WORLD BANK

Food and Agriculture Organization of the United Nations

ISL GUIDE 7 PRINCIPLES OF ENVIRONMENTAL SUSTAINABILITY

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This brief provides an overview of the Investing in Sustainable Livestock (ISL) Guide and the seven principles for sustainability in the livestock sector that were developed to guide the technical advice the ISL Guide provides.

Introduction to the ISL Guide The online Investing in Sustainable Livestock (ISL) Guide (sustainablelivestockguide.org) is both a practical instrument and an information resource for developing environmentally sound livestock production systems.

The guide provides guidance, suggested activities and indicators to help livestock projects contribute to environmental sustainability. It is grounded in tested theory and evidence organized in seven principles for sustainability in the livestock sector:

1. Contribute to a sustainable food future
2. Enhance carbon stocks
3. Increase productivity at animal and herd levels
4. Source feed sustainably
5. Couple livestock to land
6. Minimize fossil fuel use
7. Foster an enabling environment (cross-cutting)

Approaching project conceptualization in this manner presents a significant opportunity for livestock investment to go beyond the traditional objectives

Introduction to the Seven Principles

Technical teams at the World Bank and the Food and Agriculture Organization of the United Nations devised seven principles of environmental sustainability for livestock investment to guide the technical advice the ISL Tool provides. These seven principles are a framework for assessing the environmental performance of production systems and the interventions envisaged in development projects. Essentially, they guide users through the potential environmental costs and benefits associated with animal production.

Below, is an in-depth look at the seven principles, including an overview of each and a look at the principle as applied in the field, including a summary of trade-offs to consider when doing so.

Principle 1: Contribute to a sustainable food future

Engage stakeholders and undertake preparatory analysis to evaluate the comparative advantage of livestock production systems in relation to project objectives

Introduction

Livestock play a significant role in addressing many of the challenges that low- and middle-income countries face. Livestock production generates income, jobs, economic growth, and exports. Livestock in some regions are culturally significant, central to local diets, and critical to risk management and resilience.

Animal-sourced foods are a key source of protein and micronutrients across the globe. They are also sources of resilience through risk management and asset building in harsher, water-scarce environments.

Livestock often contribute to local agroecological health by consuming co-products and wastes; providing organic manure to maintain soil structure and fertility; and contributing to on-farm biodiversity. At the same time, livestock production can harm the environment, for example, through incentivizing land use change, emitting greenhouse gases (GHG), and generating pollution.

Points of Consideration

Sustainable livestock sector investment will undertake stakeholder engagement and preparatory research to consider the development objectives of the proposed project and the role of livestock in achieving those objectives.

As part of the project conceptualization process, stakeholder engagement and preparatory research can be undertaken to explore the synergies and trade-offs of investing in different food sources. Approaching project conceptualization in this manner presents a significant opportunity for livestock investment to go beyond the traditional objective of fulfilling current and projected demand for livestock products.

By considering the full range of locally suitable food sources, investment can respond to demand strategically. This incentivizes growth in specific livestock species where it can be sustainable and consumption of other foods where it is less.

Applying the Principle

Approaches and Tools

A large body of research suggests that reducing the environmental impact per unit of food produced will be a critical strategy for achieving a sustainable food system. This "per unit" approach to quantifying environmental impact can form the basis of an ex-ante analysis of potential environmental impacts and of indicators used in the project monitoring and evaluation (M&E) framework. Variables to measure would include resource use efficiency (the amount of land, pesticide, water, or other resource inputs required to produce each unit of human-edible output) and greenhouse gas emission intensity (emissions per unit of human-edible output produced).

A growing body of research, however, also points out the need to improve the sustainability of the food system from the consumer perspective, for example, by combining dietary changes with practice improvement. Depending on the project context, it may thus be relevant to consider absolute magnitudes of environmental impact as related to consumption levels, such as total land required for the project or total volume of emissions estimated to result from the project.

Guiding questions for stakeholder engagement may include:

- ✓ What is the role of livestock in local food preferences and culture?
- ✓ What is the role of livestock in the country/province's development agenda, for instance, for rural livelihoods, job creation, trade, and agricultural sector growth?
- ✓ What are the nutritional needs of the project area? Does the relevant population meet national dietary recommendations for the consumption of animal-sourced foods?
- ✓ What is the role of livestock in the country's capacity to build resilience to climate change?
- ✓ Do the local natural resource base and climate favor livestock production at present and according to future projections? If so, which species? If not, which other food sources would be suitable?
- ✓ What are the potential environmental impacts of suitable animal-sourced and plant-based foods?

Variables to Consider

As the team assesses the comparative advantage of livestock to development goals of the project, it may consider the following elements:

- ✓ Kilogram (kg) of additional animal products protein and/or milligram (mg) of micronutrients made available to project beneficiaries, and how they contribute to current diets, reduce potential deficits, and/or add to overconsumption.
- ✓ Livestock-related jobs and income generated among the poor in the project scenario, compared to alternative investment options.
- ✓ Incremental use of natural resources (water, land, nitrogen, phosphorus) in the project scenario and the related increase on resources, compared to other investment options.
- ✓ Incremental release of harmful emissions (GHG, pesticides) in the project scenario and the related increase on resources compared to other investment options.

