11</sup> are constructed to prevent urine and manure contamination of surface water and groundwater (e.g. use concrete floors, collect liquid effluent from pens, and use roof gutters on buildings to collect and divert clean stormwater);
- Keep waste as dry as possible by scraping wastes instead of, or in addition, to flushing with water to remove waste;
- Reduce the amount of water used during cleaning (e.g. by using high-pressure, low-flow nozzles);
- Minimize the surface area of manure in storage;
- Cool the manure surface to maintain temperatures at 15°C or less (e.g. by using cooling fins on the manure surface), if practical, to reduce ammonia emissions;
- Locate manure stacks away from water bodies, floodplains, wellhead fields; or other sensitive habitats;
- For feedlots, ensure that solid waste (e.g. bedding and muck) is gathered regularly and is not permitted to lie on the ground for long periods of time;
- Reduce the volume of rainwater in the storage system by covering slurry tanks or lagoons with a rigid roof or floating cover and by placing dry manure or litter in a covered or roofed area;
- Check for storage systems leakage regularly (e.g. inspect tanks for corrosion of seams, especially those near ground level; annually empty and inspect tanks);
- Use double valves on outlets from liquid tanks to reduce the probability of release;

- Conduct manure spread only as part of well planned strategy that considers potential risks to health and the environmental due to the presence of chemical and biological agents as well as nutrient balance in an agricultural setting.<sup>12</sup> Ensure that manure is applied to agricultural land only during periods that are appropriate for its use as plant nutrient (generally just before the start of the growing season);
- Manure storage facilities should have capacity for 9–12 months of manure production or as necessary to avoid over application;
- Design, construct, operate, and maintain waste management and storage facilities to contain all manure, litter, and process wastewater including runoff and direct precipitation;<sup>13</sup>
- Remove liquids and sludge from lagoons as necessary to prevent overtopping;
- Build a reserve slurry storage lagoon;
- Transport liquid effluent in sealed tankers.

### *Animal Carcasses*

Animal carcasses should be properly managed and quickly disposed of in order to prevent the spread of disease (see Animal Disease section below) and odors, and to avoid the attraction of vectors<sup>14</sup>. Operators should implement carcass management and disposal arrangements such that animal

<sup>10</sup> Further information regarding animal feed is available from the FAO Animal Production and Health Division, available at <http://www.fao.org/ag/againfo/home/en/home.html>

<sup>11</sup> Further information regarding manure storage is available from the Livestock and Poultry Environmental Stewardship Curriculum, at [http://www.lpes.org/Lessons/Lesson21/21\\_2\\_sizing\\_storage.pdf](http://www.lpes.org/Lessons/Lesson21/21_2_sizing_storage.pdf)

<sup>12</sup> Additional information on the application of crop nutrients is provided in the IFC Annual Crops EHS Guideline and Plantation Crops EHS Guidelines.

<sup>13</sup> Typically designed for 100-year flood event.

<sup>14</sup> For further information on culling and disposal of carcasses, in addition to animal health issues, see Carcass Disposal: A Comprehensive Review, Kansas State University (2004) available at <http://fss.k-state.edu/research/books/carcassdisp.html>; Guidance Note on the Disposal of Animal By-Products and Catering Waste, UK Ministry of Agriculture, Fisheries, and Food (2001) available at <http://www.defra.gov.uk/animalh/by-prods/publicat/dispguide.pdf>; and various documents provided by the Animal Health Australia, available at <http://www.animalhealthaustralia.com.au/aahc/index.cfm?E9711767-B85D-D391-45FC-CDBC07BD1CD4#ops>

carcasses are not recycled into animal feed. Recommended carcass management practices include:

- Reduce mortalities through proper animal care and disease prevention;<sup>15</sup>
- Store carcasses until collection, using cooling if necessary to prevent putrefaction;
- Use a reliable collection company approved by local authorities that disposes of carcasses by rendering or incineration, depending on the cause of fatality. Incineration should only be conducted in permitted facilities operating under international recognized standards for pollution prevention and control;<sup>16</sup>
- Where no authorized collection of carcasses is available, on-site burial may be one of the only viable alternatives, if allowed by the competent authorities. Whether onsite or offsite, the burial area should be accessible to earthmoving machinery and have stable, low-permeability soils with sufficient physical separation from houses and water resources to avoid contamination by vapors or leachate from buried, decaying materials.<sup>17</sup>

## Wastewater

### *Industrial Process Wastewater*

Livestock operations most commonly generate non-point source effluents due to runoff from feed (including silage) storage, loading, and unloading, livestock housing, feeding, and watering, waste management facilities, and areas of land application of manure. Depending on the type and intensity of

the operation, as well as the nature of stormwater management features, some facilities may also include point sources which typically require collection and treatment prior to final discharge. In either case, effluents have the potential to contaminate surface water and groundwater with nutrients, ammonia, sediment, pesticides, pathogens and feed additives, such as heavy metals, hormones, and antibiotics.<sup>18</sup> Effluents from livestock operations typically have a high content of organic material and consequently a high biochemical oxygen demand (BOD) and chemical oxygen demand (COD), as well as nutrients and suspended solids (TSS).

Effective waste management, as described above, is critical to reduce discharges to surface water and groundwater. In addition, the following management techniques are recommended to further reduce the impacts of water runoff from mammalian livestock operations:

- Reuse water used for cleaning milking equipment to clean the milking parlor;
- Reduce water use and spills from animal watering by preventing overflow of watering devices and using calibrated, well-maintained self-watering devices;
- Install vegetative filters to trap sediment;
- Install surface water diversions to direct clean runoff around areas containing waste;
- Implement buffer zones to surface water bodies, avoiding landspreading of manure within these areas;
- Reduce leachate from silage by allowing plant material to wilt in the field for 24 hours, varying cutting and harvesting times, and adding moisture-absorbent material as the silage is stored.

