

MAPPING THE SCHOLARLY LANDSCAPE: A BIBLIOMETRIC ANALYSIS OF RESEARCH ON KENYA'S DAIRY SECTOR AND ITS ALIGNMENT WITH SUSTAINABLE DEVELOPMENT GOAL

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ABSTRACT

Kenya is an agriculture-based economy and dairy farming is a major contributor to the national revenue. As production intensifies, the negative effect on the climate becomes more evident. Therefore, there is a need to align production with sustainable development goals. This study conducts a comprehensive bibliometric analysis to map the scholarly research landscape on Kenya's dairy sector and its alignment with the Sustainable Development Goals (SDGs). The 33 studies published from 2015 were obtained from the SCOPUS and analysed using R (Bibliometrix package) and VoS Viewer (1.6.19). The research established that since the enactment and ratification of the SDGs, there has been a marked increase in research on dairy farming sustainability in Kenya, though with significant yearly variations. Further, the study noted the predominance of small-scale dairy farming in Kenya, where the focus has traditionally been on increasing milk production, often at the expense of sustainable practices. Agriculture and sustainable intensification are the central themes reflecting efforts to balance increased food production and long-term sustainability, particularly in the face of climate change impacts such as droughts and heavy rainfall. The study underscores the critical role of both global and local collaborations in advancing research and addressing the sustainability challenges in Kenya's dairy sector. The findings advocate for a multidisciplinary research approach to achieve a balanced emphasis on productivity and environmental sustainability, ensuring the sector's alignment with the SDGs for long-term growth and resilience.

Keywords: Kenya, Dairy farming, Sustainable Development Goals (SDGs), Agricultural intensification, Climate change.

INTRODUCTION

Kenya's dairy sector is pivotal in the country's economy, contributing significantly to livelihoods and food security. It employs a substantial portion of the population, particularly in rural areas, and provides an essential source of nutrition through the production of milk and dairy products (Otieno, 2021). However, the dairy industry in Kenya faces numerous challenges, including low productivity, limited access to

markets, and environmental concerns, which hinder its potential for sustainable development (Otieno *et al.*, 2020). The United Nations Sustainable Development Goals (SDGs) provide a comprehensive framework for addressing these challenges and promoting sustainable practices within the dairy sector.

Significance of the Dairy Sector in Kenya

The dairy sector is a vital component of Kenya's economy- contributes approximately 14% to the agricultural gross domestic product (GDP) and 6% to the overall GDP (Otieno *et al.*, 2020). It employs over 1.8 million people directly and supports the livelihoods of numerous households through milk production, processing, and marketing activities (Kenya Dairy Board, 2024). Additionally, dairy products are a crucial source of protein and essential nutrients, playing a significant role in addressing food and nutritional security in the country (Augustin *et al.*, 2016). However, the sector faces various challenges, including low productivity, limited access to markets, and environmental concerns (Tricarico *et al.*, 2020). Besides, low milk yields, poor animal husbandry practices, and inadequate access to quality inputs and extension services contribute to low productivity (Maindi *et al.*, 2020). Limited infrastructure and inefficient marketing channels hinder farmers' ability to access lucrative markets, resulting in low returns and potential wastage of dairy products (Nyokabi *et al.*, 2021). Environmental concerns, such as greenhouse gas emissions, water pollution, and land degradation, also pose threats to the sustainability of dairy farming (Mumidasa *et al.*, 2021).

