# SYNTHESIS ON THE INTERACTION BETWEEN LIVESTOCK FARMING, THE ENVIRONMENT AND THE SUSTAINABILITY OF BUILDINGS

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***Abstract***

*Modern livestock farms represent complex systems in which the built infrastructure, biological processes, natural resources and environmental factors are in permanent interaction. The development of these farms must be analyzed from the perspective of environmental protection, the sustainability of buildings and the capacity of ecosystems to respond and recover from anthropogenic interventions. The synthesis paper brings together and correlates the main ideas from studies on the systemic approach to livestock buildings, the impact of farms on the environment, the relationship between disturbance, impact and natural recovery, as well as the influence of environmental factors on the technical condition of buildings. The types of impact generated by the location, construction and operation of farms, the forms of structural degradation produced by the aggressive environment specific to livestock farming and the role of environmental impact assessment in the design and management of modern farms are highlighted. The results show that economic performance, environmental protection and sustainability of buildings should not be analyzed separately, but in an integrated framework, capable of supporting the development of a modern, competitive and responsible livestock farming.*

***Key words:*** *animal husbandry, environmental protection, impact assessment, construction sustainability, natural restoration, sustainable development*

## INTRODUCTION

Modern animal husbandry represents one of the fundamental areas of contemporary agriculture [1-7], having an essential role in ensuring food security, in the capitalization of agricultural resources and in the development of rural areas [8-23]. The intensification of animal production has led to the emergence of increasingly complex farms [20, 24, 25], in which shelters, technological facilities, storage platforms, utility networks and auxiliary infrastructure operate as parts of a unitary system [26-29]. Under these conditions, livestock farms can no longer be analyzed exclusively as production units [30]. They must be understood as systems in continuous interaction with the environment, natural resources and human communities [31- 33]. Their location, construction and operation can influence air, water and soil quality, biodiversity, habitat balance and the sustainability of the buildings themselves [34-72]. The studies integrated in this synthesis highlight the need for a systemic and interdisciplinary approach, which brings together engineering, ecological, economic and functional requirements [73-88].

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They also emphasize that sustainable development, environmental impact assessment and the resistance of buildings to aggressive factors specific to the zootechnical environment are inseparable components of a modern farm.

## MATERIAL AND METHOD

The paper was carried out by correlating and integrating the main ideas applied in the field of animal husbandry, dedicated to the following directions:

- the foundations of the systemic approach and environmental protection in the design of livestock buildings;
- the impact of livestock farms on the environment and protective measures in the context of sustainable development;
- ecological and technical interactions between anthropogenic activities and natural recovery processes;
- assessment of the environmental impact in modern livestock farms;
- the influence of environmental factors on the technical condition of livestock buildings.

The working method consisted of:

- selecting common and complementary concepts;
- grouping them into major themes;
- reformulating them in a unitary, coherent and autonomous framework;
- highlighting the relationships between environment, exploitation and construction.

The analysis aimed to build an integrated perspective on the zootechnical system, in which the environmental impact, ecosystem restoration and construction sustainability are treated as interdependent elements.

## RESULTS AND DISCUSSIONS

**Systemic approach to livestock farms**

One of the central ideas derived from the works analyzed is that the livestock farm must be treated as a highly complex system [89-94]. This system includes not only the buildings and technological installations, but also the animals, water and energy resources, land, air, flora, fauna and the surrounding human community [29, 95-98]. In this perspective, livestock buildings are not simple housing spaces, but elements with an active role in determining the microclimate, production conditions and the relationship between the farm and the environment [99-106]. Every decision related to location, materials, exploitation technology or waste management produces effects in the entire system. This approach justifies the definition of an area of influence of the operation, which goes beyond the actual footprint of the buildings and includes the lands, platforms, storage spaces, access routes, areas exposed to emissions and surfaces where infiltration, odors, noise or ecological transformations may occur [107, 108].

**Sustainable development as a principle of organizing farms**

All the works converge towards the idea that sustainable development must be the basis for the design and operation of livestock farms. This principle requires the efficient use of resources, the reduction of energy consumption, the integration of renewable sources, the limitation of emissions and the conservation of biodiversity. In animal husbandry, sustainable development is not limited to environmental protection, but also involves ensuring animal welfare, the economic viability of farms, and maintaining the quality of the built environment. Modern farms must use sustainable materials, reduce waste, recover resources, and prevent degradation of soil, water, and air. In this sense, the sustainability of the farm depends both on the constructive and technological solutions, as well as on the way in which they are integrated into the territory and local ecosystems.

**Environmental impact assessment in livestock farms**

Another major result of the synthesis is the central role of environmental impact assessment as a preventive tool. It must be



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integrated from the conception and design phase of farms, not only applied afterwards, as a reaction to problems that have already occurred.