<sup>15</sup> Information on animal health and disease prevention is available from Animal Health Australia, at <http://www.animalhealthaustralia.com.au/aahc/index.cfm?E9711767-B85D-D391-45FC-CDBC07BD1CD4#ops> and from the United States Department of Agriculture (USDA) Animal and Plant Inspection Service, available at [http://www.aphis.usda.gov/animal\\_health/index.shtml](http://www.aphis.usda.gov/animal_health/index.shtml)

<sup>16</sup> Examples of key environmental issues associated with incinerations facilities are available in the IFC EHS Guidelines for Waste Management Facilities.

<sup>17</sup> Many countries forbid burial of carcasses. More information on the treatment of dead animals can be found in the Waste and By-products section of the EHS Guidelines for Meat Processing and Rendering.

<sup>18</sup> Forty percent of antibiotics manufactured are fed to livestock as growth enhancers (Reynolds 2003).

### *Process Wastewater Treatment*

Techniques for treating industrial process wastewater in this sector include sedimentation for suspended solids reduction using clarifiers or settling ponds; flow and load equalization; biological treatment, typically anaerobic followed by aerobic treatment, for reduction of soluble organic matter (BOD); biological nutrient removal for reduction in nitrogen and phosphorus; chlorination of effluent when disinfection is required; dewatering of residuals and composting or land application of wastewater treatment residuals of acceptable quality. Additional engineering controls may be required (i) if pass through of active ingredients (residual amounts of growth enhancers and antibiotics, among other hazardous constituents) is an issue, and (ii) to contain and neutralize nuisance odors.

Management of industrial wastewater and examples of treatment approaches are discussed in the **General EHS Guidelines**. Through use of these technologies and good practice techniques for wastewater management, facilities should meet the Guideline Values for wastewater discharge as indicated in the relevant table of Section 2 of this industry sector document.

### *Other Wastewater Streams & Water Consumption*

Guidance on the management of non-contaminated wastewater from utility operations, non-contaminated stormwater, and sanitary sewage is provided in the **General EHS Guidelines**. Contaminated streams should be routed to the treatment system for industrial process wastewater. Recommendations to reduce water consumption, especially where it may be a limited natural resource, are provided in the **General EHS Guidelines**.

### **Air Emissions**

Air emissions from mammalian livestock production include ammonia (e.g. management of animal waste), methane and nitrous oxide (e.g. animal feeding and waste management),

odors (e.g. animal housing and waste management), bioaerosols, and dust (e.g. feed storage, loading, and unloading, feeding, and waste management activities). Effective waste management, as described above, is critical to reduce the emission of air pollutants. The management techniques discussed below are recommended to further reduce the impacts of air emissions from mammalian livestock operations.

### *Ammonia and Odors*

Ammonia gas and other sources of odor are generated primarily during denitrification of manure and can be released directly into the atmosphere at any stage of the manure handling process, including through ventilation of buildings and manure storage areas. Ammonia gas levels are also affected by the ambient temperature, ventilation rate, humidity, stocking rate, litter quality, and feed composition (crude protein). Ammonia gas (NH<sub>3</sub>) has a sharp and pungent odor can act as an irritant when present in high enough concentrations. Ammonia gas deposition into surface waters may contribute to their eutrophication. Release of ammonia gas also reduces the nitrogen content and, therefore, the fertilizer value of the manure.

Recommended measures to reduce impacts of ammonia and odors include the following:

- Consider the siting of new facilities taking into account distances to neighbors and the propagation of odors;
- Control the temperature, humidity, and other environmental factors of manure storage to reduce emissions;
- Consider composting of manure to reduce odor emissions;
- Reduce emissions and odors during land application activities by applying a few centimeters below the soil surface and by selecting favorable weather conditions (e.g. wind blowing away from inhabited areas);



- If necessary, apply chemicals (e.g. urinase inhibitors) weekly to reduce conversion of nitrogen to ammonia;<sup>19</sup>

### Greenhouse gases

The livestock account for 9 percent of anthropogenic CO<sub>2</sub> emissions (mostly from deforestation / land use changes for grazing and pasture for feed crops), 37 percent of anthropogenic methane emissions, mostly from enteric fermentation by ruminants, and 65 percent of anthropogenic nitrous oxide emissions, the majority of which from manure. Methane has 23 times the global warming potential (GWP) of CO<sub>2</sub>, while nitrous oxide has 296 times the GWP of CO<sub>2</sub>.

By improving livestock production efficiency, producers can both increase profits and reduce methane emissions.<sup>20</sup> Methane can also be produced from microbial action in manure.

The recommended measures to reduce methane generation and emission follow:

- Improve the productivity and efficiency of livestock production (thus lowering the methane emissions per unit of livestock) through improvements in nutrition and genetics;
- Supplement livestock diets with nutrients, as necessary (e.g. increasing the level of starch and rapidly fermentable carbohydrates, use of urea supplements). Production of feed supplements, may also, however, result in production of GHGs.
- Increase the carbon to nitrogen ratio in feeds to reduce methane and nitrous oxide production;

- Implement balanced feeding (e.g. optimizing proteins and amino acids to correspond to requirements of particular animal groups)
- Consider various techniques to manage methane emissions from manure including controlled anaerobic digestion (to produce biogas), flaring / burning, use of biofilters, composting, and aerobic treatment. Use of anaerobic digestion may also reduce emissions of nitrous oxide;
- Minimize the amount of manure production through the implementation of animal waste management approaches;
- Control the temperature, humidity, and other environmental factors of manure storage to reduce methane and nitrous oxide emissions. This may involve use of closed storage tanks, or maintaining the integrity of the crust on open manure storage ponds / lagoons.
- Implement pasture / grazing management techniques to reduce nitrous oxide and methane emissions, including not overstocking pastures, avoiding late fall and winter grazing, improving soil drainage, and avoiding soil compaction from grazing to maintain the anaerobicity of the soil.

