World Bank

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INVESTING IN SUSTAINABLE LIVESTOCK: MAJOR ENVIRONMENTAL ISSUES AND RELATED OPTONS

This document serves as a summary of the environmental issues addressed in the ISL Guide and Tool. While it is not meant to be an exhaustive review, it contains the main issues relevant to the guidance provided. The issues included are structured along three major areas of impact: greenhouse gas (GHG) emissions, nitrogen and phosphorus losses to the environment, and impacts on land and water.

Please note that biodiversity, a major environmental category, is not mentioned on its own, as impacts on biodiversity are most often consequences of the three impact categories below. (For example, climate change and water pollution will, in turn, impact biodiversity.)

Also note that other references on environmental issues are available on the ISL Guide website, www.sustainablelivestockguide.org.

GHG emissions

While estimates vary, emissions from livestock sector supply chains have been estimated to contribute 14.5% of global anthropic emissions. By emissions type, methane is the most emitted GHG from livestock supply chains, about 44% (expressed in CO2-eq), with the remaining parts about equally shared between nitrous oxide at 29% and carbon dioxide at 27%. On a global scale, emissions from livestock supply chains account for 44% of anthropogenic methane, 53% of anthropogenic nitrous oxide, and only about 5% of carbon dioxide emissions.

There are four major sources to GHG emissions from livestock:

1 Emissions from the production, processing, and transport of feed. These account for almost half of all livestock value chains emissions at about 45%.

2 Emissions associated with land use change, i.e., when natural vegetation, such as forest, is being turned into grassland or cropland for the production of feed crops. Natural vegetation and the soils it grows on often contain much greater carbon stock than agricultural soils. The organic matter degraded during the transition of land use causes carbon dioxide and methane losses. Less than 10% of livestock value chains emissions are related to land use change.

3 Emission of methane from the rumen of cattle, sheep, and goats during the digestion of feeds. Enteric fermentation represents about 40% of all GHG value chain emissions, mostly emitted from cattle (77%).

4 Manure storage and handling phases. They generate methane and more importantly nitrous oxide emissions, amounting to about 10% of GHG emitted by livestock value chains globally.

Across the above processes, emissions associated with fossil fuel use (e.g., inputs production, transport, mechanization) amount to about 20% of the GHG emissions. Livestock production systems have opportunities to contribute to renewable energy economies by incorporating on-farm production of energy through technologies such as wind or solar. Biogas can also be a major source of renewable on-farm energy production.

Several production decisions can reduce GHG emissions across supply chains. Increasing production efficiency through improved animal health, nutrition, and herd management, while maintaining or decreasing herd size, and increasing soil carbon sequestration through better land management practices are two examples that both reduce emissions and also provide added on-farm benefits.

Nitrogen and phosphorus losses to the environment

The nitrogen and phosphorus losses to the environment from livestock production are either directly associated with animal manure management or the fertilization of crops and grasslands for feed production. Nitrogen and phosphorus are important nutrients for crops, grassland, and livestock.

In agricultural systems, nitrogen and phosphorus flow from soil to crop and grass, then to livestock via feed, and then again to the soil via manure. Ideally, such nutrient cycling would be with minimal losses. When substantial, losses cause nitrogen and phosphorus pollution that can result in i) eutrophication (excessive growth of algae in water) through the accumulation of nutrients in bodies of water which may lead to “dead zones” in aquatic systems, and ii) acidification of the environment (acidic compounds in rain and soils). Acidification of the environment may affect vegetation (e.g., forests) and aquatic life.

Nitrogen and phosphorus losses generally take place in three stages:

1. Manure collection and storage. Manure comprises livestock feces and urine. Both fractions can be collected either separately or as a mixture referred to as slurry. The urine fraction and the slurry are occasionally directly discarded into the environment, causing severe pollution of water, air, and soils. Manure is generally collected and stored for processing and/or recycling. During collection and storage of manure, gaseous components, such as ammonia, and nitrous oxide may be formed and volatilize from uncovered manure heaps or basins. Nutrients may also leach through the bottom of lagoons and storage facility or be washed away by rain and floods.

