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Systematic Literature Review and Key informant interviews on the impact of poor animal health on climate change

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ADMINISTRATIVE INFORMATION

Support - Climate fund through BALLMER group.

Review Stage at time of this submission - Data analysis.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 10 December 2025 and was last updated on 10 December 2025.

INTRODUCTION

Review question / Objective Objectives • Quantify the contribution of poor animal health and associated deaths which may necessitate change in production systems to GHG emission intensity (emissions per unit of product) in dairy and beef cattle. Metrics to measure this contribution include: 1) Emissions intensity per unit of product, considering factors like milk yield, feed conversion, and disease-related mortality; 2) Changes in GHG emissions due to disease outbreaks and their impact on herd size and productivity; and 3) Metrics that account for the different warming potentials of various GHGs (e.g., methane and carbon dioxide).

• Identify and evaluate suitable and realistic mitigation strategies (veterinary, nutritional, breeding) to reduce GHG emissions from unhealthy cattle.

• Review existing policy and regulatory frameworks targeting animal health for climate change mitigation.

• Identify research gaps and future priorities at the intersection of animal health and its impact on food production.

Research Questions

1. What is the contribution of poor animal health to greenhouse gas emission intensity? – Examine how diseases, malnutrition, and poor management in livestock contribute greenhouse gas emissions (methane and carbon dioxide emissions).

2. What practices and strategies can contribute to the mitigation of the effects of poor animal health on greenhouse gas emissions and climate change? – Explore veterinary, nutritional, and breeding strategies that can mitigate negative environmental impacts.

PECOS framework

Population: Dairy and beef cattle kept in intensive, semi-intensive and extensive production systems

Exposure: Diseases in beef and dairy cattle, feed types and feeding systems

Control/comparison: control group or no control group (or studies with/without explicit control groups).

Outcome: primary: amount of GHGs, – enteric methane (animal emissions) - Metrics to measure this contribution include: 1) Emissions intensity per unit of product, considering factors like milk yield, feed conversion, and disease-related mortality; 2) Changes in GHG emissions due to disease outbreaks and their impact on herd size and productivity; and 3) Metrics that account for the different warming potentials of various GHGs (e.g., methane and carbon dioxide).
secondary: disease measure – prevalence/ incidence (common diseases including Food and mouth disease, East Coast Fever, Contagious Bovine Pleuropneumonia, Lumpy Skin disease and mastitis.
Study design: observational studies, Experimental studies, case studies
Geographical coverage: Global
Timeframe: No time limit.

Rationale Global climate change is caused by greenhouse gas (GHG) emissions that result in global warming (IPCC,20213). The livestock sector contributes approximately 14.5% of global GHG emissions, with beef and cattle milk production accounting for the majority of emissions, contributing 41 and 20 percent of the sector's emissions, respectively (Bellarby et al., 2013; Gerber et al., 2008; Rojas-Downing et al., 2017). Emissions from livestock not only contribute to global warming but also exacerbate land degradation, air and water pollution, and contribute to biodiversity loss (Bellarby et al., 2013)..
As much as livestock contributes to climate change, they are also impacted by this through increased competition for natural resources, reduced feedstuffs availability and quality, greater disease burden, and heat stress (Garnett, 2009). Poor animal health, including infectious diseases like mastitis, lameness, and metabolic diseases, reduces feed efficiency and productivity, leading to increased GHG emissions per unit of edible animal product (Džermeikaitė et al., 2024). Sick animals need more resources and often result in higher emissions per unit of intake are likely to eat less and have a slower passage rate. Feed intake and emissions are highly correlated and reduced feed intake will lead to reduced daily emissions per animal. In contracts emissions per product (emission intensity) will be higher because the animals are going to produce less and thus emissions associated with animal maintenance will be greater than the output. CH4 emissions as a result of inefficient digestion and increased maintenance energy demands. Additionally, disease management interventions (e.g. antibiotics and veterinary care), implies the use of more resources with this further increasing the sector's environmental footprint ((Ezenwa et al., 2020; Fox et al., 2018).
While the impacts of climate change on livestock health are well documented, the reverse relationship, how livestock health influences emissions and climate change, remains under explored. Addressing this gap is important for designing effective mitigation strategies and informing policy. Improved livestock health management can enhance production efficiency and reduce emissions, contributing to more sustainable agricultural systems and climate resilience (Capper & Williams, 2023). This study will conduct a systematic literature review (SLR) alongside with key informant interviews to synthesize current knowledge, identify evidence gaps, and inform future policies linking improved animal health to climate mitigation.

Condition being studied The condition being studied is poor animal health in dairy and beef cattle and its link to greenhouse gas (GHG) emissions and climate change. Poor animal health encompasses a wide range of infectious, metabolic, and production-related diseases such as mastitis, lameness, metabolic disorders, Foot and Mouth Disease, East Coast Fever, Contagious Bovine Pleuropneumonia, Lumpy Skin Disease, parasitic infections, and other subclinical conditions. These diseases negatively affect feed intake, digestion efficiency, growth, and milk production, causing animals to produce less while maintaining similar or higher metabolic demands.
As a result, unhealthy cattle generate higher GHG emission intensity, meaning more methane and carbon dioxide emissions per unit of meat or milk produced. This occurs due to inefficient digestion, reduced productivity, increased maintenance energy requirements, and the additional resources needed for disease management (e.g., veterinary treatments, antibiotics). Although the effects of climate change on livestock diseases are well documented, the reverse relationship—how poor animal health contributes to GHG emissions—remains underexplored. The study therefore examines poor animal health as a significant but understudied driver of livestock-related emissions and environmental impact.