### Dust

Dust can reduce visibility, cause respiratory problems, and facilitate the transport of odors and diseases. Recommended measures to reduce dust generation include the following:

- Install dust-collection systems at dusty operations, such as feed grinding;
- Prevent overgrazing of pastureland;
- Implement fugitive-dust-control measures, such as wetting frequently traveled dirt roads, as necessary.

### Hazardous Materials

Hazardous materials are used throughout the beef, milk, and pork production cycles (e.g. disinfecting agents, antibiotic and

<sup>19</sup> U.S. Department of Agriculture, Use of Urease Inhibitors to Control Nitrogen Loss from Livestock Waste, 1997.

<sup>20</sup> For further information on strategies to reduce emissions of methane from livestock rearing activities is available in Livestock's Long Shadow, Livestock Environment and Development Initiative (LEAD), FAO 2006, available at [http://www.virtualcentre.org/en/library/key\\_pub/longshad/A0701E00.pdf](http://www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.pdf)

hormonal products). Guidance on the handling, storage, and transport of hazardous materials is provided in the **General EHS Guidelines**.

### *Use of Pesticides*

Pesticides may be applied directly to livestock or to structures (e.g. barns and housing units) and to control pests (e.g. parasites and vectors) using dipping vats, sprayers, and foggers. Pesticides can also be used to control predators. The potential pollutants from pesticides include the active and inert ingredients, diluents, and persistent degradation products. Pesticides and their degradation products may enter groundwater and surface water in solution, in emulsion, or bound to soil particles. Pesticides may, in some instances, impair the uses of surface waters and groundwater. Some pesticides are suspected or known to cause chronic or acute health hazards for humans as well as adverse ecological impacts.

By reducing pesticide use, mammalian livestock production operators may reduce not only the environmental impacts of their operations, but also production costs. Pesticides should be managed to avoid their migration into off-site land or water environments by establishing their use as part of an Integrated Pest Management (IPM) strategy and as documented in a Pesticide Management Plan (PMP). The following stages should be considered when designing and implementing an IPM strategy, giving preference to alternative pest management strategies, with the use of synthetic chemical pesticides as a last option.

### *Integrated Pest Management*

IPM uses an understanding of the life cycle of pests and their interaction with the environment in combination with available pest control methods to keep pests at a level that is within the economically damaging threshold with a minimum of adverse

environmental and human health impacts. Recommended IPM approaches in the mammalian livestock industry include the following:

- Maintain structures to keep out pests (e.g. plug holes, seal gaps around doors and windows);
- Use mechanical controls (e.g. traps, barriers, light, and sound) to kill, relocate, or repel pests;
- Use predators to control pests. Protect natural enemies of pests by providing a favorable habitat (e.g. bushes for nesting sites and other indigenous vegetation) that can house pest predators;
- Use good housekeeping practices in barns and other facilities to limit food sources and habitat for pests;
- Improve drainage and reduce standing water to control mosquito populations;
- Consider covering manure piles with geotextiles (which allow water to enter the pile and maintain composting activity) to reduce fly populations;
- If pesticides are used, identify in the IPM plan the need for the pesticide and evaluate their effectiveness, as well as potential environmental impacts, to ensure that the pesticide with the least adverse impact is selected (e.g. nonleachable pesticides).

### *Good Management Practices*

If the application of pesticides is warranted, spill prevention and control measures consistent with the recommendations applicable to pesticides and other potential hazardous materials as noted in the **General EHS Guideline** should be followed.

In addition, the following actions specific to mammalian livestock production should be taken to reduce environmental impacts:

- Train personnel to apply pesticides according to planned procedures, while using the necessary protective clothing.



Where feasible or required, pesticide application personnel should be certified for this purpose<sup>21</sup>

- Review the manufacturer's instructions on the maximum recommended dosage and treatment, as well as published experiences on the reduced rate of pesticide applications without loss of effect, and apply the minimum effective dose
- Avoid the use of pesticides that fall under the World Health Organization Recommended Classification of Pesticides by Hazard Classes 1a and 1b
- Avoid the use of pesticides that fall under the World Health Organization Recommended Classification of Pesticides by Hazard Class II if the project host country lacks restrictions on distribution and use of these chemicals, or if they are likely to be accessible to personnel without proper training, equipment, and facilities to handle, store, apply, and dispose of these products properly
- Avoid the use of pesticides listed in annexes A and B of the Stockholm Convention, except under the conditions noted in the convention;<sup>22</sup>
- Use only pesticides that are manufactured under license and registered and approved by the appropriate authority and in accordance with Food and Agriculture Organization's (FAO's) International Code of Conduct on the Distribution and Use of Pesticides;
- Use only pesticides that are labeled in accordance with international standards and norms, such as the FAO's Revised Guidelines for Good Labeling Practice for Pesticides;

<sup>21</sup> For example, the US EPA classifies pesticides as either "unclassified" or "restricted." All workers that apply unclassified pesticides must be trained according to the Worker Protection Standard (40 CFR Part 170) for Agricultural Pesticides. Restricted pesticides must be applied by or in the presence of a certified pesticide applicator. For more information, see <http://www.epa.gov/pesticides/health/worker.htm>.

<sup>22</sup> The Stockholm Convention on Persistent Organic Pollutants (2001), controls the use of the following POPs-pesticides: Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene, Mirex, and Toxaphene.

