

Challenges and innovations for grasslands resilience

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Edited by

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D. Fangueiro
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European Grassland Federation EGF

A. van den Pol-van Dasselaar, Federation Secretary

Aeres University of Applied Sciences

De Drieslag 4

8251 JZ Dronten

The Netherlands

E-mail: fedsecretary@europeangrassland.org



Biodiversity impacts of European livestock systems: a review of indicators

Proença V., Baptista L. and Ribeiro I.

MARETEC—Marine, Environment and Technology Centre, LARSyS, Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal

Abstract

European livestock production systems can have both positive and negative impacts on biodiversity, depending on their management regime or ecological context. The objective of this study was to systematically review scientific literature to identify studies evaluating the positive and negative impacts of European livestock production systems on biodiversity, across levels of biological organization from populations to communities and ecosystems. The search included peer-reviewed, open-access articles in English (2015–2024), yielding 815 records. After duplicate removal and screening, 96 studies met eligibility criteria. Data were extracted on study features, including livestock type, management regime, systems or practices being compared, biodiversity indicators and overall impact of livestock. The studies represent 26 countries, with France, Spain, and Italy most frequently represented. Most focus on extensive systems, mainly cattle. Studies often compare land uses with or without livestock and differing grazing intensity. Community composition indicators are most common, followed by indicators of ecosystem structure and population abundance. Livestock presence is often associated with positive biodiversity outcomes, or conversely, the absence of grazing with negative effects. In contrast, increasing grazing intensity is generally linked to negative impacts, particularly under high pressure, whereas positive impacts are reported when very low-intensity regimes are compared with moderate regimes.

Keywords: biodiversity indicators, grazing intensity, systematic review

Introduction

The livestock sector represents both a challenge and an opportunity for biodiversity conservation. On the one hand, livestock production is a major driver of environmental pressures, including land use change, habitat degradation, GHG emissions, and nutrient runoff (FAO, 2020). On the other hand, especially in low-intensity systems, livestock can contribute positively to ecosystem management and help maintain structurally and biologically diverse landscapes (Ribeiro *et al.*, 2023). This dual role highlights the sector's potential to shape biodiversity outcomes—either by mitigating its negative impacts or by enhancing its positive contributions. A synthesis of the existing literature on the impacts of livestock on biodiversity is needed to inform such efforts. The main goal of this study is to review the scope and indicators used in studies assessing the impacts of livestock systems on biodiversity.

Materials and methods

The literature search applied a search string comprising four main components: (i) terms related to indicator terminology, (ii) the term biodiversity, (iii) terms representing livestock species and products, and (iv) terms covering the European territory (i.e., countries' names). The search was restricted to peer-reviewed, open-access research articles published in English between 2015 and 2024. A total of 815 records were retrieved from Web of Science ($n = 412$), Scopus ($n = 332$) and PubMed ($n = 71$). After merging results from all databases and removing 286 duplicates, 529 records remained

for title and abstract screening. Of these, 388 were excluded for falling outside the review scope, not covering Europe, not addressing livestock impacts on biodiversity, or not measuring/modelling biodiversity. This screening yielded 141 studies for full-text assessment, of which 96 were retained for data extraction.

Data were extracted on: (1) Study reference, (2) Geographic scope (country(ies) covered), (3) Livestock type (species and production system, e.g., dairy cattle, beef cattle), (4) Management regime (e.g., extensive, intensive), (5) System comparison (systems or practices being compared, e.g., grazed vs. ungrazed, species comparison), (6) Biodiversity indicators, (7) Targeted taxa or biodiversity component, and (8) Overall impact (qualitative assessment of the system's impact, based on the study main findings, as highlighted by the authors).