Trade-offs to Consider When Applying Principle 1

Principle 1 offers a framework for broadly considering the role of livestock in the context of a potential development investment. It thus applies to the early stages of project conceptualization before other principles are triggered.

Principle 1 applies to broad development objective as formulated in the 17 Sustainable Development Goals of the United Nations, and to how livestock production systems may contribute to those.

Principle 2: Enhance carbon stocks
Livestock sector investment presents an opportunity to protect and enhance carbon stocks

Introduction

Forests, grasslands, and other terrestrial ecosystems release into the atmosphere and sequester in their soils and biomass considerable amounts of carbon. The quantity of carbon sequestered, i.e., carbon stocks, depends on the natural carbon cycle and on the impacts of human activities that may disturb soils and vegetation and cause carbon to be released back into the atmosphere. Both protecting and expanding the world's terrestrial carbon stocks in agricultural areas are thus critical components of global climate change mitigation and biodiversity conservation efforts.

Principle 2 provides guidance for livestock investment to contribute to the enhancement of carbon stocks in and around the proposed project area. This principle is relevant for all livestock species and production systems, and is applicable to project site selection and project design.

Enhancing carbon stocks through livestock investment is critical to sustainable development. Livestock production historically has been associated with the conversion of forests, natural grasslands, and other natural habitats to pasture and feed production. However, an increasing awareness of climate change and the importance of biodiversity has, in many regions, built support for livestock production practices that avoid land conversion.

Research suggests that halving global livestock-driven land use change rates over the next two decades could avoid an estimated 0.4 gigatons of equivalent carbon dioxide emissions each year. In addition, a growing body of literature has demonstrated the potential for improved grazing management practices to sequester carbon and conserve biodiversity on both natural grasslands and managed pastures. Studies estimate that, through improved management practices, varying amounts of additional carbon can be sequestered on about 28% of the world's existing grasslands. In addition, increasing carbon stocks through vegetative buffers, especially near waterways, can help mitigate nutrient pollution from manure or fertilizer. Biodiversity conservation is also an important contributor to agricultural resilience to climate change.

Points of Consideration

Are there forests, natural grasslands, and other natural areas in and around the project site? If so, in project design, incorporate incentives to enhance carbon stocks:

- ✓ Incorporate incentives to conserve and restore natural areas into the project design, for instance, through:
  - – Payment for environmental service programs (PES).
  - – Carbon offset programs.
  - – Conservation certification programs.

- ✓ In grazing areas, increase the amount of biomass per unit of grassland and pasture area, for example, through:
  - – Adjusting the grazing intensity and timing to maximize grass productivity.
  - – Oversowing pasture with nitrogen-fixing legumes or improved grass species.
  - – Adopting silvopastoral systems.
- ✓ Include a baseline and indicators in project M&E to track and capture the benefits.

Applying the Principle

Approaches and Tools

To preserve carbon stocks in forests and other natural areas, incentivize natural habitat conservation and restoration. Project sites that include or lie in proximity to forests, natural grasslands, and other natural habitats can include incentives and regulations for conserving and restoring them. These may include support for livestock production systems that can thrive on existing pasture and cropland, as opposed to land converted from natural areas. Further incentives may include PES, forest carbon offset programs, and the promotion of certification programs for higher-value, zero-deforestation products. For an effective reduction of land conversion rates, such incentive programs should be combined with policies that control land use change (ref to Brazil programs).

To enhance grassland carbon stocks, increase biomass per unit of grassland area. Adoption of specific management practices will depend on the context of each project location. A key practice from the literature includes optimizing grazing pressure and timing to maximize grass productivity. Both increasing and decreasing grazing intensity can achieve this goal. Sowing nitrogen-fixing legumes over a portion of pastureland has also shown to increase sequestration while providing nutrient-rich legumes to grazers. Silvopastoral systems, in which trees and fodder shrubs are cultivated on managed pastures, can significantly increase biomass while generating the co-benefits of supplemental forage sources, shade, fencing (in the case of live tree fences), and habitat creation.

Carbon sequestration has important limits to consider. While carbon sequestration is an effective mitigation strategy, it also faces certain limits: saturation and reversibility. Over time, rates of carbon sequestration decrease as soils approach the point of saturation. In addition, it is possible that current, improved practices that enhance carbons stocks will at a future point be reversed. In the project design phase, teams may consider the current estimated rate of sequestration and the potential for improved practices under the project to be adopted and supported past the project lifetime. Nonetheless, even limited amounts of carbon sequestration contribute significantly to long-term climate change mitigation due to the long life span and thus persistent warming effect of carbon dioxide relative to the other greenhouse gases that livestock production emits.

Variables to Consider
- ✓ Hectares (ha) of forest, natural grassland, and other natural area that remain protected.
- ✓ Ha of forest, natural grassland, and other natural area restored.
- ✓ Estimated annual rate of carbon sequestered during the project, including project capitalization.
- ✓ Number of improved production practices integrated into long-term environmental governance.