The SDGs and Sustainable Dairy Development

The SDGs, adopted by the United Nations in 2015, provide a comprehensive framework for addressing the challenges faced by the dairy sector in Kenya and promoting sustainable development practices. By aligning efforts with the relevant SDGs, stakeholders can work towards poverty reduction, improved food security, gender equality, decent work opportunities, and environmental conservation (United Nations, 2015). On SDG 1: No poverty, dairy farming has the potential to contribute to poverty reduction in Kenya by providing a reliable source of income for smallholder farmers and rural communities (Basu & Galie, 2021). Efforts to improve productivity, market access, and value addition can increase the profitability of dairy enterprises, thereby enabling farmers to escape the poverty trap (Eldridge *et al.*, 2022). SDG 2: Zero hunger, dairy products are a valuable source of protein and essential nutrients, contributing to food and nutritional security (Górska-Warszewicz *et al.*, 2019). Enhancing the availability and affordability of dairy products can play a crucial role in combating hunger and malnutrition, particularly among vulnerable populations (Makoni *et al.*, 2014). SDG 3: Good health and well-being. The consumption of dairy products has been linked to improved health outcomes, such as reduced risk of chronic diseases and better nutritional status (Wangu *et al.*, 2021). However, ensuring food safety and quality control throughout the dairy value chain is essential to prevent foodborne illnesses and promote good health (Rozenberg *et al.*, 2016). SDG 4:

Gender Equality. Women play a significant role in dairy farming activities, but often face gender-based discrimination and limited access to resources and decision-making processes (Bullock & Crane, 2021). Promoting gender equality in the dairy sector by empowering women through education, access to credit, and leadership roles can contribute to improved livelihoods and sustainable development.

Achieving sustainable development in Kenya's dairy sector requires a collaborative effort among various stakeholders, including policymakers, farmers, processors, researchers, and civil society organizations. The dairy industry contributes largely to the sustainable development of Kenya and improvement of livelihoods of those involved in the sector (Lelea et al., 2023). This study maps the intellectual structure of the dairy sector in Kenya and its alignment to the sustainable development goals by addressing the following research questions:

RQ1: What are the publication trends in Kenya's dairy sector and its alignment with the sustainable development goals?

RQ2: What are the most prolific scholars, articles, journals, and countries contributing to Kenya's dairy sector and its alignment with the sustainable development goals?

RQ3: What are the future research directions?

This study is organized into five sections to address the aforementioned research questions. The first section provides a background to Kenya's dairy sector and its alignment with the sustainable development goal. The second section explains the materials and methods used in the study, the third section presents the findings, the fourth section discusses the findings, and the fifth section draws conclusions from the findings and provides recommendations for further studies.

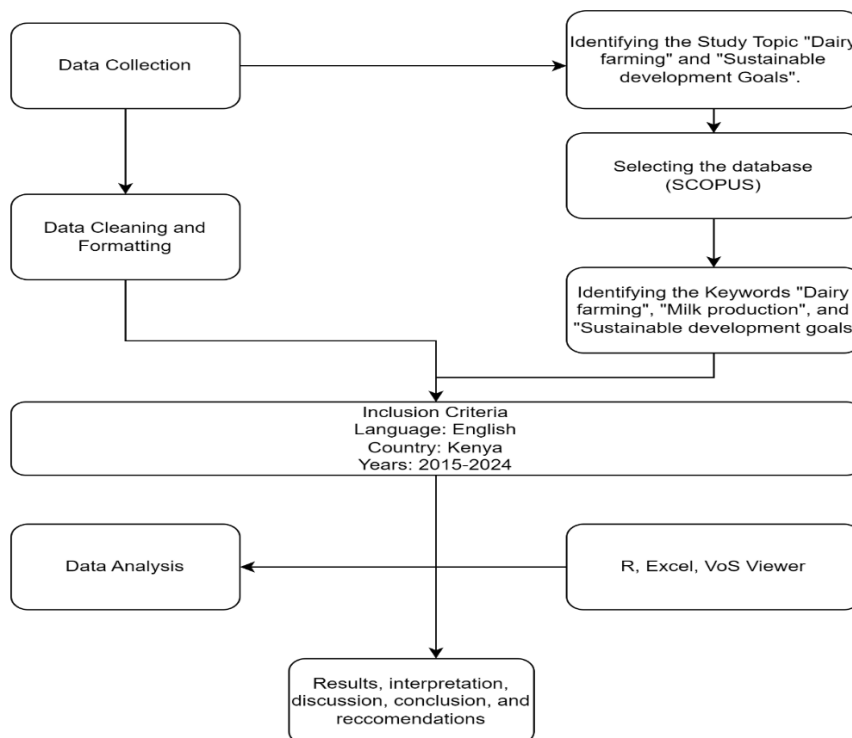
MATERIALS AND METHODS

The studies were drawn from SCOPUS, which is the most widely used and reliable source of scientific information in social and economic science. The R, MS Excel, and VoS Viewer were used to analyse the data. The search string combining multiple keywords was used as shown below.