Impact assessment allows:

• identification of potential sources of pollution;

• comparison of location and design options;

• estimation of direct and indirect effects on the environment;

• establishment of impact reduction measures;

• correlation of economic objectives with environmental protection requirements.

In the case of livestock farms, the impact must be analyzed both in the construction phase and in the exploitation phase. Effects on soil, water, atmosphere, biodiversity, landscape and local communities are distinguished. Through an integrated approach, impact assessment contributes to the achievement of efficient exploitations compatible with the requirements of sustainable development.

**Types of impacts generated by livestock activities**

Livestock farming generates both beneficial and negative effects.

Positive effects include the economic development of rural areas, job creation, the valorization of agricultural resources, and the support of food production. However, negative effects are multiple and must be carefully managed.

The impact on the environment is manifested by:

• air pollution with ammonia, methane, nitrous oxide, dust and bioaerosols;

• soil and water contamination by manure, nitrates, phosphates and wastewater;

• habitat modification and biodiversity reduction;

• noise, odors and discomfort for neighboring communities;

• land occupation and transformation;

• alteration of the rural landscape.

These effects can be direct, indirect, temporary, permanent, cumulative or synergistic. Particularly in sensitive areas, the interaction between several polluting factors can produce effects that are more serious than the sum of the individual influences.

**Disturbance, impact and natural recovery**

An important contribution of the reviewed works is the introduction of the disturbance-impact-natural recovery relationship in the analysis of livestock farms. Any anthropogenic intervention, including the construction of an exploitation, can be interpreted as a disturbance applied to a natural system.

The ecosystem's response to this disturbance depends on the intensity of the stress, the sensitivity of the habitat, and the existence of refuge and regeneration structures. Natural recovery is not an automatic process, but one conditioned by the connectivity of habitats, the self-regulating capacity of the system, and the maintenance of fundamental ecological processes. In this context, ecological refuges - segments of undisturbed habitat, vegetated curtains, wetlands, buffer zones or biological corridors - play an essential role in conserving biodiversity and recolonizing affected areas. This perspective extends the analysis of environmental impact beyond the simple observation of pollution, emphasizing the capacity of the ecosystem to adapt, resist and recover.

**The interaction between environment and the technical condition of buildings**

An essential aspect highlighted in the synthesis is that the relationship between the farm and the environment is bidirectional [109-116]. Not only does exploitation affect the environment, but the environment also significantly influences the sustainability of constructions.



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Livestock buildings operate in an aggressive environment, characterized by:

• high humidity;

• temperature variations;

• the presence of ammonia, sulfides, nitrogen compounds and carbon dioxide;

• the action of manure and wastewater;

• mechanical stresses produced by animals and machinery.

These conditions cause complex degradation processes, especially on concrete and reinforced concrete elements.

The main mechanisms include:

• carbonation of concrete;

• sulfate attack;

• action of nitrogen compounds and ammonia;

• freeze-thaw cycles;

• shrinkage due to humidity variations;

• mechanical wear and erosion;

• corrosion of reinforcement.

Manifestations of deterioration include cracks, peeling, delamination, seepage, efflorescence, corrosion and structural deformation. Therefore, the durability of constructions must be included in the overall analysis of the sustainability of the exploitation.

**Integrated prevention and protection measures**

From the correlation of the works it follows that environmental protection and construction protection must be thought of together [117-120].

Effective measures include:

• careful site design;

• use of materials resistant to aggressive environments;

• waterproof platforms and safe manure collection systems;

• controlled ventilation and efficient microclimate management;

• use of vegetal curtains and buffer zones;

• limiting water and energy consumption;

• energy recovery of organic waste;

• monitoring of emissions and the technical condition of buildings;

• periodic inspections and repairs;

• integration of impact assessment into all stages of the project.

By applying these measures, the livestock farm can become not only an efficient productive system, but also a system capable of reducing losses, valuing resources and limiting pressure on the environment.

## CONCLUSIONS

The synthesis highlights the fact that modern livestock farms must be understood as complex systems in permanent interaction with the natural environment, resources and built infrastructure.

From this perspective, sustainable development, environmental impact assessment, ecosystem restoration and construction sustainability are not separate themes, but components of the same functional reality.

The design and operation of farms must simultaneously pursue economic performance, animal welfare, environmental protection and maintenance of the technical condition of the buildings.

The impact on air, water, soil and biodiversity must be assessed and controlled from the early stages of the project, and the aggressive environment specific to livestock farming must be taken into account in the choice of materials and technical solutions.

At the same time, the capacity of ecosystems to respond and recover from disturbances must be treated as an important criterion in the evaluation of locations and constructive solutions.

Only through such an integrated approach can the development of modern, competitive and responsible animal husbandry be supported.



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