Trade-offs to Consider When Applying Principle 2

Potential remote environmental impacts. Global trade enables livestock producers to import feed grown across the world. Production systems that import feed to avoid land conversion locally may thus contribute to biodiversity and habitat loss in other countries. In such cases, projects may consider incentives to source feed sustainably (Principle 4).

Limited suitability for livestock production. In some regions, the prevalence of natural areas and lack of an existing feed base may render the initial project site unsuitable for livestock production. In such cases, teams may seek alternative locations for the project or alternative food sources for investment.

Principle 3: Increase productivity at animal and herd levels

Where ruminant yields are low, increase productivity. Where possible, avoid significant growth in animal numbers

Introduction

Improving the efficiency of natural resource use along the livestock value chain can contribute to a range of social, economic, and environmental benefits. Principle 3 provides guidance for contributing to these efficiency gains through improvements in productivity. This principle is applicable to all livestock systems with potential for productivity improvements. It has particular relevance for mixed and extensive ruminant systems in Africa, Asia, and Latin America and the Caribbean, which are generally lower-yielding.

Improving livestock productivity enables producers to sustain and/or increase output without significant growth in animal numbers, thus contributing to multiple development goals.

Practices that improve productivity at the animal level (yield per animal) are commonly included in development activities to lower the costs of production; increase the amount of protein- and micronutrient-rich animal-sourced food available for household consumption; and raise incomes. In addition, yield improvements can contribute to climate change mitigation by reducing the amount of greenhouse gases that ruminants emit per kg of animal protein produced. Herd-level productivity improvements can provide multiple benefits as well through avoiding the economic and environmental costs associated with herd losses and unproductive animals.

Points of Consideration

Does the project involve low-yielding livestock, particularly ruminants? If so, in project design, include incentives for increasing animal and herd productivity:

- ✓ Key practices to incentivize at animal level:
  - – Improving feed rations: overall digestibility and balancing of protein, energy, and micronutrients.
  - – Improving animal health and welfare through disease prevention and control, and adoption of the Five Freedoms.
- ✓ Key practices to incentivize at herd level:
  - – Improving reproductive management through breeding and selecting for high-yielding, high-fertility genetic potential; using artificial insemination; and managing reproduction and offtake rates to minimize unproductive animals in the herd.
  - – Unless large animal herds are used for risk mitigation or asset saving, consider alternatives to keeping nonfood-producing livestock.
- ✓ Include a baseline and indicators in project M&E to track and capture the benefits of productivity improvements.

Applying the Principle

Approaches and Tools

Increasing the digestibility of the diet, as well as the protein and micronutrient content, generally results in higher productivity. Key approaches are increasing the proportion of highly digestible forages in the diet; managing cultivated forages and pasture to maximize digestibility; adding high-energy and high-protein supplements, such as concentrates (e.g., grains, brans, oilseed cakes) to the diet; adopting precision feeding; and applying feed analysis and ration optimization to meet animal nutrient requirements. To be resilient, such diet improvements need to be based on sound knowledge of local feed resources and of import opportunities and risks. Regions that experience weather variability and/or drought may adopt forage conservation and storage practices, such as silage production, to sustain higher-quality diets through periods of scarcity.

Improve animal health and welfare. Animal health and welfare improvements reduce the adverse effects of distress, disease, and infection on productivity in all livestock systems and species. They also help avoid the environmental impacts associated with low- or nonproducing animals. Key approaches include avoiding animal distress, for instance, due to heat, crowding, and injury (Five Freedoms); proper administration of vaccines, mastitis (udder), and other disease prevention and control; and judicious use of antibiotics to avoid spreading antimicrobial resistance (AMR).

Improve reproductive management. Breeding overhead, or nonfood-producing reproductive animals, can account for significant portions of the herd: about 69% in specialized beef and 52% in dairy systems as a global average. Improving herd-level reproductive management can reduce the breeding overhead required to maintain herd size. Key approaches include low calving intervals; multiple births; offtake (for sale or slaughtering) of young males and unproductive females; genetic selection within herds for high yields; longevity; high conception rates; and use of artificial insemination (AI). Adequate health and nutrition, particularly in pre- and postcalving intervals, can enhance milk quality and improve animal health and longevity.

Consider alternatives to nonfood-producing livestock. Livestock producers in many developing countries rely on large herds for purposes other than food production such as for draft power; manure to use as fertilizer; asset saving; and risk mitigation. Where possible and culturally appropriate, alternatives to livestock may be considered, such as mechanized labor, use of synthetic fertilizers, and banking and insurance systems.

Variables to Consider

- ✓ Age at first calving.
- ✓ Age structure of the herd.
- ✓ GHG emission from the whole herd divided by total milk and meat production, i.e., emission intensity at herd level.
- ✓ Annual rate of herd growth.
- ✓ Male-to-female ratio in dairy herds.