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( TITLE-ABS-KEY ( ( "dairy sector" OR "dairy industry" OR "milk production" OR "livestock farming" ) ) AND TITLE-ABS-KEY ( ( "sustainability" OR "sustainable development goals" OR "SDGs" ) ) ) AND PUBYEAR > 2015 AND PUBYEAR < 2025 AND ( LIMIT-TO ( SRCTYPE , "j" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( LIMIT-TO ( AFFILCOUNTRY , "Kenya" ) ).
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The articles were limited to Kenya and between 2015 and 2024 since only studies published post 2014 when the sustainable development goals were ratified have been considered. Besides, only articles written in English were analysed. The search methodology is shown in *Figure 1*.

Figure 1. The Search Methodology



Following the search methodology in *Figure 1*, the results are shown in *Table 1*.

Table 1. The Search Results

| | |
|----------------------------|----|
| Article | 28 |
| Reviews | 4 |
| Editorials | 1 |
| Total | 33 |
| Exclude Editorials (Total) | 32 |

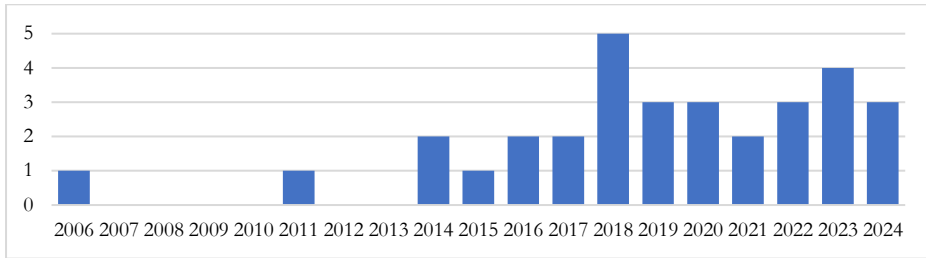
RESULTS AND DISCUSSIONS

This section highlights the findings from the analysis. It shows the publication trends, most prolific sources, articles, authors, and countries. Besides, it contains the bibliometric coupling of key words, authors, and countries.

Annual Scientific Production

The research sought to examine the annual scientific production in dairy farming sustainability in Kenya. The results are shown in *Figure 2*.

Figure 2. Annual Scientific Production (number)

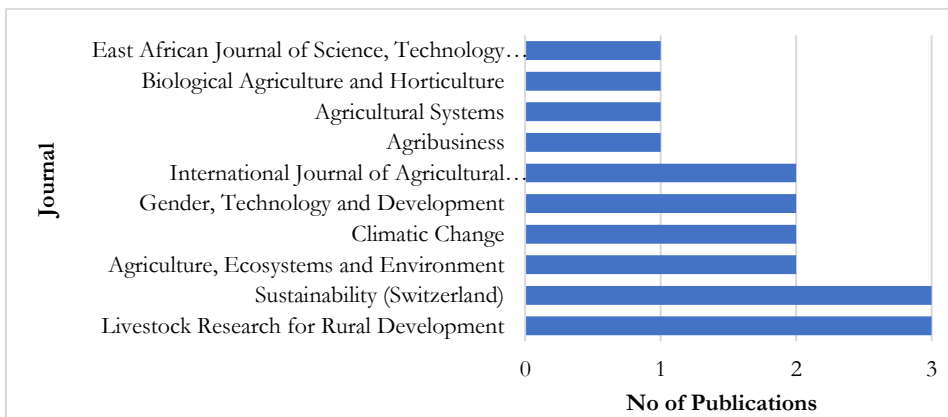


Since the enactment and ratification of the sustainable development goals, the number of studies on dairy farming sustainability in Kenya has increased over time. Nonetheless, there is variation over time. From 2006 to 2017, the number of studies ranged from 0 to 2. No study was undertaken in half of the years between the period. Nonetheless, there was a rapid rise in studies from 2018. In 2018, five studies were recorded, which is the largest number of publications in a single year recorded during the period under study. The publications reduced in the subsequent years, for instance 2019, 2020, 2022, and 2024, there were 3 publications, while in 2021 and 2023, 2 studies and 4 respectively. The findings demonstrate a rise in interest in sustainability in the dairy sector in Kenya. Nonetheless, there have been constant variations, which show that more studies are required to be done in the dairy sector and its alignment with sustainable development goals. Kenya’s dairy sector is largely small scale where individual households own few animals for milk production. Therefore, less focus is given to sustainable development in the sector.