- Select application technologies and practices designed to reduce unintentional drift or runoff, only as indicated in an IPM program, and under controlled conditions
- Maintain and calibrate pesticide application equipment in accordance with the manufacturer's recommendations;
- Store pesticides in their original packaging, and in a dedicated location that can be locked and properly identified with signs, with access limited to authorized persons. No human or animal food should be stored in this location
- Mixing and transfer of pesticides should be undertaken by trained personnel in ventilated and well lit areas, using containers designed and dedicated for this purpose
- Used pesticide containers should not be used for any other purpose (e.g. drinking water) and should be managed as a hazardous waste as described in the **General EHS Guidelines**. Disposal of containers contaminated with pesticides also should be done in a manner consistent with FAO guidelines and with manufacturer's directions;<sup>23</sup>
- Purchase and store no more pesticide than needed and rotate stock using a "first-in, first-out" principle so that pesticides do not become obsolete. Additionally, the use of obsolete pesticides should be avoided under all circumstances;<sup>24</sup> A management plan that includes measures for the containment, storage and ultimate destruction of all obsolete stocks should be prepared in accordance to guidelines by FAO and consistent with country commitments under the Stockholm, Rotterdam and Basel Conventions
- Implement groundwater supply wellhead setbacks for pesticide application and storage;
- Maintain records of pesticide use and effectiveness.

<sup>23</sup> See FAO Guidelines for the Disposal of Waste Pesticides and Pesticide Containers on the farm.

<sup>24</sup> See the FAO publication on pesticide storage and stock control manual. FAO Pesticide Disposal Series No. 3 (1996).

## Ecological Impacts

The most significant potential ecological impacts resulting from mammalian livestock production are associated with water and air emissions, as discussed above. In addition, livestock with access to creeks, rivers, and other natural water sources may cause environmental damage by contaminating the water with animal waste, destroying riparian habitat, and eroding the stream banks. In addition overgrazing may contribute to soil losses because of severe erosion, and a reduction in soil productivity caused by alteration of the vegetation composition and associated organisms in rangelands.

Effective waste management, control of water discharges and air emissions, and management of pest control products, as described above, are critical to reducing adverse ecological impacts from mammalian livestock rearing operations. In addition, the management techniques discussed below are recommended to further reduce potential ecological impacts:

- Prevent animals' access to surface water bodies using fences, buffer strips or other physical barriers;
- Prevent overgrazing of pastureland through use of:
  - Rotational grazing systems based on seasonal and local ecosystem resilience (e.g. riparian zones)
  - Use of livestock trails to reduce soil trampling and gully formation / erosion near streams

The following actions should be taken to help maintain regional biodiversity:

- Before converting land to livestock production, survey the project area to identify, categorize, and delineate natural and modified habitat types and ascertain their biodiversity value at the regional or national level;
- Ensure that any natural or modified habitat to be converted to livestock production does not contain critical habitat, including known habitat of critically endangered or

endangered species, or important wildlife breeding, feeding, and staging areas;

- Be aware of the presence of critically endangered or endangered species in the areas already used for livestock production and consider them during management processes;
- Provide for minimum disturbance to surrounding areas when managing livestock.

## Animal Diseases

Animal disease-causing agents can spread rapidly, especially in intensive livestock operations. Animal diseases can enter a facility with new animals, on equipment, and on people. Some diseases can weaken or kill large numbers of animals at an infected facility. In some cases, the only remedy available to an operation is to sacrifice an entire group of animals to prevent the spread of the disease to other parts of the facility or to other facilities. The procedures to protect against the spread of animal diseases will depend on the type of animal at a facility, the way the diseases of concern spread to and infect animals, and the vulnerability of the animals to each specific disease.

The key to developing adequate disease-prevention procedures is to find accurate information about animal diseases and how to prevent them. Some of the recommended general types of management methods to reduce the potential for the spread of animal pathogens include the following:

- Control farm animals, equipment, personnel, and wild or domestic animals entering the facility (e.g. quarantine periods for new animals, washing and disinfecting crates, disinfection and coverage of shoes before entry into livestock zones, providing protective clothing to personnel, and closing holes in buildings to keep out wild animals);
- Vehicles that go from farm to farm (e.g. transport of veterinarians, farm suppliers, buyers, etc.) should be

subject to special precautions such as limiting their operation to special areas with biosecurity measures, spraying of tires and treating parking areas with disinfectants;

- Sanitize animal housing areas;
- Identify and segregate sick animals<sup>25</sup> and develop management procedures for adequate removal and disposal of dead animals).<sup>26</sup>

## 1.2 Occupational Health and Safety

Agriculture has one of the worst fatal accident and occupational health records of any major employment sector. Occupational health and safety hazards related to the daily operations of the mammalian livestock sector include:

- Exposure to physical hazards
- Exposure to chemical hazards
- Exposure to biological agents
- Confined spaces

### Physical Hazards

Many occupational safety and health hazards injuries associated with equipment and vehicle operation and repair, trip and fall hazards, and lifting heavy weights, are common to other industries and are discussed in the **General EHS Guidelines**. In

<sup>25</sup> Information on animal health and disease prevention is available from Animal Health Australia, at <http://www.animalhealthaustralia.com.au/aahc/index.cfm?E9711767-B85D-D391-45FC-CD4#ops> and from the United States Department of Agriculture (USDA) Animal and Plant Inspection Service, available at [http://www.aphis.usda.gov/animal\\_health/index.shtml](http://www.aphis.usda.gov/animal_health/index.shtml)

<sup>26</sup> For further information on culling and disposal of carcasses, in addition to animal health issues, see Carcass Disposal: A Comprehensive Review, Kansas State University (2004) available at <http://fss.k-state.edu/research/books/carcassdisp.html>; Guidance Note on the Disposal of Animal By-Products and Catering Waste, UK Ministry of Agriculture, Fisheries, and Food (2001) available at <http://www.defra.gov.uk/animalh/by-prods/publicat/dispguide.pdf>; and various documents provided by the Animal Health Australia, available at <http://www.animalhealthaustralia.com.au/aahc/index.cfm?E9711767-B85D-D391-45FC-CD4#ops>

addition, the following management measures specific to mammalian livestock production may reduce the risk of accidents and injuries.