Trade-offs to Consider When Applying Principle 3

Incentives to scale up production. Livestock productivity gains and the profits they yield can incentivize producers to scale up production and increase animal numbers. This may result in higher overall emissions and other environmental impacts from the additional animals. Incentives to increase yields may thus require complementary incentives to constrain herd growth.

Environmental impacts of feed production. While high in digestible energy and protein, concentrated production is often characterized by high-intensity inputs, monoculture, and greenhouse gas emissions. The environmental impacts associated with producing such feeds must be accounted for when designing feed improvement strategies (Principle 4).

Soil and water pollution. Productivity improvements can result in increased output of manure. Depending on the system, manure can contain damaging concentrations of nutrients and the pharmaceuticals used in animal health. Incentives to improve productivity should thus incorporate adequate waste management strategies (Principle 5).

Principle 4: Source feed sustainably
Responsible feed production and sourcing are an integral part of sustainable livestock systems

Introduction

Feed production for intensive systems has increasingly become decoupled from livestock farms, sourced from high-input intensity grain and legume monocultures, and supplied from international markets. This can result in remote impacts on natural resources in feed-exporting regions, as well as competition for resources between the production of livestock feed and human-edible food. This fourth principle provides guidance for sourcing feed and applies to systems that import off-farm feed.

The procurement of feed from sustainable production systems contributes to global environmental outcomes.

Importing feed from sustainable production systems can reduce remote environmental impacts in feed-producing regions. Key aspects of sustainable feed production include precision use of irrigation water, fertilizers, and pesticides, as well as principles of organic agriculture where possible. These practices also contribute to agricultural resilience. Sourcing feeds produced on existing cropland is also key to avoiding feed-driven deforestation. Mixed systems and agroforestry can further help improve agrobiodiversity.

Most of water used in livestock supply chains (about four-fifths) is dedicated to feed production. Water use efficiency in feed crops and the efficiency with which feed is used at animal production level (feed conversion ratio) are thus determinants to the water use efficiency of the system. The relative reliance on irrigated feed crops in the ration and the sheer size of the sector will further affect the absolute impact livestock systems may have on water resources.

Although human-edible products only account for less than a fifth of the global livestock ration, livestock consume more than one-third of the world's cereal grain and 70% of the grain used in developing countries. In regions facing resilience challenges, this can result in the allocation of scarce biomass resources to the production of livestock feed instead of directly human-edible food. Using nonhuman-edible material in livestock feed, such as crop residues and industry waste, can reduce pressure on land and water resources and thereby contribute to global food and nutrition security.

Points of Consideration

Does the project import feed from off-farm sources? If so, in project design:

- ✓ Identify and contract feed producers with environmental standard certification.
- ✓ Carry out a comprehensive feed resource assessment survey, including crop residues, industry byproducts, swill, and restaurant wastes into livestock. Avoid as much as possible feeding human-edible material to livestock.
- ✓ Include indicators in project M&E to track the benefits of sourcing feed sustainably in the project.

Applying the Principle

Approaches and Tools

To procure feed crops from sustainable production systems, identify and contract feed producers with environmental standard certification. These certifications may relate to the use of fertilizer, pesticides, and water in feed production; conversion of natural areas for feed production; and greenhouse gases emitted for feed production, processing, and transport.

To minimize pressure on natural resources, integrate crop production and industry wastes into livestock diets. Explore options to include material other than human-edible grain and legumes in livestock diets. Ruminants in intensive systems can consume hay, silage, and crop residues that are too fibrous for human consumption. Most livestock can consume industry by-products such as brewer's grain, wheat processing, sugar mill waste, and whey from milk and cheese production, as well as restaurant waste.

Variables to Consider

- ✓ Proportion of feed consumed by livestock in the project which meets select environmental standards.
- ✓ Proportion of feed consumed by livestock in the project which is not directly human-edible.

Level 3: Trade-offs to Consider When Applying Principle 3

The rapid growth of livestock production has partly been enabled by decreasing prices of intensive feed production (e.g., corn and soy). Feed produced through more environmentally sustainable practices may have higher costs, resulting in higher animal production costs, and thus reduced competitiveness compared to conventional production. Increased consumer awareness and market differentiation may stimulate willingness to pay for more environmentally sustainable products.

Principle 5: Couple livestock to land
In intensive systems, manage nutrient flows to improve local and global nutrient balances

Introduction

More than 70% of nutrients contained in livestock feed are excreted as manure and urine. In grazing and mixed crop-livestock systems, livestock tend to consume grasses and farm residues, returning a significant portion of their dietary nutrients directly to the soil while roaming and grazing, or through active manure collection, storage, and application.

In intensive systems, which often decouple livestock from land, large concentrations of manure — and nutrient — can, however, build up where animals are raised, away from the feed production area. This issue is amplified by the typical geographical concentration of intensive animal production units.

This fifth principle provides guidance for managing manure in a way that contributes to soil nutrient balances, while generating multiple environmental and economic co-benefits. It has particular relevance for intensive pig and poultry systems, which tend to confine animals indoors.

