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Environmental Impacts of the Bioeconomy: A Systematic Review of Variables, Methods, Sectors and Policy Relevance

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ABSTRACT

The bioeconomy has become a component of sustainability strategies addressing climate change, resource scarcity and economic transformation. Despite a growing body of literature, evidence on the environmental impacts of the bioeconomy remains fragmented, heterogeneous and distributed across sectors and regions. This paper provides a systematic literature review of 432 peer-reviewed studies analysing the environmental dimensions of the bioeconomy, with attention to how environmental impacts are measured, and linked to economic and social outcomes. Articles published up to September 2023 were reviewed and analysed. The results show a rapid expansion of research over the past decade, strongly concentrated in Europe and a limited number of data-rich regions. Greenhouse gas emissions and land use emerge as the most frequently analysed environmental variables, while innovative sectors such as bioenergy and bioplastics dominate emission-related studies and traditional sectors such as agriculture and forestry prevail in land-use analyses. The review demonstrates that methodological and data choices, particularly life-cycle assessment, input–output and computable general equilibrium models, play a decisive role in how environmental impacts are evaluated and interpreted. Although environmental impacts are the primary focus, most studies combine environmental analysis with economic and, to a lesser extent, social dimensions, revealing both synergies and persistent trade-offs. Overall, the findings highlight that the bioeconomy is widely associated with decarbonisation and green growth, although land-based strategies remain linked to environmental trade-offs. These results underline the need for more integrated analytical approaches, data coverage and governance frameworks that balance bioeconomic development with environmental and social sustainability.

1 | Introduction

In recent decades, the effects of climate change have become increasingly evident on a global scale, with adverse impacts on food and water security, human health and socio-economic stability. These effects have been unequivocally attributed to human activities (Masson-Delmotte et al. 2021). Since the beginning of the industrial era, economic activity has significantly contributed to global warming, primarily through the emission of greenhouse gases. It is therefore crucial to reconsider the global production system for products and services. Achieving this requires rethinking the economic framework to integrate not only financial factors but also social and environmental dimensions at a global level.

This global challenge necessitates coordinated action from both public and private institutions. In 2015, the United Nations introduced the Agenda 2030, comprising 17 Sustainable Development Goals (SDGs), as the principal roadmap for promoting sustainable development (United Nations 2015). Sustainable

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development is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs (WCED 1987). Within this global sustainability agenda, the bioeconomy has emerged as a key priority area for achieving a sustainable economic model.

The European Commission (2025) defines the bioeconomy as 'the activities that deliver sustainable solutions based on biological resources to create added value. These include products, services, science and technologies benefiting sectors ranging from agriculture, forestry, fisheries and aquaculture to value chains based on biomass processing, biomanufacturing and biotechnologies such as in food, health, energy, industry, ecosystem and other services.

The bioeconomy is emerging as a pivotal catalyst for the future development of production models and for fostering economic growth. It plays a key role in the global transition towards a more sustainable economic framework, supported by proactive policy interventions. Consequently, many regions and nations have developed their own strategies with the objective of promoting a more sustainable economy, with particular emphasis on the bioeconomy.

In Europe, the European Green Deal, launched in 2020, has the primary objective of transforming the European Union (EU) into a modern, resource-efficient and competitive economy, aiming to achieve climate neutrality by 2050 (European Green Deal 2019). Specifically, the EU launched its bioeconomy strategy in 2012, which was later updated in 2018 and 2025 (European Commission 2012, 2018, 2025). Similarly, several nations across the globe have developed their bioeconomy strategies, exemplified by initiatives such as 'The Bioeconomy to 2030: Designing a Policy Agenda' (2009) by the OECD (OECD 2009); the 'National Bioeconomy Blueprint' (2012) in the United States (The White House 2012); the 'National Policy Strategy on Bioeconomy' (2020) in Germany (Federal Government of Germany 2020); the 'Finnish Bioeconomy Strategy' (2014) in Finland (Ministry of Environment 2014) and the 'Spanish Bioeconomy strategy–2030 Horizon' (2016) in Spain (Gobierno de España 2016), among others. Actually, over 50 countries across the world have adopted bioeconomy strategies (Goritz et al. 2026).