Most Relevant Sources

The study further examined the most relevant sources based on the number of articles published per annum. The results are shown in *Figure 3*.

Figure 3. Most Relevant Sources



The most relevant sources were examined to identify journals with the most publications in Kenya's dairy sector sustainability. The Livestock Research for Rural Development and Sustainability Journal had the most publication with three articles each. On the other hand, Agriculture, Ecosystems, and Environment, Climate Change, Gender Technology and Development, and International Journal of Agricultural Sustainability had the second greatest number of articles with two publications each. Lastly, the Agribusiness, Agricultural Systems, Biological Agriculture and Horticulture, and East African Journal of Science Technology had the least number of articles, one. These findings show that the sustainable development goals in Kenya's dairy sector have been studied across different scholarly areas and disciplines. However, agriculture and sustainability journals are the most predominant sources exploring sustainability development in Kenya's dairy sector.

Sources Local Impact

The study further explored the local impact of journals using H index. The H index is a widely used measure of scientific output of a research journal or author. The *table 2* shows the H index of the top ten journals that have published studies on Kenya's dairy sector and sustainable development goals.

Table 2. Sources Local Impact

| Element | H_Index |
|------------------------------------------------------|---------|
| Livestock Research for Rural Development | 3 |
| Agriculture, Ecosystems and Environment | 2 |
| Climatic Change | 2 |
| Gender, Technology and Development | 2 |
| International Journal of Agricultural Sustainability | 2 |
| Sustainability (Switzerland) | 2 |
| Agribusiness | 1 |
| Agricultural Systems | 1 |
| Biological Agriculture and Horticulture | 1 |

The journal of Livestock Research for Rural development has the highest H index (3). Moreover, the Agriculture, Ecosystems and Environment, Climate Change, Gender, Technology and Development, International Journal of Agricultural Sustainability, and Sustainability Journal have the second largest H index (2). The rest have an H index of 1. These findings imply that the articles on sustainable development of the dairy sector in Kenya that are published in the top ten sources have at least a single citation. It is worth noting that sources that appeared among the top 10 in *Figure 3* have not appeared in the similar rank in sources local impact. Therefore, the impact of a research journal in each area of study is effectively measured by the H index, as it measures both the impact and quantity of a scientific output.

Author Impact

The study further examined the impact of the author relative to their citations and H index. The results are shown in *Table 3* and *Table 4*.

Table 3. Author Impact

| Element | H_Index |
|----------------|---------|
| Rufino Mc | 4 |
| Baltenweck I | 3 |
| Brandt P | 2 |
| De Neergaard A | 2 |
| Franzel S | 2 |
| Herold M | 2 |
| Kiptot E | 2 |
| Montcho M | 2 |
| Oelofse M | 2 |
| Omondi I | 2 |

Rufino has the highest H index score,4, followed by Baltenweck with an index of 3. The rest have an H index of 2. The scores imply that the top ten authors on sustainable development goals and the dairy sector in Kenya have an H index that is more than 2. This infers that 2 of their papers have at least two citations. A further review of their publications shows that they are drawn from different research specializations, such as climate change, livestock production, agricultural economics, and sustainability. Therefore, exploring sustainable development goals in Kenya’s dairy sector requires a multidisciplinary approach and collaboration between scholars from varying areas of study.