Coupling livestock to land underpins long-term agricultural resilience

In livestock-producing regions, nitrogen, phosphorous, and other nutrients contained in manure may evaporate or leach into the environment and impair soil fertility; cause freshwater eutrophication; and damage ecosystem health. In feed-producing regions, the loss of soil nutrients embedded in feed exports may, over time, result in soil nutrient depletion and jeopardize soil fertility. "Coupling" livestock to land or managing nutrient flows from livestock production to improve local and global nutrient balancing thus strengthens the natural resource base on which long-term agricultural resilience depends.

Managing manure such that it can be used to fertilize crops and grasslands can contribute significantly to nutrient balancing. The organic matter in manure also enhances the capacity of soil to absorb and retain water. Integrated manure management is a recommended approach that requires attention to the entire manure chain: collection, treatment, storage, and application. Through the processing and marketing of transportable manure products to complement or replace synthetic fertilizers, manure recycling can contribute to nutrient balancing at both local and global levels.

Importantly, adequate land/livestock balances will minimize the need to transport manure out of livestock concentration areas and thus reduce manure management costs.

Points of Consideration

Does the project confine animals indoors? If so, in project design, ensure adequate manure management along the entire manure chain:

- ✓ Estimate the project impact on nutrient flows:
  - – Quantity of manure to be produced.
  - – Nutrient content of the manure.
  - – Nutrient absorption capacity of local crops and grasslands (on-farm, within financially viable transportation range).
- ✓ Link to local nutrient flows and demand for organic fertilizer:
  - – Application of fresh manure.
  - – Manure composting.
  - – Anaerobic digesters.
- ✓ Link to regional nutrient flows and demand for fertilizer:
  - – Manure drying and export (pellets, granules).
- ✓ Include a baseline and indicators in project M&E to track and capture the benefits of enhancing nutrient cycling through the project.

Applying the Principle

Approaches and Tools

Estimate the project impact on local nutrient flows. Selection of an appropriate manure management system will depend on the estimated quantity of manure to be produced; the nutrient content of the manure; and the capacity of the local land base to absorb these nutrients. These figures can be derived through standard values or site-specific sampling of livestock manure excretion, manure nutrient content, and soil nutrient levels in crop- and grasslands.

Consider local and regional/global demand for manure as organic fertilizer. Where there is demand for manure as fertilizer, livestock producers may design manure systems that link to local crop production and grassland management. Conducting a cost-benefit analysis of using manure as organic fertilizer in place of and/or compounded with synthetic fertilizers may help stimulate local demand and build a market for manure products. In addition, producers may explore producing transportable manure products and linking to regional/global fertilizer demand.

Options for linking to local crop- and grasslands

Application of fresh manure. Manure can be collected manually, stored, and applied fresh to crop- and grasslands as fertilizer. While solid manure can be collected through shoveling or other forms of manual labor, collecting liquid manure or "slurry" may require flushing with water into pit storage and pumping into distribution pipes or tanks for transport. Fresh manure is often too heavy and wet for long transport to be efficient.

Production of compost. Composting generally entails collecting, storing, and processing manure over time, together with plant material, into decayed organic matter. For easier integration with solid manure, slurry may be mixed with bedding, wood shavings, or other dry material. Recommended composting techniques depend on the climate, available space and time, and hygienic safety, generally ranging from closed systems maintained indoors in containers to open systems consisting in outdoor piles.

Anaerobic digesters. Anaerobic digesters or "bio-digesters" are covered pits or tanks in which bacteria convert organic waste, such as manure, into methane biogas through anaerobic digestion. Small-scale digesters are often used to power off-the-grid households, and large-scale digesters can fuel electric power generators. Electricity may be used on farm use or fed to the grid. The nutrient content of the liquid digester effluent or "bio-slurry," while often overlooked, is similar to the content in the original manure (gases generated through the digestor contain marginal amounts of nitrogen, phosphorus, and potassium). Digestor outflows must thus be stored and applied according to a nutrient management plan, as for fresh manure and compost.

Options for linking to regional/global fertilizer demand

Manure pellets and other dry products. Manure products with low water content are most cost-effective for longer transport and export. These include pellets and granules produced through processing and drying manure at high temperatures. Challenges to manure product export may include difficulty in meeting health standards for trade in animal by-products.

Variables to Consider

- ✓ Nitrogen and phosphorus surpluses (often expressed per ha) at different aggregation levels (plot, farm, watershed).
- ✓ On farm and/or regional nutrient and organic matter management plans.

Trade-offs to Consider When Applying Principle 5

Potential for overfertilization. Integrating manure into crop- and grassland fertilization without evaluating the nutrient balance can result in overfertilization. Identifying where the introduction or expansion of manure recycling may imply reductions in the use of synthetic fertilizer will help avoid this outcome.

De-prioritization of synthetic fertilizer economy. While the benefits of organic soil amendments are broadly known, producers of synthetic fertilizers are, in many regions, significant private sector stakeholders in agriculture. Effective promotion of recycling manure as fertilizer may require economic and policy planning to reduce market barriers for manure products and ensure equal access to subsidies and other public support.