The bioeconomy offers a sustainable model for production that supports economic development while integrating social and environmental concerns, addressing current ecological threats such as climate change, deforestation, water acidification and greenhouse-gas emissions. However, despite its clear benefits, the bioeconomy is not without its controversies (Ramcilovic-Suominen and Pülzl 2018).

The principal concern associated with the expansion of the bioeconomy pertains to the potential adverse impact of using food and feed crops to produce non-food bio-based products, which could affect food availability and subsequently result in an increase in food prices, thereby compromising food security. Furthermore, considering the country where the crops are produced, the effects of the bioeconomy in a region such as the EU can extend to other regions of the world, resulting in a global impact that is challenging to quantify. This is due to its heterogeneous and geographically dispersed effects (Bruckner et al. 2019).

Over the last decade, a growing number of systematic literature reviews (SLRs) have examined the bioeconomy from different perspectives, including innovation dynamics, circular economy linkages, institutional and policy dimensions, and sustainability transitions. While these reviews provide valuable insights into the evolution of the bioeconomy concept and its economic and institutional dimensions, less attention has been paid to how environmental impacts are defined, measured and compared across studies, and to how methodological choices influence the sustainability narratives emerging from this literature. In particular, existing reviews rarely offer a systematic comparison of environmental variables, analytical approaches, sectoral coverage and geographical focus, nor do they critically reflect on how these dimensions influence the interpretation of environmental performance and the policy relevance of bioeconomy research.

Beyond conceptual and policy discussions, recent research has increasingly focused on measuring and comparing bioeconomy performance across countries and regions. For example, D'Adamo et al. (2020) developed a socio-economic indicator to assess the performance of bioeconomy sectors across European countries, which was later applied to specific regional contexts such as Italy (D'Adamo et al. 2022). These studies contributed to addressing gaps in the monitoring of bioeconomy development and enabled comparative analyses across territories. However, due to data availability constraints, the proposed indicators did not incorporate environmental dimensions. More recently, subsequent studies have examined the role of institutional quality in shaping bioeconomy performance (Barra and Falcone 2024a, 2024b). Together, these contributions highlight the importance of institutional capacity and governance in supporting bioeconomy development. Nevertheless, much of the existing measurement literature remains primarily focused on socio-economic performance, while the environmental dimensions of the bioeconomy continue to be comparatively underexplored.

The aim of this article is to provide a systematic review of the environmental dimensions of the bioeconomy while moving beyond a purely descriptive mapping of the literature. Specifically, the study examines how key environmental variables, such as greenhouse gas emissions, land use, biodiversity and water use, are conceptualised, measured and linked to economic and social outcomes across sectors, regions and analytical frameworks. By critically analysing how methodological choices, sectoral focus and geographical focus influence reported environmental impacts, this review identifies structural patterns, trade-offs and potential biases in current bioeconomy research. In doing so, the paper contributes to a more nuanced understanding of how environmental evidence on the bioeconomy is generated and interpreted and discusses the implications of these patterns for sustainability governance and policy-oriented research.

This paper is structured as follows. Section 2 outlines the SLR methodology and explains the scope and analytical choices adopted. Section 3 presents the findings of the review. Section 4 discusses the implications of the results and Section 5 concludes by summarising the main findings, outlining the study's limitations and identifying directions for future research.

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2 | Methods and Data Collection

2.1 | SLR

This paper follows the methodology of a SLR. The literature review is a crucial component of research, providing insights into the current status of the literature and facilitating a deep understanding of the topic under analysis (Tranfield et al. 2003). It also allows the identification of important issues and gaps in the literature, thus guiding future research lines (Kraus et al. 2022). Systematic reviews differ from traditional narrative reviews by following a specific methodology for searching and identifying publications on a topic with a high level of objectivity (Fisch and Block 2018; Kraus et al. 2020; Li et al. 2024; Beisenbina et al. 2023; Nelson et al. 2023).