METHODS

Search strategy Search syntax
("cattle" OR "cow" OR "dairy cow*" OR "dairy cattle" OR "dairy animal*" OR “beef cattle" OR "beef cow*" OR "bovine*")
AND

("sick*" OR "diseas*" OR "infect*" OR "poor health" OR "unhealthy" OR "death" OR "metabolic disorder*" OR "respiratory disease*" OR "mastitis" OR "lameness" OR "foot and mouth disease" OR FMD OR "East Coast Fever" OR ECF OR "Contagious Bovine Pleuropneumonia" OR CBPP OR "Lumpy Skin Disease" OR LSD OR "parasit*" OR "subclinical" OR "immunocompromis*")
AND
("greenhouse gas*" OR "GHG emission*" OR "methane" OR "CH4" OR "carbon dioxide" OR "CO2" OR "nitrous oxide" OR "N2O" OR "climate change" OR "global warming" OR "carbon footprint*" OR "environmental impact*" OR "emission factor*" OR "enteric fermentation")
Databases
Searches will be conducted across the following databases:
• PubMed
• The Science Web
• ScienceDirect
• Google Scholar
• CAB Abstracts
• African Journals Online (AJOL)
• AGRIS
• JSTOR
• SCOPUS
• Springer link
• SSRN (Social Science Research Network)
• Web of science
• AGRICOLA.

Participant or population Dairy and beef cattle kept in intensive, semi-intensive and extensive production systems.

Intervention Diseases in beef and dairy cattle, feed types and feeding systems.

Comparator Control group or no control group (or studies with/without explicit control groups).

Study designs to be included Observational studies, Experimental studies, case studies, Geographical coverage: Africa.

Eligibility criteria
• Inclusion Criteria:
o Peer-reviewed articles, conference papers, government reports, institutional reports
o Articles reporting dairy and beef cattle diseases in connection with impacts on animal productivity and enteric CH4 emissions
o No time limit
• Exclusion Criteria:
o Non-English studies (unless translated).
o Studies focusing on other livestock species, wildlife, and their environmental impacts.
o Studies that do not directly assess the impact on climate change.

Information sources
• Databases Used:
o PubMed, Cabdirect, Web of Science, Scopus, ScienceDirect, Google Scholar.
• Grey Literature Sources:
o FAO, WHO, IPCC reports.

Main outcome(s) Amount of GHGs, – enteric methane (animal emissions) - Metrics to measure this contribution include: 1) Emissions intensity per unit of product, considering factors like milk yield, feed conversion, and disease-related mortality; 2) Changes in GHG emissions due to disease outbreaks and their impact on herd size and productivity; and 3) Metrics that account for the different warming potentials of various GHGs (e.g., methane and carbon dioxide). Secondary: disease measure – prevalence/incidence (common diseases including Food and mouth disease, East Coast Fever, Contagious Bovine Pleuropneumonia, Lumpy Skin disease and mastitis. Amount of GHGs, – enteric methane (animal emissions) - Metrics to measure this contribution include: 1) Emissions intensity per unit of product, considering factors like milk yield, feed conversion, and disease-related mortality; 2) Changes in GHG emissions due to disease outbreaks and their impact on herd size and productivity; and 3) Metrics that account for the different warming potentials of various GHGs (e.g., methane and carbon dioxide).

Additional outcome(s) Disease measure – prevalence/incidence (common diseases including Food and mouth disease, East Coast Fever, Contagious Bovine Pleuropneumonia, Lumpy Skin disease and mastitis.

Data management Data extraction will be done using pre-developed and pretested data extraction template and analysis and simple analysis conducted in excel to generate simple table summaries of the included studies.

Quality assessment / Risk of bias analysis Due to the limitation in the literature in the subject we subjectively assessed the risk of the include studies.

Strategy of data synthesis Data will be qualitatively described and highlight the research trend in this area. Summary tables will be generated to highlight the main findings along the PECOS framework describing the different aspects

of the SLR. A map will also be generated to show where the different studies have been conducted.

Subgroup analysis N/A.

Sensitivity analysis N/A.

Language restriction Only studies published in English.

Country(ies) involved Kenya.

Keywords Cattle health, Greenhouse gas emissions, Emission intensity, Climate change, Livestock diseases, Enteric methane, Mitigation strategies.

Dissemination plans Journal publication and dissemination of results in research workshops and conferences.

Contributions of each author

Author 1 - Ngwili Nicholas - Conceptualized the study idea and defined the review objectives. Led the development of the study protocol and methodology. Conducted the literature search and oversaw data extraction. Drafted the first version of the manuscript and coordinated revisions.
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Author 2 - Cook Elizabeth -Contributed to developing the search strategy and eligibility criteria.Performed independent screening of titles, abstracts, and full texts. Participated in data extraction and quality appraisal. Provided critical revisions and contributed to interpretation of findings.
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Author 3 - Abigael Chemutai - Assisted with the design of the methodology and data synthesis plan. Validated extracted data. Contributed to writing the results and discussion sections. Reviewed the manuscript for intellectual content and approved the finalversion.
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