Limited suitability for livestock production. In some regions, the limited availability of crop production and/or grassland on which to apply increased amounts of manure may lead to evaluating whether the project site is suitable for expanding intensive livestock production. Teams may seek alternative locations for livestock development, where land/livestock balances are more favorable.

Principle 6: Minimize fossil fuel use

Livestock development presents significant opportunities to invest in energy-efficient technologies and renewable energy generation along the value chain

Introduction

The food and agriculture sector accounts for about 30% of global energy consumption. A significant portion of this energy demand is generated by the production, processing, and transport of livestock feed, largely due to the energy-intensive nature of manufacturing synthetic fertilizers applied to feed crops. Emissions from on-farm energy use, the construction of farm buildings and equipment, and post-farm gate processing and transport of livestock products account for the remaining fossil fuel emissions. This sixth principle provides guidance for contributing to clean energy development in livestock production. It applies to the entire livestock value chain for all livestock species.

Efficient and renewable energy generation provides a range of environmental and economic co-benefits.

Improving energy efficiency can reduce both emissions from fossil fuels and energy costs for farmers and processors. Key approaches include improving the maintenance and operating time of existing machinery, as well as introducing new machinery purposed for energy savings, such as energy-efficient milk chillers.

Generating renewable energy along the supply chain and off-farm can reduce energy expenditure while also contributing to climate change mitigation. On-farm bio-digesters can be used to capture renewable biogas energy from livestock manure and other farm by-products. Digesters at various scales can power households, farms, and processing operations (Principle 5). Solar installations on rooftops can also contribute to powering buildings and machinery on farms and in processing plants.

Solar and wind energy installations may also be constructed on marginal lands unsuitable for crop production or pasture, and with the use of net metering devices, be used to sell energy back to the grid and/or to offset on-farm emissions. In rural areas not connected to the grid, these installations can provide opportunities to improve rural energy access and resilient energy diversification.

Points of Consideration

Do project beneficiaries use fossil fuel? If so, in project design, incorporate incentives for efficient and renewable energy generation:

✓ Increase energy efficiency:
- Optimize management of machinery and equipment.
- Adopt devices purposed for energy savings.

✓ Increase renewable energy generation along the supply chain:
- Incorporate bio-digesters to power household, farm, and processing operations.
- Incorporate solar installations on rooftops and pastures.
- Incorporate wind energy installations on marginal land to power processing and other larger operations.

✓ Adopt a net metering device to sell renewable energy back into the grid and/or provide livestock sector carbon offsets.

✓ Include a baseline and indicators in project M&E to track and capture the benefits of contributing to the clean energy economy through the project.

Applying the Principle

Approaches and Tools

To increase energy efficiency, optimize management of existing machinery and equipment. Investing in adequate maintenance of existing farm machinery and equipment can avoid energy use associated with malfunctions. Strategic use of fossil fuel-powered machinery can also increase efficiency. For example, running diesel generators at optimal (cooler, evening) ambient temperatures and supplementing tractor use with conservation tillage methods can reduce fossil fuel consumption.

Adopt devices purposed for energy savings. Household energy savings devices can also be used in farm operations to reduce overall energy consumption. These include efficient fluorescent lights to replace incandescent light bulbs; combined heat and power units; energy-efficient motor pumps; and improved insulation to reduce loss of heating energy to weatherizing and air leaks.

To increase the generation of renewable energy, incorporate bio-digesters to power household, farm, and processing operations. Anaerobic digesters or "bio-digesters" are covered pits or tanks in which bacteria convert organic waste, such as manure, into methane biogas through anaerobic digestion. Small-scale digesters can be used to power off-the-grid households; large-scale digesters can power on-farm operations and, in some cases, feed into the grid.

Incorporate solar installations on rooftops and pastures. Producers may install photovoltaic (PV) cells on household and farm building rooftops and/or fields. On rooftops, these solar panels can connect directly to the circuit breaker so that during daytime, when electricity consumption is highest, they are providing electricity directly to the source of consumption. Producers may also install solar-powered outdoor lights, store energy in the daytime to use at night, and therefore have no operating costs.

Incorporate wind energy on marginal lands. Producers may install windmills to generate electricity on lands not suitable for production. These can include small windmills to provide electricity for the household and farm operations, as well as larger windmills off-farm that feed into the grid.

Use of net metering devices to sell back to the grid. For any of the above renewable energies, producers may install net metering devices in coordination with the local energy utility. Any excess electricity can then be sold back to the utility to offset future energy needs or as part of a livestock sector carbon offset program.

Variables to Consider

- ✓ Fossil fuel emissions and/or use avoided through the project's interventions.
- ✓ Watts/capacity of renewable energy produced due to the project.
- ✓ Number of biogas installations, solar panels, etc. constructed with project support.

Trade-offs to Consider When Applying Principle 6

High up-front production costs. In intervention areas already connected to the grid and/or with low-cost fossil fuel-based energy available, renewable energy installation may present relatively high up-front costs. Analysis of the longer-term costs and benefits of renewable energy production may demonstrate over time cost-savings that offset initial capital investment. Projects may include resources to cover the initial capital where up-front costs are unaffordable for producers. Fossil fuel-based energy providers may also be active stakeholders in agriculture and other sectors; effective promotion and certification programs for renewable energies may require economic and policy planning to reduce market barriers and provide access to subsidies and other public support.