In recent years, SLRs have been applied in many fields of management and economics, including human resources (Marin-Zapata et al. 2022), bioeconomy and circular economy (Ferreira et al. 2018, 2022), marketing (Rahman and Kamboj 2017), rural coworking (Sánchez-Vergara et al. 2023), sustainable development (Barberà-Mariné et al. 2024) and sustainable finance (Beisenbina et al. 2023). The SLR method used for this study follows a combination of steps: Identification, Screening and Eligibility, as illustrated in Figure 1, in line with the recommendations from Kraus et al. (2020), Tranfield et al. (2003) and Williams et al. (2021). Following this structure, a high-quality objective review that can be replicated by other researchers can be obtained. To complete the SLR it is necessary to describe the methodological selection and exclusion criteria following Fisch and Block (2018). The tool used to define this SLR is the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), which is a commonly used method for this type of literature (Figure 1) (Moher et al. 2009; Page et al. 2021).

2.2 | Scope and Analytical Choices of the Review

The scope of this review is focused on the environmental dimensions of the bioeconomy. This analytical choice is grounded in existing literature, which consistently identifies environmental variables as policy-relevant dimensions in bioeconomy impact assessments (Ferreira et al. 2022). In particular, previous studies highlight greenhouse gas emissions (GHG), land use, biodiversity and water use as the core environmental variables