- Ensure that all underground manure storage tanks and lagoons are properly covered and fenced off at a sufficient height;
- Store liquid manure (e.g. in barn pits, pumping stations, storage tanks, and application tankers) to minimize release of dangerous gases (e.g hydrogen sulfide);
- Design pens, gates, and chutes to facilitate movement of livestock and reduce the need for farm workers to enter pens;
- Instruct staff in correct livestock care, to reduce the incidence of bites and kicks.

### Chemical Hazards

Hazardous materials are used throughout the beef, milk, and pork production cycles (e.g. disinfecting agents, antibiotic and hormonal products). Chemical exposures should be prevented and controlled according to guidance presented in the **General EHS Guidelines**.

#### *Exposure to pesticides*

Potential exposures to pesticides include dermal contact and inhalation during their preparation and application as well as ingestion due to consumption of contaminated water. The effect of such impacts may be increased by climatic conditions, such as wind, which may increase the chance of unintended drift, or high temperatures, which may be a deterrent to the use of personal protective equipment (PPE) by the operator.

Recommended management practices include the following:

- Train personnel to apply pesticides and ensure that personnel have received the necessary certifications,<sup>27</sup> or equivalent training where such certifications are not required;
- Respect post-treatment intervals to avoid operator exposure during reentry to crops with residues of pesticides;
- Respect preharvest intervals to avoid operator exposure to pesticide residues on products during harvesting;
- Ensure hygiene practices are followed (in accordance to FAO and PMP) to avoid exposure of family members to pesticides residues.

### *Air quality*

Sources of organic dust in mammalian livestock operations include handling and storage of grain and milk powder which may include particles from grain, mites, fungi, and bacteria, as well as inorganic material. Other respiratory sensitizers include animal urine and manure. Manure storage areas (e.g. in pits within the barns, and in pumping stations, storage tanks, and application tankers) may release dangerous gases such as hydrogen sulfide.

Jobs that can entail a risk of exposure to dust include cleaning silos and grain hoppers, milling feed grain, and handling animal waste, among others. Acute toxic alveolitis, otherwise known as organic dust toxic syndrome, can accompany brief, occasional exposures to heavy concentrations of organic dust in agricultural environments. Some dust (e.g. from moldy forage, grain, or hay, carries antigens that can cause severe irritation to the respiratory tract. Breathing dust from moldy feed materials can

result in a permanent lung condition commonly known as farmer's lung.

In addition to the general dust exposure prevention and control guidance provided in the occupational health and safety section of the **General EHS Guidelines**, industry specific recommendations for dust control include:

- Use local air extraction devices at dust-generating equipment, such as silos and grinders;
- Store only dry grain (and dry, well-cured forages and hay) to reduce microorganism growth;
- Repair and / or decommissioning of facilities for liquid manure should be carried out by experts with relevant training and qualifications following strict confined space entry procedures, including the use of personal protective equipment such as air-supplied breathing apparatuses.

### **Biological Agents**

Workers may be exposed to disease-agents such as bacteria, fungi, mites, and viruses transmitted from live animals, manure, animal carcasses, and parasites and ticks (zoonoses). Workers may also be exposed to skin sensitizers such as animal proteins from urine that can cause an allergic reaction. Because of the use of antibiotics in feed, antibiotic-resistant microorganisms might develop in the gastrointestinal tract of animals. Resistant bacteria can potentially infect humans on or in the vicinity of the farm. The genetic material (DNA) can be taken up by other bacterial human pathogens.

Management measures that can be taken to avoid the negative consequences of worker exposure to biological agents include the following:

- Inform workers of potential risks of exposure to biological agents and provide training in recognizing and mitigating those risks;

<sup>27</sup> The US EPA classifies pesticides as either "unclassified" or "restricted." All workers that apply unclassified pesticides must be trained according to the Worker Protection Standard (40 CFR Part 170) for Agricultural Pesticides. Restricted pesticides must be applied by or in the presence of a certified pesticide applicator. For more information, see <http://www.epa.gov/pesticides/health/worker.htm>

- Provide personal protective equipment to reduce contact with materials potentially containing pathogens;
- Ensure that those who have developed allergic reactions to biological agents are not working with these substances.

Additional guidance on prevention and control of biological hazards is presented in the **General EHS Guidelines**.

### Confined Spaces

Occupational health and safety impacts associated with confined spaces associated with mammalian livestock operations (e.g. manure pits, silos, grain bins, water tanks, or inadequately ventilated buildings) are common to most industries, and their prevention and control are discussed in the **General EHS Guidelines**.

## 1.3 Community Health and Safety

Community health and safety issues associated with the construction and decommissioning of livestock production facilities are similar to those of other large projects and are addressed in the **General EHS Guidelines**. Community health and safety hazards specific to mammalian livestock operations include the potential spread of animal diseases already addressed in this document as well as the following food safety issues.

### Food Safety Impacts and Management

Routine treatment of animals with antibiotics may result in antibiotic-resistant microorganisms in the intestinal tract of treated animals. Potential routes for infection of humans are the consumption of contaminated meat or water or of food contaminated by manure. People living near the farm may also be at risk of infection. Residues of feed additives and contaminants may also be present in meat and dairy products.

Measures to mitigate environmental and occupational safety and health also will reduce potential risks to the community.

Additional management measures that can be taken to prevent any detrimental effects on the community include the following:

- Banned chemical and biological substances in mammalian livestock production should not be used;
- Avoid application of solid or liquid manure directly onto grazing areas or edible crops.