Most Cited Sources

Table 4 shows the most cited sources, total citations, and total citation per year. Herrero (2014) has the most total citations, 95 and total citation per year of 8.64. Alvarez (2014) has 46 total citations and 4.18 total citations per year followed by Ranjitkar (2020) with 35 total citations and 7.00 total citations per year. The top three most cited sources have more than 35 total citations. However, the total citations per year vary because it is the average number of citations computed by dividing total citations by the number of years the author has been publishing papers. Authors with more years may have lesser total citations per year, while those with less years but have more citations have a high total citation per year. The high citation shows that sustainability in Kenya’s dairy sector is under consideration, and it is drawing scholarly interest as the world grapples with the effect of climate change, which has largely impacted sub-Saharan Africa.

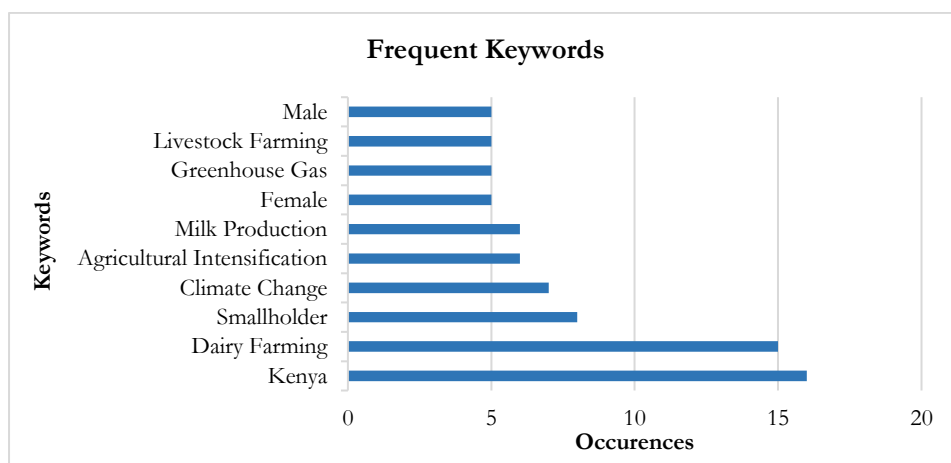
Table 4. Most Cited Sources

| Paper | TC | Tc/Year | Findings |
|----------------------------------------------|----|---------|-----------------------------------------------------------------------------------------------------------------|
| Herrero M, 2014, Global Environ Change | 95 | 8.64 | Dairy expansion in Kenya is viable when land is abundant |
| Alvarez S, 2014, Agric Syst | 46 | 4.18 | Dairy productivity can be enhanced by use of concentrate feeds and improving manure management practices. |
| Ranjitkar S, 2020, Clim Change | 35 | 7.00 | Heat stress induced by climate change affects milk production |
| Ortiz-Gonzalo D, 2017, Agric Ecosyst Environ | 31 | 3.88 | Diversification and better commercialization can improve the productivity of small dairy farms. |
| Wetende E, 2018, Environ Dev | 28 | 4.00 | Facilitating easy access to technology on climate change can enhance dairy productivity and climate adaptation. |
| Brandt P, 2018, Agric Ecosyst Environ | 25 | 3.57 | Intensifying small holder dairy farming sustainably reduces forest disturbance. |
| Kiptot E, 2016, Int J Agric Sustainability | 23 | 2.56 | Adopting volunteer farmer trainer approach helps in disseminating livestock feed innovations |
| Omondi I, 2017, Agribusiness | 23 | 2.88 | Incorporating technology cuts cost, enhances innovativeness, and creates a broader competitors' line. |
| Ortiz-Gonzalo D, 2018, Sci Total Environ | 22 | 3.14 | Greenhouse gases emission remained low despite intensification in zero grazing. |
| Brandt P, 2020, Global Change Biol | 20 | 4.00 | Improving the quality of dairy feeds can have climate change mitigation |

Most Relevant Keyword

The study examined the keywords to identify scholars' areas of interest and trends in sustainable development and dairy sector in Kenya. The results are shown in *Figure 4*.

Figure 4. The Most Relevant Keyword



The top ten most relevant keywords from the analysis are Kenya, dairy farming, smallholder, climate change, agricultural production, milk production, female, greenhouse gas, livestock farming, and male. Kenya and dairy farming are predominant because the study focuses on dairy farming in Kenya and its relationship with sustainable development goals. Small holder appears in the list since Kenya's dairy sector is mainly small scale and practiced in the rural region. Moreover, climate change is a critical subject associated with sustainable development goals.