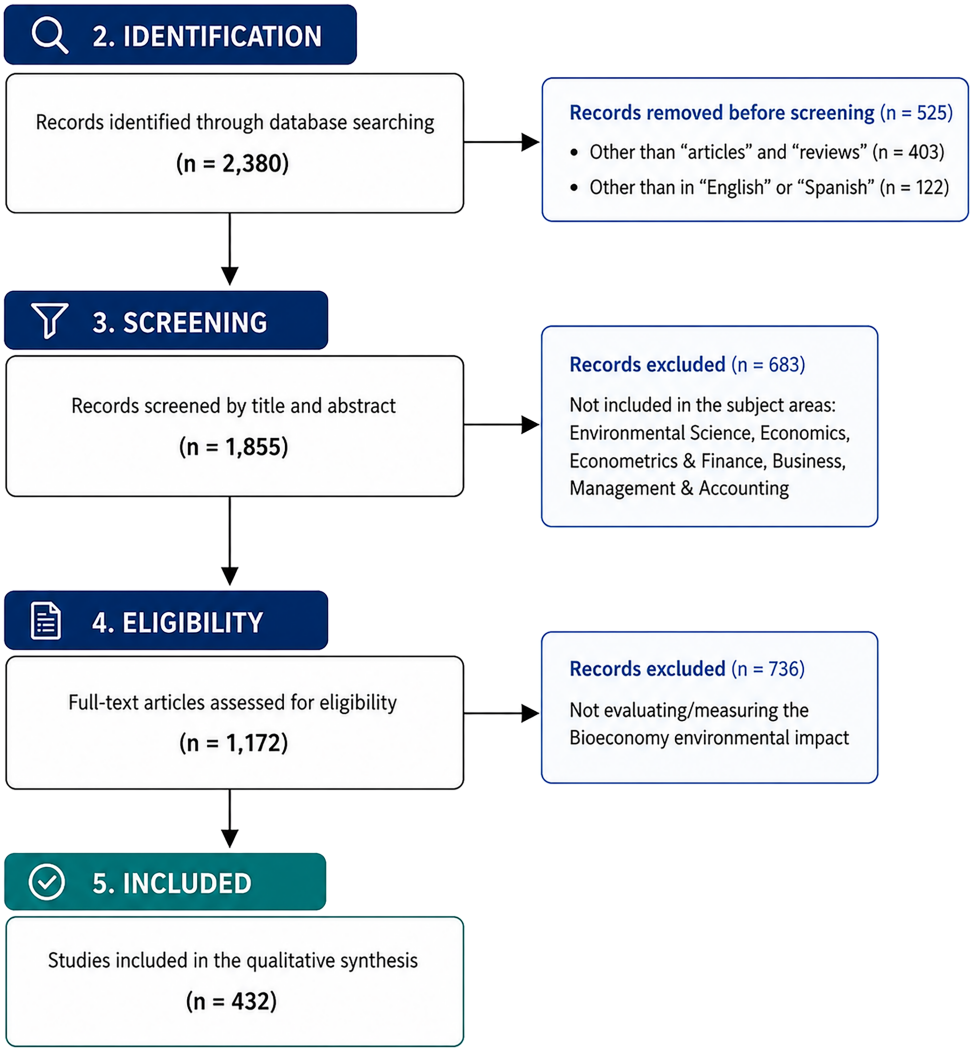


FIGURE 1 | PRISMA flowchart: Description of the search process. *Source:* Authors' elaboration based on Page et al. (2021).

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used to evaluate the sustainability implications of bioeconomy activities.

With regard to GHG emissions, prior research has analysed impacts across different national contexts, such as Brazil (de Souza Ferreira Filho 2013), the Netherlands (Hoefnagels et al. 2013) and the Baltic region (Brizga et al. 2019), as well as across sectors including biomass (Bais-Moleman et al. 2018), bioplastics (Spierling et al. 2018) and bioenergy and biochemicals (van Meijl et al. 2018). In terms of land use, studies have focused on regions such as the EU (Bruckner et al. 2019; de Jong et al. 2018), individual countries such as Botswana (Kgathi et al. 2012) and sectors including bioplastics (Escobar et al. 2018; Escobar and Britz 2021), forestry (Haddad et al. 2019), bioenergy (Hertel et al. 2013) and biochemistry (Nong et al. 2020).

As evidenced by the literature, these variables represent the primary focus of debate in studies addressing the environmental impacts of the bioeconomy (Escobar et al. 2018; Ferreira et al. 2022; Nong et al. 2020). Focusing on these variables allows for a systematic comparison of how environmental impacts are conceptualised and assessed across sectors, regions and methodological approaches.

2.3 | Data Collection

Following the PRISMA method, keywords were entered in Scopus to have an initial number of documents. Scopus is a scientific database that offers the advantage of covering a larger number of scientific publications compared to, for instance, the Web of Science (WoS) (Gusenbauer and Haddaway 2020), and it is more transparent in its content selection than, for instance, Google Scholar (Gusenbauer and Haddaway 2020; Martín-Martín et al. 2021).

The keywords selected for this review include 'bioeconomy' as the primary topic and its main environmental variables such as climate change, emissions, greenhouse gases, land use, water use, biodiversity, ocean acidification and deforestation. To ensure the inclusion of papers related to these topics but using different terminology, specific variations of keywords were utilised, including:

- (TITLE-ABS-KEY ("bioeconom*" OR "bio-econom*" OR "bio econom*" OR "biobased econom*" OR "bio-based econom*" OR "bio based econom*") AND TITLE-ABS-KEY (ghg* OR "Greenhouse gas*" OR emission* OR co2 OR carbon OR "land use*" OR "land AND footprint" OR biodiversity OR water OR deforestation OR ecosystem OR "resource efficiency" OR footprint OR climate AND change OR sustainability OR "sustainable development"))

After this screening process, an initial number of 2380 publications were obtained (last search conducted on September 29th of 2023). In the second step, the initial number was filtered to include only documents in English or Spanish and limited to articles or reviews, resulting in 1855 papers. Subsequently, the third step related to the subject area was taken, limiting the search to the fields of 'Economics, Econometrics and Finance', 'Business, Management and Accounting' and 'Environmental Science', obtaining 1172 papers. These papers constitute the initial sample for the literature review.

Following the creation of this initial sample, a manual review was carried out to select the most relevant articles for inclusion in the final sample. In this selection, articles analysing the relationship between the bioeconomy and the selected environmental keywords were included, while articles mainly describing a specific method, technologies, specific tool or organic product and their applications were excluded. After completing the review of the initial sample, the final sample of 432 articles was obtained.

These papers provide a comprehensive overview of the current state of the bioeconomy, its connection with the main environmental variables, and enable researchers to conduct a descriptive and content analysis of the bioeconomy and its environmental impacts.