2. Collected manure and slurry can be processed in different ways, e.g., separation of solid and liquid fractions, drying, composting, biogas production, mixing into compound fertilizers, incineration, aerobic treatment in which nitrogenous components in manure are converted to harmless nitrogen gas. These processes can all improve the nitrogen and phosphorus recycling options and thus be beneficial to the environment. If done improperly, they may, however, contribute to increased nitrogen and phosphorus losses.

3. Applying manure, as well as synthetic fertilizer, to crops and grassland, may result in losses of nitrogen and phosphorus through leaching and runoff, and in volatilization of nitrogen compounds, such as ammonia and nitrous oxide. The higher the rate of application of manure and synthetic fertilizer per hectare of land, and the less it is phased with plant uptake, the higher the risk of losses. This may happen on production units or watersheds with high animal density, but also where manure application is not adequately dosed and timed.

Because of the many factors that can potentially influence pollution processes, the variability in nitrogen and phosphorus pollution per kg of animal product is high. On a general level, studies have shown that the production of pork and beef showed higher risks of pollution, and higher variability of those risks than chicken meat, cattle milk, and egg production. Globally, nitrogen losses in pork value chains are estimated at 14.7 Teragrams. With a contribution of 76%, feed production is the primary contributor to total nitrogen losses, whereas losses from pig housing and manure management contribute 22% to total nitrogen losses, and post-farm activities contribute only 2%.

Proper manure management and application of manure and synthetic fertilizer can promote better cycling of nutrients and limit nutrient volatilization, leaching, and run-off to water bodies. Such practices increase farm efficiency and can reduce the costs of inputs, such as fertilizer. Frequent collection of feces and urine, concrete storage platforms, sheds, lined lagoons, and covered storage help preventing losses of nutrients to the environment. At farms with high stocking densities, measures can be taken to reduce nitrogen and phosphorus pollution, such as minimizing the nitrogen and phosphorus imports through feed and exporting manure (e.g. after processing into products with added value), whereas precision fertilization of manure and synthetic fertilizer can reduce losses after application to crops.

Impacts on land and water

Within the agricultural sector, livestock production is the largest user of land and water resources. The sector uses most of the world's grasslands and more than a third of the world's arable land for feed production, as well as the irrigation and rainwater used on those lands. Livestock uses land and water sources predominantly for feed production, with four broad pathways of impact:

First, forests and other natural vegetation may be cleared and converted to feed cropland and pasture. Such land use changes result in the release of GHG, and they negatively affect biodiversity and replenishing of aquifers.

Second, livestock may compete with food crops for land and water. Livestock production is generally less efficient regarding the use of arable land to produce human food than crop production and may thus lower the land and water use efficiency of the food systems, resulting in an increased amount of those resources drawn into food production versus other potential functions. For example, livestock uses most of the world's 2 billion hectares of grassland, of which 700 million hectares could potentially be used as cropland. The production of livestock feed uses approximately 10 % of annual rainfall, which corresponds to about a third of agricultural water use. Irrigation of feed crops can be of local significance but is globally limited.

Third, livestock production can cause land degradation. Overgrazing is a frequent cause of degradation, affecting vegetation cover (reducing it, changing it from grass to shrub, or even entirely eliminating it) and potentially resulting in soil erosion, carbon losses, and adverse impacts on biodiversity and water cycles. Overgrazing occurs when the stocking density (and associated removal of biomass by animals) and its management is disconnected from biomass production on the land. Such production, and its variations over seasons and during extreme weather events are driven by the nature of vegetation and by climate. Land degradation can also be a long-term process: Through grazing and through crop growth for feed production, nutrients are re-moved from soils. If these are not replenished (e.g., if no fertilization occurs), soil fertility may slowly decline, affecting yields and ultimately resulting in land degradation.

Fourth, livestock production and processing may impact water and land resources through pollution: losses of nutrients and other substances, e.g., pesticides and chemicals. Losses eventually migrate into the ecosystems through the food chain and through water flows and affect the fauna and the flora, as well as fisheries, recreation, and drinking water.

A range of practices, mostly related to the management of grasslands and the production of feed crops can contribute to reducing land and water impacts, e.g., adaptive grazing, integrated pest management, farm nutrient management plans, organic production. Broader approaches, such as reducing food wastes, feeding food wastes and by-products to animals, or shifting to species and foods whose production requires comparatively less land and water, are further ways to reduce pressure on land and water resources.