Concerning risks to community health and safety from the ingestion of hazardous substances in beef, milk, and pork, the FAO/WHO *Codex Alimentarius* provides guidance on veterinary drug residues (such as growth hormones) and pesticide residues and provides official Codex standards for dairy and meat products, such as cheese and ham. For example, the Codex contains 147 maximum residue limits (MRLs) for veterinary drugs in cattle tissue (including milk), as well as MRLs for pesticide residues in cattle and pig tissue.<sup>28</sup>

The following actions should be taken at the system level to ensure the proper use of veterinary drugs:

- Facilities involved in livestock production should use a veterinary service on an annual or more frequent basis to review and assess the health of the stock and employees' competence and training. With the assistance of the veterinary service, facilities should develop a Veterinary Health Plan to include the following aspects<sup>29</sup>:
- Summary of major diseases present and potentially present;
- Disease prevention strategies;

<sup>28</sup> The *Codex Alimentarius* provides maximum residue limits (MRLs) for veterinary drug residues and pesticide residues in all major food raw materials, including cattle and pigs. The FAO/WHO veterinary drug MRL database is available at [http://www.codexalimentarius.net/mrls/vetdrugs/jsp/vetd\\_q-e.jsp](http://www.codexalimentarius.net/mrls/vetdrugs/jsp/vetd_q-e.jsp). The FAO/WHO pesticide MRL database is available at [http://www.codexalimentarius.net/mrls/pestides/jsp/pest\\_q-e.jsp](http://www.codexalimentarius.net/mrls/pestides/jsp/pest_q-e.jsp)

<sup>29</sup> For more information, see EUREPGAP guidance on integrated farm assurance at <http://www.eurepgap.org/farm/Languages/English/documents.html>

- Treatments to be administered for regularly encountered conditions;
- Recommended vaccination protocols;
- Recommended parasite controls; and
- Medication recommendations for feed or water.

If antibiotics are recommended, the following measures should be considered:

- Apply approved over-the-counter antibiotics in strict accordance with the manufacturer's instructions to ensure responsible and correct use;
- Apply approved antibiotics that are purchased and utilized on prescription under the guidance of a qualified professional;
- Make a contingency plan covering how antibiotics should be applied following the identification of disease outbreaks;
- Store antibiotics in their original packaging, in a dedicated location that:
  - Can be locked and is properly identified with signs, with access limited to authorized persons
  - Can contain spills and avoid uncontrolled release of antibiotics into the surrounding environment
  - Provides for storage of containers on pallets or other platforms to facilitate the visual detection of leaks
- Avoid stockpiles of waste antibiotics by adopting a "first-in, first-out" principle so that they do not exceed their expiration date. Any expired antibiotics should be disposed of in compliance with national regulations.

## 2.0 Performance Indicators and Monitoring

### 2.1 Environment

#### Emissions and Effluent Guidelines

Table 1 presents effluent guidelines for this sector for concentrated livestock feeding operations generating point source effluents. Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in relevant standards of countries with recognized regulatory frameworks. These guidelines are achievable under normal operating conditions in appropriately designed and operated facilities through the application of pollution prevention and control techniques discussed in the preceding sections of this document.

**Table 1. Effluent levels for mammalian livestock production**

Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD <sub>5</sub>	mg/l	50
COD	mg/l	250
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Temperature increase	°C	<3 <sup>b</sup>
Total coliform bacteria	MPN <sup>a</sup> / 100 ml	400
Active Ingredients / Antibiotics	To be determined on a case specific basis	

**Notes:**

<sup>a</sup> MPN = Most Probable Number

<sup>b</sup> At the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity



These levels should be achieved, without dilution, at least 95 percent of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours. Deviation from these levels in consideration of specific, local project conditions should be justified in the environmental assessment.

Mammalian livestock production operations may also be characterized by non-point sources of effluents or emissions which may need to be monitored through the proper implementation of nutrient management strategy as described above, taking into consideration potential impacts to human health and the environment from the presence of disease-agents in the waste streams. The objective should be the minimization of "excess" nutrients and other pollutants in runoff with additional considerations for discharge to surface waters as described in the **General EHS Guidelines**.

### **Resource Consumption and Waste**

The following section presents benchmarks for emissions and waste in the mammalian livestock production industry. These benchmarks may be used to facilitate the estimation of nutrient balances. Tables 2 and 3 provide a summary of manure

production and nutrient content and nitrogen availability rates respectively that can be used as part of a manure nutrient management strategy.

### **Environmental Monitoring**

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project.

Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on monitoring programs is provided in the **General EHS Guidelines**.

**Table 2. Nutrient balance for beef, milk, and pork production.**

Type of livestock and housing		Type of manure	Annual manure production per animal housed all year (tons at storage)	Content of nutrients in manure (kg per animal per year at storage)			Number of livestock per livestock unit
				N	P	K	
1 dairy cow, heavy type, per year	Tied up	Solid manure	10.6	60.3	19.1	33.5	0.85
		Urine	10.4	55.4	2.1	85.2	
	Free range; cubicles and slats	Liquid manure	22.8	124.1	21.5	118.7	0.85
	Free range; deep litter with straw	Deep litter	15.2	128.4	23.8	168.2	0.85
1 dairy cow, small type (Jersey), per year	Tied up	Solid manure	8.7	49.8	16.5	28.1	1.0
		Urine	8.5	45.5	1.7	72.0	
	Free range; cubicles and slats	Liquid manure	18.2	102.2	18.5	100.1	1.0
	Free range; deep litter with straw	Deep litter	12.6	105.9	20.1	141.3	1.0
1 sow per year incl. 23 piglets to 7.2 kg	Partly slatted floor	Liquid manure	5.4	24.0	6.6	9.6	4.3
1 piglet 7.2–30 kg	Partly slatted floor	Liquid manure	1.13	0.5	0.1	0.3	175.0
1 growing pig 30–102 kg	Partly slatted floor	Liquid manure	0.49	2.8	0.6	1.3	35.0

Source: Values calculated from Danish Agricultural Advisory Service Instruction 95.03-03 and Plant Directorate, Danish Ministry of Food, Agriculture and Fisheries.