3 | Results and Analysis

This section presents the results of the SLR, starting with a descriptive analysis of the selected literature, followed by a content analysis aimed at categorising the results by study topic and identifying dominant patterns, trends and key thematic contributions in the publications.

3.1 | Descriptive Analysis

Of the total number of publications obtained, Figure 2 illustrates a notable increase since 2012, underscoring the significance of literature focused on the bioeconomy and its associated economic, social and environmental impacts. Consequently, the last decade (2014–2023) represents 90% of the total publications, indicating the recent evolution of the topic, with a notable 47% of articles published since 2021. This trend underscores the continuing and growing interest of the research community in the topic and highlights its potential as a significant tool for future research and public policy decisions.

Among the most influential contributions within the reviewed sample are original articles that have helped shape conceptual and analytical debates on the bioeconomy, such as Bugge et al. (2016) and Stegmann et al. (2020). These works are frequently referenced across subsequent studies and reflect the consolidation of the bioeconomy as a relevant field of research.

These publications are distributed among 169 journals, of which 110 (65%) have only one publication, indicating a broad distribution of research on this topic. The top 10 journals by publication volume account for 182 papers, representing 42% of the total sample and demonstrating a significant concentration of articles in a limited number of journals.

3.2 | Content Analysis

3.2.1 | Analysis of the Sectors and Regions Studied

The initial step involved an examination of the economic activities studied in each article. At the primary level, economic activities are categorised into primary, secondary and tertiary sectors.

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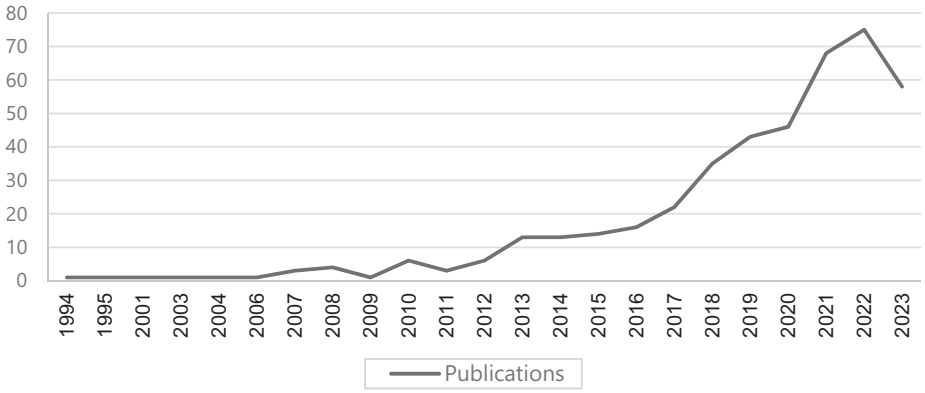


FIGURE 2 | Evolution of bioeconomy-related literature (2010–2023). *Source:* Authors' elaboration based on Scopus data.

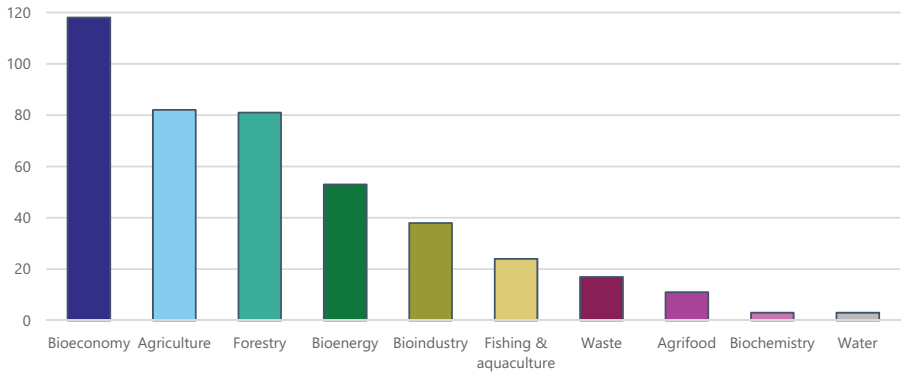


FIGURE 3 | Main economic sectors analysed. *Source:* Authors' elaboration.