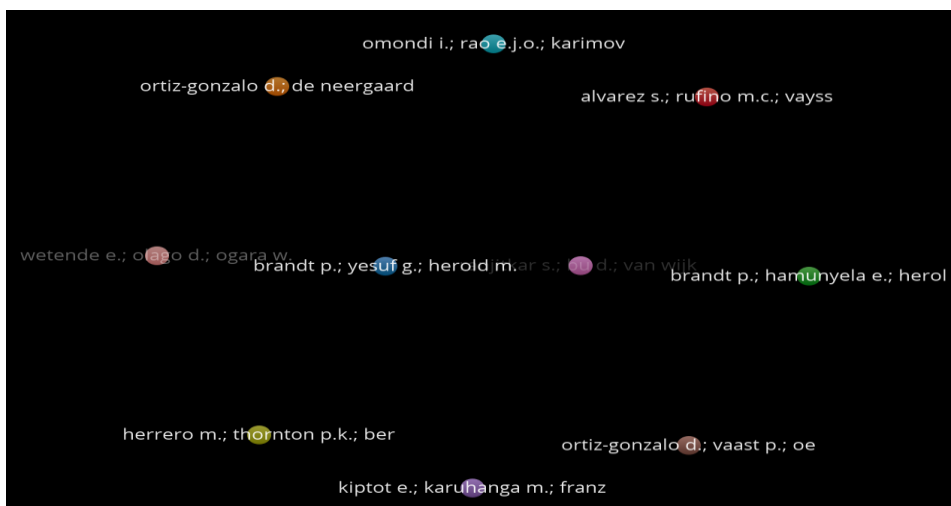
Climate change has adversely impacted sub-Saharan Africa and scientists' interest has been drawn to identify mitigation and adaptation strategies. Agricultural and milk production are related to Kenya's focus to increase agricultural production in rural areas and address poverty as stipulated in the country's Vision 2030. As the production rises, the negative consequences of growth, such as greenhouse gases emission, land dereliction, climate change among others are likely to increase, which explains the appearance of greenhouse gases among the top ten most relevant keywords from the analyzed studies. The ownership of income generating projects at household level in developing countries has been a subject of discussion among scholars. The male and female ownership of key economic resources and its impact on household productivity and poverty is widely examined to identify possible approaches to address poverty. Since milk production is a common source of livelihood in rural areas, which are predominantly poor and patriarchal, the ownership of dairy animals and control of economic benefits varies between women and men in a family set up.

Co-authorship

The study analyzed co-authorship to examine the collaborative relationship between authors who have worked together on research publications, which provides insight into the structure of scientific collaboration, understand the dynamics of research networks in dairy farming and sustainability in Kenya, and identify influential research. *Figure 6* shows co-authorship from the analysis of Kenya's dairy sector relative to sustainable development goals.

The result shows multiple co-authorship between scholars in dairy sector and sustainable development goals in Kenya. The key researchers are Brandt and Herold, who have co-authored multiple publications in dairy sector and sustainable development in Kenya. Brandt has co-authored numerous publications with Yesuf, Herold, and Hamunyela. Other co-authors are Herrero and Thornton, Ortiz and Vaast, Kiptot and Franz, Alvarez and Rufino, and Omondi and Karimov. Notably, only three scholars are Kenyans, but they have co-authored with scholars from other countries. Therefore, while global research collaboration is essential in a research area, local collaborations are equally important to address sustainable shortcomings in dairy sector in Kenya. The limited scholarly works in dairy sector and local collaboration shows Kenya's lower research output in the sector. Consequently, there is a need to scientifically examine problems and opportunities in the dairy sector in relation to sustainable development goals to achieve sustainable long-term growth in the dairy sector.