**Table 3. Nitrogen losses from manure management.**

Animal	Manure management system	N excreted	Losses from			Total losses to air	Total available for crops
			Building	Storage	Field		
		(pounds N per head per year)					
Hogs	Lagoon, uncovered	18.3	4.9	9.5	0.8	15.2	3.1
	Lagoon, covered	18.3	4.9	0.5	2.8	8.2	10.1
	Deep pit, surface applied	18.3	6	0	2.6	8.6	9.7
	Deep pit, incorporated	18.3	6	0	0.4	6.4	11.9
Dairy	Flush barn, surface applied	220	44	125	11.2	180.2	39.8
	Flush barn, incorporated	220	44	125	2.8	171.8	48.2
	Daily spread, surface applied	220	15.2	2.2	37.7	55.1	164.9
	Daily spread, incorporated	220	15.2	2.2	8.3	25.7	194.3
Fed beef	Solid storage, surface applied	102	0	20.8	13.8	34.6	67.4
	Solid storage, incorporated	102	0	20.8	0.7	21.5	80.5

Source: Aillery et al. (2005)

## 2.2 Occupational Health and Safety

### Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV<sup>®</sup>) occupational exposure guidelines and Biological Exposure Indices (BEIs<sup>®</sup>) published by American Conference of Governmental Industrial Hygienists (ACGIH),<sup>30</sup> the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),<sup>31</sup> Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),<sup>32</sup> Indicative Occupational Exposure Limit Values published by European Union member states,<sup>33</sup> or other similar sources.

### Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive)<sup>34</sup>.

### Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be.<sup>35</sup>

designed and implemented by accredited professionals as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents, diseases, and dangerous occurrences and other kinds of accident. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

<sup>30</sup> Available at: <http://www.acgih.org/TLV/> and <http://www.acgih.org/store/>

<sup>31</sup> Available at: <http://www.cdc.gov/niosh/hpg/>

<sup>32</sup> Available at:  
[http://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=STANDARD&p\\_id=9992](http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARD&p_id=9992)

<sup>33</sup> Available at: [http://europe.osha.eu.int/good\\_practice/risks/ds/oe/](http://europe.osha.eu.int/good_practice/risks/ds/oe/)

<sup>34</sup> Available at: <http://www.bls.gov/iif/> and  
<http://www.hse.gov.uk/statistics/index.htm>

<sup>35</sup> Accredited professionals may include certified industrial hygienists, registered occupational hygienists, or certified safety professionals or their equivalent.

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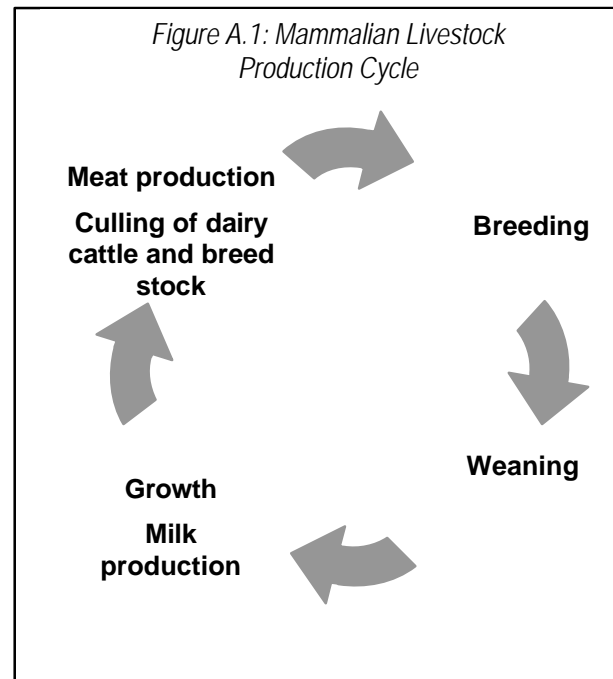


## Annex A: General Description of Industry Activities

The EHS Guidelines for Mammalian Livestock Production covers cattle ranching and farming, dairy farming, and hog and pig farming. Sheep and goat farming operations, while not explicitly discussed, are similar to the operations included in this document. The document does not address the processing of agricultural livestock products (e.g. meat processing plants, milk processing, and so on) and only discusses livestock production to the point of sending the livestock to the processing point (e.g. beyond the feedlot). The individual processes involved in raising different livestock for different purposes vary significantly. However, many of the basic process and operations described below are common to most operations in this sector.

Mammalian livestock facilities generally include the following operations: feed storage and handling, livestock housing, feeding and watering, management of animal waste, and pest control. Facilities generally consist of a core production area with an agricultural hinterland. The livestock are gathered in the core production area to facilitate drinking, watering, and animal welfare; the surrounding agricultural hinterland is ideally used for tillage crop production and facilitates the use of the manure as a crop nutrient. The typical land requirement for the core production area varies considerably, depending on the number of livestock units and the type of production.

The typical land area requirement for the agricultural hinterland also varies considerably, depending on the number of livestock units and, among other things, the volume of manure generated. It is essential to conduct a mass balance of nutrients when considering the location of a livestock facility. The mass nutrient



balance should provide information on the land area requirement for the agricultural hinterland and the manure application rates to ensure that the nutrient load resulting from landspreading does not become an environmental problem.

### Breeding

Traditionally, cattle breeds have been selected simultaneously for beef and milk production, and this integrated form of production is still used in many parts of the world. Increased specialization means that milk and beef production have become separate sectors, and farms may even specialize in a particular part of the production cycle, for example, fattening beef cattle in feedlots. The milk production sector uses special cattle breeds characterized by a high milk yield, and the beef production sector uses special cattle breeds that are characterized by high daily gain and good meat quality.

Although dairy cattle herds are culled to remove cows that are no longer suitable for milk production, the meat quality is not normally as high as that of beef cattle.

Pork production is always divided into three phases: (1) sow section, (2) weaned piglets section, and (3) growing pigs section. These phases are collectively known as “three-site” or “multisite production.” The three sites can be located at the same site; however, the intention is to physically separate the growth phases for environmental and animal health reasons. The sow section holds the breeding stock and consists of a mating section, a gestation section, and a farrowing section. Sows typically farrow a litter of 8–12 piglets.