At the secondary level, a number of sectors are included within each of the initial activities. Examples of these sectors include agriculture, agri-food, forestry, fishing and aquaculture, as well as bioenergy and bioindustry. In addition, the bioeconomy was included as a sector to encompass those papers that undertake a comprehensive analysis of the entire bioeconomy.

This classification allows an assessment of how different bioeconomy-related activities are addressed in terms of their environmental impacts, rather than assuming a uniform effect of the bioeconomy across sectors.

The findings indicate that the study of the entire bioeconomy, which represents 27% of the total sample, is a prominent area of focus. Agriculture and forestry are particularly significant sectors, representing 19% of the sample each, while bioenergy and bioindustry account for 12% and 9% respectively. Other sectors with less representation include fishing and aquaculture, waste and agri-food. This uneven sectoral distribution suggests that environmental impact assessments of the bioeconomy tend to prioritise land- and biomass-intensive activities, potentially overlooking other relevant sectors. Figure 3 illustrates the distribution of the economic sectors within the sample.

Subsequently, a geographical distribution analysis was conducted to examine the countries, regions or land/water areas (i.e., Sahara, Baltic Sea, Himalaya, Mediterranean Sea) covered in the reviewed papers (Figure 4). Most of the articles focus on Europe (12%), with Germany accounting for 7% of the total, followed by France and Italy, representing 4% and 3% respectively. These values are not mutually exclusive, as several studies cover multiple countries or regions.

Beyond Europe, Brazil emerges as a frequently studied case (4%), followed by the United States (2%). In addition, a notable number of studies focus on Northern European countries such as Finland, Sweden and Norway, often grouped under the Nordic region. This concentration reflects the strong research interest and data availability related to forestry, land use and bio-based industries in these countries, rather than an exclusive environmental significance when compared to other biodiverse regions.

Overall, the results indicate that bioeconomy-related environmental impact research is geographically concentrated in a limited number of regions, which may influence the generalisability of findings and the formulation of globally relevant sustainability and policy conclusions.

3.2.2 | Analysis of the Impact of Bioeconomy and Its Main Variables Studied

The documents identified in this literature review focus on studies of the economic, social and environmental impact of the bioeconomy, or a combination thereof. For instance, an article may examine the economic and environmental impacts, the

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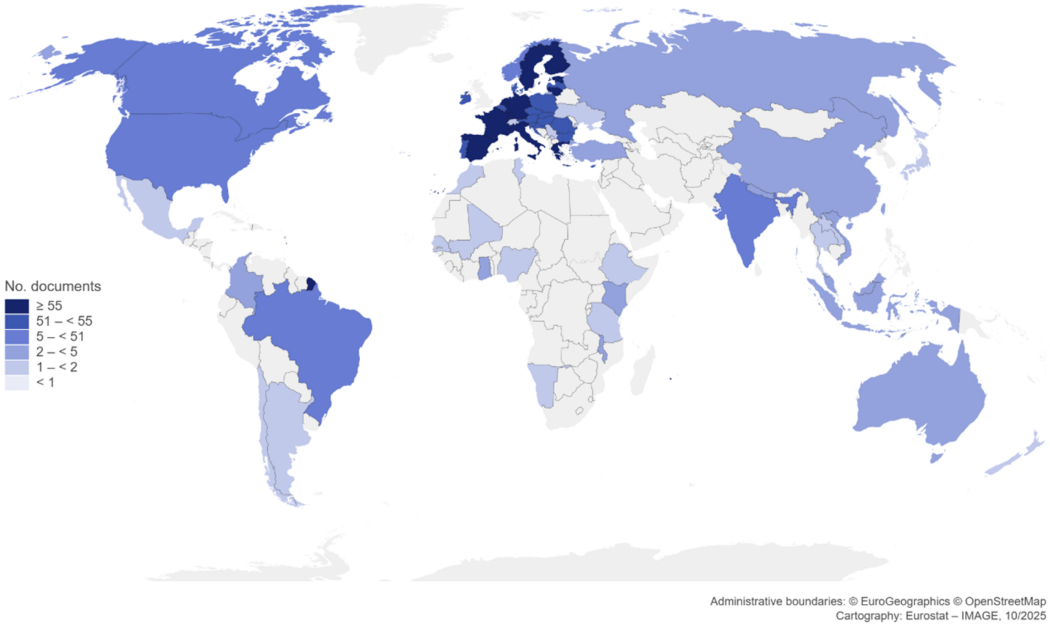


FIGURE 4 | Geographical distribution of the studies analysed. *Source:* Authors' elaboration using IMAGE from Eurostat.