Principle 7: Foster an enabling environment

Enabling institutions, policies, knowledge, and awareness are necessary for achieving principles 1 through 6

Introduction

Decision-making about principles 1 through 6, from the farm to the supply chain level, will highly depend on local political, institutional, and economic contexts. Ensuring that the institutional, knowledge, and economic environment enables decision-making and innovation for improved sustainability is key to enhancing project outcomes, both during and after the project itself. A strong enabling framework is also key to evaluating the many synergies and trade-offs related to livestock development and require evidence- and consensus-based decisions.

Points of Consideration

Is there potential to improve the enabling environment for sustainable livestock investment in
the project country? If so, include project resources to:

✓ At the project concept stage, identify and analyze the knowledge, awareness, policy, and institutional challenges to implementing the relevant principles.

✓ In project design, include resources to address these challenges through:

Awareness:

– Shape the livestock and environment narrative strategically, flagging synergies and trade-offs.

– Raise and leverage consumer awareness.

– Build consensus and political will.

Knowledge:

– Support local pilot programs and extension research to identify appropriate solutions.

– Utilize life-cycle assessment (LCA) approaches to quantify nutrient, chemical, and GHG flows.

Policy:

Pair project investment with policy investment to:

– Establish environmental certification programs and market differentiation for sustainable livestock products.

– Pilot payments for environmental service and carbon offset programs.

– Establish and clarify regulations for environmental stewardship, land tenure, and animal health and welfare.

– Redirect subsidies toward environmental outcomes.

Institutions:

– Establish a unit within the relevant ministry to perpetuate the enabling environment.

– Develop country capacity for M&E to establish baseline data.

Applying the Principle

Awareness

Shape the livestock and environment narrative strategically. Some of the literature on livestock and environment considers animal-sourced food production to be unsustainable. However, considering the contributions that livestock make to a broad range of development outcomes conveys a more realistic view. These outcomes include improved food and nutrition security; crop productivity; jobs and income diversification; asset saving and risk management; and biodiversity conservation and carbon stock enhancement on well-managed grasslands. Awareness raising in projects about the importance of sustainable livestock should objectively balance these contributions and account for them in efforts to quantify livestock impacts on the environment and economy.

Raise and leverage consumer awareness. Consumers increasingly are becoming aware of the health and environmental implications of animal-sourced food consumption. Investment in livestock can benefit from this awareness by linking producers who adopt sustainable practices to demand for sustainable products. Projects can include resources for awareness raising among consumers to help producers under the project link to this demand. Consumer demand may also influence political support for adopting the principles.

Build consensus and political will. Adoption of the principles may not benefit all stakeholders and will often generate costs. Conservation of natural areas, for example, may adversely impact producer incomes or a country's trade balance. Strong political consensus around the importance and urgency of sustainable livestock production practices may be necessary to enable a balanced assessment of synergies and trade-offs and put in place the regulations, subsidies, and market-based instruments that can shift production practices. Development investment can contribute to building such consensus and political will for adopting the principles by accounting for environmental costs in the economic assessment of projects.

Knowledge

Support local pilot programs and extension research. While the literature provides considerable technical guidance to support adoption of the principles, projects will need to provide support for piloting and adopting improved practices for local conditions. Projects should include technical assistance and extension services where necessary to support each principle adopted. Consolidating knowledge and evidence for the local applicability of the principles can help encourage further farmers to adopt them.

Support education and research in the area of sustainable livestock systems. While knowledge is progressing at the global level, it is mostly advancing in high-income countries. The growth of animal production is, however, much more robust in low- to middle-income countries, and much work is still needed to properly grasp livestock-environment interactions in these regions, and to establish the technical itineraries that can bring livestock development on a more sustainable path.

Policies

Establish environmental certification programs and market differentiation for sustainable livestock products. Certification programs can help link consumer demand for sustainable products to producers who are adopting the principles. Projects may include resources to support producers in adopting existing certification programs, as well as to develop and pilot new, voluntary certifications for products such as livestock feed that are not generally certified. Projects may support certification and market development for organic manure products to compete with synthetic fertilizers.

Develop payments for environmental services and carbon offset programs. Low- and middle-income countries often have limited funds for incentive-based environmental programs. Pairing project investment with policy instruments to pay or in other ways incentivize producers to adopt the principles may significantly enhance project outcomes. Payments for environmental services programs have proven to be successful in Costa Rica in protecting natural areas. Carbon offset and other emission reduction programs in the livestock sector should be linked to national targets for greenhouse gas emission reductions and accounting under nationally determined contributions to the United Nations Framework Convention on Climate Change.