Results and discussion

The list of selected publications covers a total of 26 countries and nearly two-thirds (61 out of 96) were published after 2020. Fifty studies focus on a single livestock species, with cattle being the most frequently represented ($n = 26$); 41 studies adopt a multi-species approach, and 5 studies do not specify the livestock species. Across all studies, cattle are the most frequently represented species ($n = 62$), followed by sheep ($n = 44$), and horses ($n = 20$). Most studies focus on extensive management systems ($n = 36$), followed by those comparing extensive and intensive systems ($n = 18$). Unassisted grazing (e.g., rewilding systems, producing environmental services) is examined in 9 studies, while intensive management alone is addressed in 4. Other management types not explicitly linked to intensity (e.g., specialized livestock farms vs. mixed farms) are considered in 15 studies.

Regarding system comparison (Figure 1), most studies compare land uses with or without livestock grazing and regimes under different grazing intensity, followed by comparisons based on livestock type (includes species, breeds and production sectors), farming system, and timing of grazing. Three studies compare diets or livestock products.

The range of reported biodiversity indicators is highly diverse, reflecting the studies' varied biodiversity concerns.

Most studies use community composition indicators (e.g., species richness, diversity indexes, composition) (Figure 2), followed by indicators of ecosystem structure (e.g., vegetation structure, habitat

Type of comparison		
Livestock presence	50	52%
Livestock intensity	26	27%
Livestock type	15	16%
Farming system	12	13%
Livestock timing	10	10%
Other	3	3%

Figure 1. Main comparison types reported in the reviewed studies. Each study may include multiple types. Numbers on the left show study counts; bars on the right indicate percentages of the total ($n = 96$).

Indicator dimension			
Community Composition	75		78%
Ecosystem structure	29		30%
Species Populations	15		16%
Other	30		31%

Figure 2. Biodiversity dimensions represented by indicators in the reviewed studies. Each study may cover multiple dimensions. Numbers on the left show study counts; bars on the right indicate percentages of the total ($n = 96$).

	Presence		Intensity	
Positive	16	32%	1	4%
Positive & Neutral	9	18%	2	8%
Neutral	4	8%	2	8%
Negative & Neutral	5	10%	2	8%
Negative	7	14%	16	62%
Positive & Negative	9	18%	3	12%

Figure 3. Type of impacts reported by studies comparing livestock-grazed vs. ungrazed areas ('Presence', $n = 50$) and higher vs. lower grazing intensity regimes ('Intensity', $n = 26$). Bars show the percentage of studies reporting each type of impact. Intensity comparisons include only studies conducted under grazing conditions.

richness, ecological infrastructure) and species populations (mainly species abundance). 'Other' indicators include ecosystem function, species traits, scoring systems using proxy variables, and LUC-driven biodiversity loss.

With respect to the biodiversity components targeted by the studies, 48 included variables related to plant communities or species, 17 focused on vertebrates (primarily birds (15 studies), followed by mammals (8) and herptiles (3)), 15 addressed invertebrate communities, and 25 examined overall ecosystem-level variables.

Regarding overall impacts, the analysis of studies comparing livestock presence and grazing intensity reveals two main patterns (Figure 3). First, livestock presence is often associated with positive impacts on biodiversity—or conversely, the absence of grazing with negative effects. Second, higher grazing intensity is predominantly linked to negative outcomes. Positive impacts of livestock presence are reported across a broad range of biodiversity dimensions, including the richness and diversity of plant, invertebrate, and vertebrate communities, ecological infrastructure, and the maintenance of habitat quality for fauna. However, negative impacts are also observed for many of the same components, particularly plant community composition and diversity, habitat quality for target species, and in cases of overgrazing.

In the case of increased livestock grazing intensity, negative impacts are primarily associated with higher intensity levels, affecting multiple biodiversity dimensions. These include reductions in plant and invertebrate diversity, declines in mammal and bird presence and habitat availability, and overall community simplification. In contrast, positive impacts are reported when very low-intensity regimes are compared with moderate grazing levels, including increased plant community diversity and evenness, as well as improved habitat conditions for open-land bird species.

Conclusion

This review provides an overview of the scope of existing research and the types of indicators used to assess the impacts of livestock systems on biodiversity, with grazing presence and intensity emerging as the most common comparison types. While grazing presence and moderate regimes can support biodiversity under certain conditions, higher grazing intensity is generally associated with negative outcomes across multiple dimensions of biodiversity.

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