### **Weaning**

After birth, the calf is usually removed from the cow after less than 1 day. As soon as it is dry, it is moved to an individual pen or hutch. Initially it is fed with milk, which is gradually replaced with water and starter feed before it is fully weaned at the age of 6–8 weeks. Male calves from dairy and beef cattle herds may either be castrated and raised as steers for beef production or raised as veal calves. A small number of bull calves from dairy and beef cattle herds may be raised for breeding stock. Female calves from the dairy herd are raised as replacement heifers to replace culled cows. Female calves from the beef cattle herd become heifers and part of the breeding stock.

The piglets are typically kept with the sow until reaching an age of 4 weeks and a weight of 7 kg. Some facilities use farrowing crates in the sow section to protect piglets from being crushed when suckling. The piglets that weigh 7–30 kg are in the weaned piglets section; once they reach 30 kg, they are moved to the nursery section.

### **Growth and Milk Production**

Growth and milk production constitute the main operational phase of the production cycle. Steers in beef and dairy cattle herds are fed until they reach market weight. Heifers in beef and dairy cattle herds are bred to deliver their first calf at 24 months of age. A 12-month calving interval then takes place, in which the cow is rebred 2–3 months after birth of a calf and then

delivers another calf 9 months later. Dairy cows are normally milked after calving for a period of 12–14 months before milking is terminated some 2 months before the next calving. Dairy cows average 2.5 lactations in a lifetime, although some may remain productive for longer.<sup>36</sup> Pigs 30–100 kg are kept in the growing section. At 100 kg they are ready for the market. Some gilts may be transferred back to the sow section to replace culled sows.

### **Production Infrastructure**

The need and specifications for cattle production buildings depend on which climatic region the production is located in and the type of production. Milk production in temperate regions requires dairy barns with insulation and a milking parlor. Milk production in subtropical and tropical regions also requires a milking parlor and dairy barns to provide protection from the sun and rain. In some climatically favorable regions, only milking parlors are required because the cows can stay outside year-round with or without access to grazing. Beef cattle production normally has no specific requirements for building facilities. Cows with suckling calves are put to graze, and steers are either put to graze or finished in feedlots, which requires only some feeding and manure-handling facilities. Shelter for protection against rain and sun is recommended under certain climatic conditions. Milking parlors and milking equipment are cleaned with water and disinfected after each milking; other buildings and equipment are cleaned regularly.

The need for pork production buildings depends on the climatic region in which the production is located and the type of production. Pig farm buildings in the temperate regions should be fully insulated and equipped with mechanical or natural ventilation to remove ammonia gas. Building requirements are simpler in subtropical regions, where a roof to protect against the sun and rain is sufficient. Ventilation systems are not

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<sup>36</sup> US EPA.

installed in these open constructions, but ventilators for air movement and nozzles for water spraying are often required. All building facilities and equipment are cleaned with water and disinfected after each batch of pigs has been moved from a section.

## Feed

Cattle feeding varies according to the type of production and the climatic region in which the production is located. Dairy cow feed is based on roughage, such as corn or grass silage, hay, fresh grass, and grazing. However, high-yield dairy production requires that a certain proportion of the feed be concentrate feed. Beef cattle feed is based on grazing and roughage, such as corn or grass silage and hay. The final fattening of beef cattle for slaughter is based mainly on concentrate, although a certain proportion of roughage can be used. Roughage feed is normally produced on the farm. Concentrate can be produced on the farm or purchased from a feed mill. By-products from the food processing industry are often available — for example, molasses from sugar manufacture — and can contribute as a resource-efficient cattle feed.

Pig feed is normally 100 percent concentrate based on grain, protein source, minerals, and vitamins, but in some regions a minor part of the feed can be based on roughage feed. The main part of the feed can be produced at the pork production location. The pig feed is produced on the farm in accordance with the pigs' nutrient requirements. Another option is to purchase ready-made feed from a feed mill. By-products from the food processing industry — for example, molasses from sugar manufacture — are often available and can be used as inexpensive pig feed supplement.

## Manure

Livestock manure left by cattle grazing on grassland is not normally considered to have an environmental impact; however, the volumes of manure generated by intensive livestock

production constitute an environmental risk if not managed correctly. The qualities of the manure produced reflect the animal housing and the feed given. For example, pigs raised in production systems that do not use bedding produce slurry with a dry matter content of 5–10 percent. Pigs raised in production systems that do use bedding materials, generally straw, produce pig dung with a dry matter content of 15–20 percent.<sup>37</sup>

Manure can be gathered by a wide variety of methods. The simplest is dry scraping of livestock areas, such as feedlots, to remove solids. A more sophisticated method, used in production buildings, is to place animals on slatted floors above manure pits. The manure pits are emptied, according to need, by a vacuum system. Mechanical or biological methods can be used to separate the manure into a solid fraction and a liquid fraction. Liquid effluent is pumped to manure storage tanks on site. Solid waste is stored on a sealed concrete slab. Manure is applied to agricultural land where it acts as a fertilizer. Other treatment methods include incinerating it and using it to develop biogas.

## Slaughtering and Culling

Fully grown cattle and pigs are sold to the market and slaughtered for the production of beef and pork. Culling is the process in which animals that show signs of weakness are removed from the herd or stock. The average cow in a beef cattle herd remains productive for 7–9 years; this interval is usually 5 years for dairy cattle.

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<sup>37</sup> Irish EPA (1998).

Dairy cows may be culled for a number of reasons, including low milk production, infertility, mastitis, and lameness. Beef cattle are culled because of infertility and disease. Sows may be culled because of age,

health problems, and failure to conceive or because they are able to raise only a low number of pigs per litter. Culled animals may be sold to the market for conversion into meat products or disposed of by incineration or by other means, depending on their health.

*Figure A-2. Principal Operations in Mammalian Livestock Production*