Establish and clarify regulations for environmental stewardship, land tenure, and animal health and welfare. Many countries today lack an effective regulatory framework for environmental, health, and welfare issues related to livestock. Pairing project investment with policy investment can significantly enhance the long-term outcomes of the project and of the broader sustainability agenda. Policy investments may include support for developing voluntary guidelines, for instance, for nutrient management, as well as regulations for the siting of livestock projects. Providing secure land access and rights can also help clarify responsibilities for environmental stewardship on productive lands.

Redirect subsidies toward environmental outcomes. Agricultural subsidies worldwide amount to about $1 billion per day and have a range of impacts on soil, air, and water resources. These include subsidies for specific land uses, price, and income support for specific agricultural products and practices, and subsidies for agricultural inputs. Ensuring that agricultural subsidies incentivize good environmental management can help enable environmental outcomes in livestock investment projects.

Institutions

Develop country capacity for M&E to establish baseline data and to track and capture investment benefits. Many countries do not collect detailed data on the livestock sector and are unlikely to collect data on its environmental impacts. Projects may include resources to develop monitoring and evaluation capacity to create livestock information systems, drawing on novel information technology options. Projects may also provide training in survey methodology and in data collection and analysis for livestock numbers, herd structure, forage and feed, and production practices, as well as for cost, income, and other economic data.

Establish an environment unit within the ministry/department of livestock. While projects may hire an environmental expert during implementation, the knowledge and capacities gained through the project may dissipate without a permanent, dedicated office. The project may thus include resources for the establishment of a permanent unit to continue to advance the livestock and environment agenda after the project closes. The capacities of such a unit would be developed as part of project activities and may serve to perpetuate the enabling environment for investing in sustainable livestock past the duration of the project.

Principles: Synergies and Trade- offs Matrix

The tool's seven principles are not independent but related by a complex web of interactions.

Principles 2 to 6 describe a complementary and comprehensive set of recommendations to address environmental issues in livestock projects. Principle one is overarching, clarifying the expected roles of livestock given the development objective, and principle seven underpins the implementation of the six other principles by helping to put in place the required institutions and financial mechanisms.

For each context, objective and intervention, the guidance provided in the tool integrates trade-offs and synergies between principles: the preparation team reviewed the potential trade-offs and synergies in each combination of context, objective and intervention, and factored these different relationships in the proposed guidance.

Project teams may however also use the matrix of trade-offs and synergies as a framework to assess potentially competing interventions and make decisions in view of the specific context and objectives of the project. Due to the overarching nature of principles one and seven, they are not included in the matrix.

■ Synergies ■ Trade-offs

Principle 2. Enhance Carbon Stocks

P3 Intensification to achieve higher productivity may result in (i) removal of trees in pastures and live fences (ii) shift from permanent pasture to cropped feed and fodder. Hence, benefits from increased productivity may be nullified by additional losses in carbon stocks. Consequently, decision should be based on the computation of net GHG emissions

P4 None, since sustainable feed resources will be sourced from systems that maintain carbon stocks

P5 Use of crop residues for improvement of soil organic carbon competes with its use as animal feed. Additionally, forage production on former grasslands reduces soil carbon stocks. Net GHG emissions should be estimated and minimalized .

P6 Manure treated in bio-digester before application has lower carbon content and consequently lower potential to contribute to soil organic matter. The effect of use of manure for biogas production should be evaluated on basis of the net effect on GHG emissions and be compared to direct application of manure to soils.

Principle 3. Increase Productivity at Animal and Herd Levels

P2 (i) Grassland restoration and improvement may enhance soil carbon stocks and increase feed availability and quality and reduce land use change for feed production (ii) Trees in pastures and live fences protect animals from heat stress (hot climate)

P4 Increased productivity per animal often only achievable through import of feeds which implies additional transportation.

P5 Increased productivity and the associated additional feed requirements increase the import of nutrients to farms and consequently n- and P-surpluses and the risk on pollution

P6 Increased productivity increases the energy requirements on-farm as well as off-farm

Principle 4. Source Feed Sustainably

P2 (i) Soy cropped on non-deforested land; (ii) Feed from no-tillage agriculture

P3 Imported feeds may be produced under conditions where land, water, fossil fuel and pesticide use per unit feed is lower than when produced at the farm itself. Increased herd productivity may reduce feed requirements

P5 Though imported feeds may be produced sustainably, they still are an influx of additional nutrient into the farm and could cause pollution if not properly managed

P6 None, since sustainable feed resources will be sourced form systems with minimal fossil fuel use

Principle 5. Couple Livestock to Land

P2 i) use of organic fertilizer contributes to improving soil organic matter content ii) livestock at optimal stocking rates may contribute to improved carbon sequestration, cycling of nutrients to maintain soil fertility and livestock production

P2 Regional integration between livestock and arable farms may contribute to regional circular use of resources: crop by-products as feed to livestock farmers and manure as fertilzer to crop farmers

P3 Regional integration between feed producing farms and livestock farms through trade in feeds and manure

P6 None

Principle 6. Minimize Fossil Fuel Use

P2 None

P3 Biogas production at farms with high animal productivity

P4 Sourcing of feeds with minimal embedded fossil fuel use

P5 Farms with N- and P-surpluses applying manure treatment which could be combined with biogas production