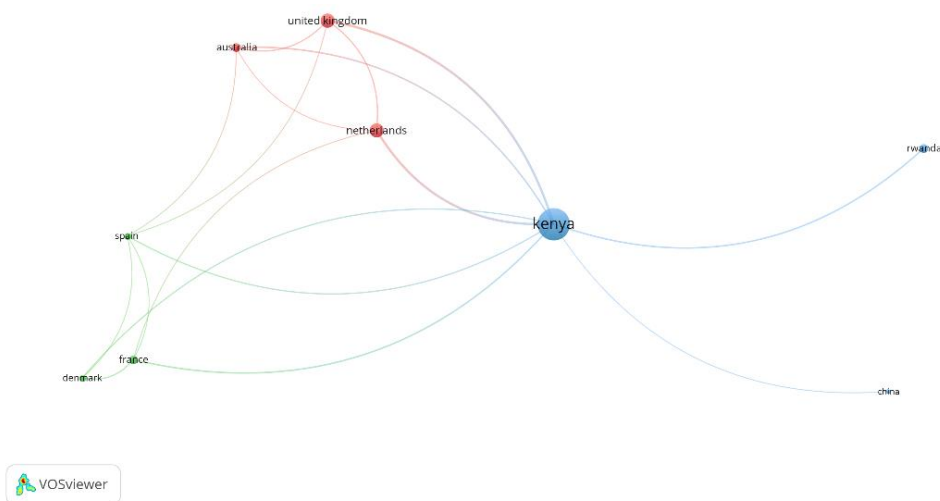
Figure 6. Co-authorship



Bibliographic Coupling of Countries

The study further examined the bibliographic coupling of countries to analyze and visualize the relationship between countries based on their citation networks and scholarly publications. The results are shown in *Figure 7*.

Figure 7. Bibliographic Coupling of Countries



The results show that Kenya is central in the network and leading in research on dairy sector and sustainable development goals. Other countries in the network are Netherlands and United Kingdom. They are the leading countries in the research

on Kenya's dairy sector and sustainable development. This is evidenced by long-term collaboration between Kenya, United Kingdom, and the Netherlands. Other countries in the periphery are Spain, France, Denmark, China, and Rwanda. Kenya and Rwanda are within East Africa and the only countries in Africa that authors have collaborated as shown in *Figure 7*.

CONCLUSIONS

Since the enactment and ratification of the Sustainable Development Goals (SDGs), the number of studies on dairy farming sustainability in Kenya has shown a marked increase over time, albeit with significant variations. This trend demonstrates a growing interest in sustainability within Kenya's dairy sector, though the consistent variations indicate a need for more focused and sustained research to align the sector with the SDGs.

Kenya's dairy sector is predominantly small-scale, with individual households typically owning a few animals for milk production. The examination of relevant sources reveals that the SDGs related to Kenya's dairy sector have been explored across various scholarly disciplines, with agriculture and sustainability journals being the predominant sources. Notably, the top researchers in this field, such as Rufino with an H-index of 4, and Baltenweck with an H-index of 3, come from diverse research backgrounds including climate change, livestock production, agricultural economics, and sustainability, highlighting the multidisciplinary nature of research required to address sustainability in Kenya's dairy sector. While there is a rising trend in research focusing on sustainability in Kenya's dairy sector, the variation in the number of studies over the years and the predominant focus on production underscore the need for a more balanced and sustained research effort.

The analysis reveals a close interconnection between dairy farming, smallholder livestock management, and sustainability, indicating their frequent co-occurrence in the literature on Kenya's dairy farming sector. Agricultural intensification, including both traditional and sustainable approaches, emerges as a central theme within the research, reflecting a dual focus on increasing food production and ensuring long-term sustainability.

The co-authorship analysis offers insights into the collaborative dynamics among researchers focusing on Kenya's dairy sector and its alignment with SDGs. Key researchers such as Brandt, Herold, Herrero, Thornton and others have formed significant collaborative networks, indicating a strong foundation of scholarly partnerships. Further analysis of bibliographic coupling illustrates Kenya's central role in the research network on dairy farming and sustainable development goals, with significant contributions from the Netherlands and the United Kingdom. This long-term collaboration underscores the importance of international partnerships in advancing research. These findings highlight the critical role of both global and local collaborations in enhancing the research landscape and addressing the sustainability challenges of Kenya's dairy sector.

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