TABLE 1 | Classification of studies by impact type.

Impact	No. of documents
Environmental, economic and social	157
Environmental and economic	154
Environmental	66
Environmental and social	55
Total	432

Source: Authors' elaboration.

environmental and social impacts, or the economic, social and environmental impacts. Considering these combinations, the analysed articles can be classified into different categories according to the impacts studied, as presented in Table 1.

In general, most studies focus on analysing the economic, social and environmental impact, or solely the economic and environmental impact. The results demonstrate that when the focus of the study is on the environmental effect of the bioeconomy, it is often combined with an analysis of the economic and social effect. This indicates that environmental impacts are rarely assessed in isolation, but rather as part of broader sustainability assessments in which the bioeconomy is treated both as a driver of change and as a system whose performance is shaped by economic and social dynamics. This is a significant consideration in the study of the bioeconomy, as an effective approach necessitates an understanding of sustainability that encompasses a comprehensive examination of the causes and consequences associated with it.

In terms of variables, a variety of variables have been used to assess the impact of the bioeconomy at different levels. Given that this review focuses on studies addressing environmental impacts, the most frequently employed variables have been identified. In this regard, 'climate change' is the most significant, with 31% of the articles, followed by 'GHG' and 'land use', with 28% and 20% of the papers, respectively (see the first graph in Figure 5). These variables primarily capture pressure-oriented environmental outcomes associated with production and land-based bioeconomy activities, reflecting the dominant analytical focus of the literature.

In addition to the environmental analysis, several articles address the economic analysis as a secondary focus. The main economic variable present in 38% of the papers is 'output', followed by 'value added' with 16% of the papers. The second graph in Figure 5 illustrates the principal economic variables identified in the sample. The predominance of these aggregate economic indicators suggests that economic impacts are often assessed in terms of scale and growth effects, rather than distributional or structural dimensions.

Finally, it is notable that the analysis of social variables is the least frequent combination with environmental impact studies. The analysis of 'employment' is particularly prevalent, appearing in 10% of the articles, followed by 'food security' (7%) and 'human well-being' (6%). The third graph in Figure 5 depicts the key social variables identified in the sample. This comparatively limited integration of social variables points to an imbalance in sustainability assessments, in which social outcomes remain underrepresented relative to environmental and economic dimensions.

These three impacts are interrelated, as it is more common for specific variables to be linked with other variables depending on the specific topic of the paper. However, the nature and direction of these interlinkages are not always explicitly discussed in the reviewed studies, which may limit the interpretation of trade-offs and synergies associated with bioeconomy development.

Figure 6 illustrates the variables that are most frequently used, which are situated in the centre of the graph. These include

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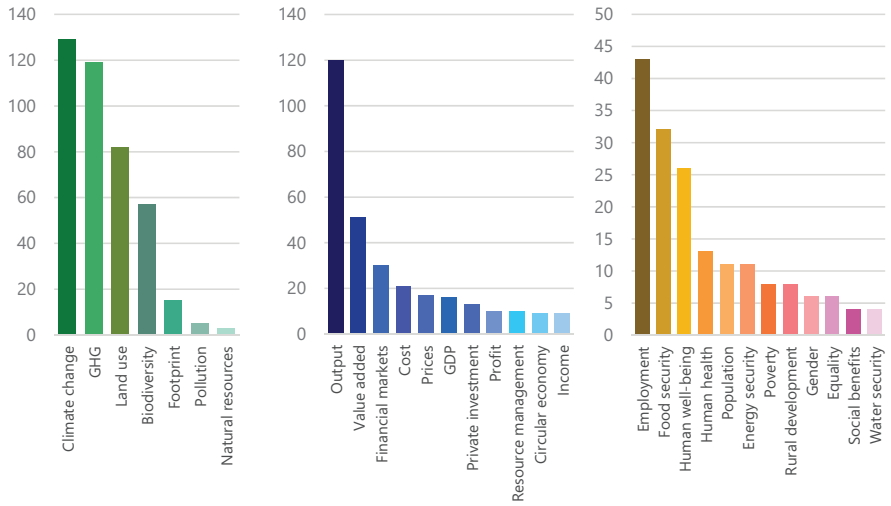


FIGURE 5 | First graph (main variables associated with environmental impact analysed), second graph (main variables associated with economic impact analysed), third graph (main variables associated with social impact analysed). Footprint refers mainly to land and carbon footprint. *Source:* Authors' elaboration.



FIGURE 6 | Keyword density visualisation of the Bioeconomy impact analysis variables by volume of appearance. *Source*: Authors' elaboration with VOSViewer.

climate change, GHG, land use, output, value added and biodiversity. Variables that are less prominent are situated in the boundaries of the graph, such as gender, rural development or pollution. This distribution highlights the concentration of research around a limited set of core variables, while broader social and environmental dimensions remain marginal in the literature.

Figure 7 presents the primary variables, illustrating the frequency of occurrences by volume of the bubble and the strength of the link by line thickness. Additionally, Figure 7 shows the year of publication of the variables, which are represented by different colours. The variables and their relative importance evolve over time in response to changing research interests. In recent papers, social variables such as equality and gender have gained prominence, while economic and environmental terms such as prices, resource management, land use and income have been more prominent in previous papers. This temporal evolution suggests a gradual, although still limited, broadening of sustainability perspectives within bioeconomy research.

Figures 8 and 9 provide a detailed visualisation of the keyword trend for the main environmental variables examined in the

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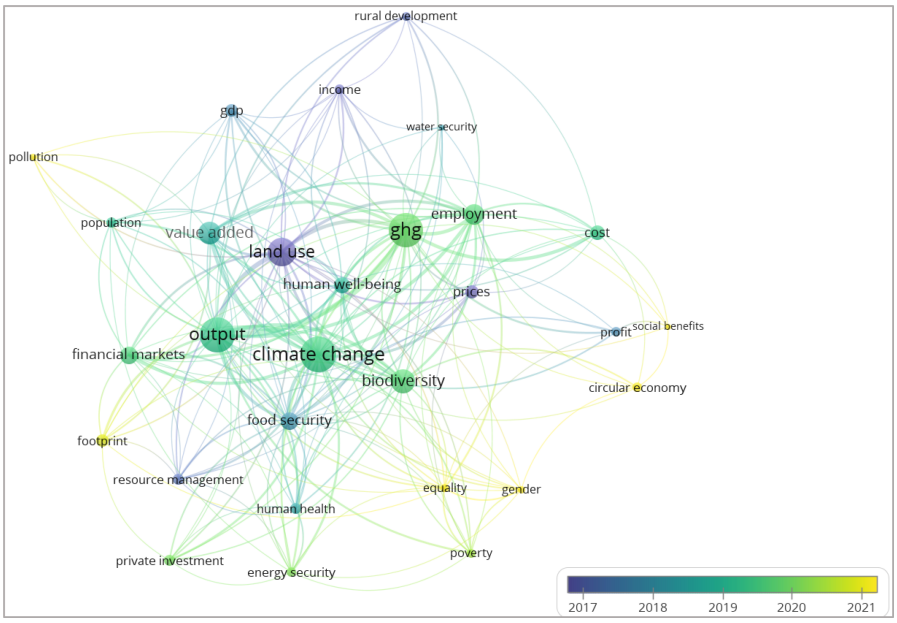


FIGURE 7 | Keyword trend visualisation of the Bioeconomy impact analysis variables. *Source:* Authors' elaboration with VOSViewer.

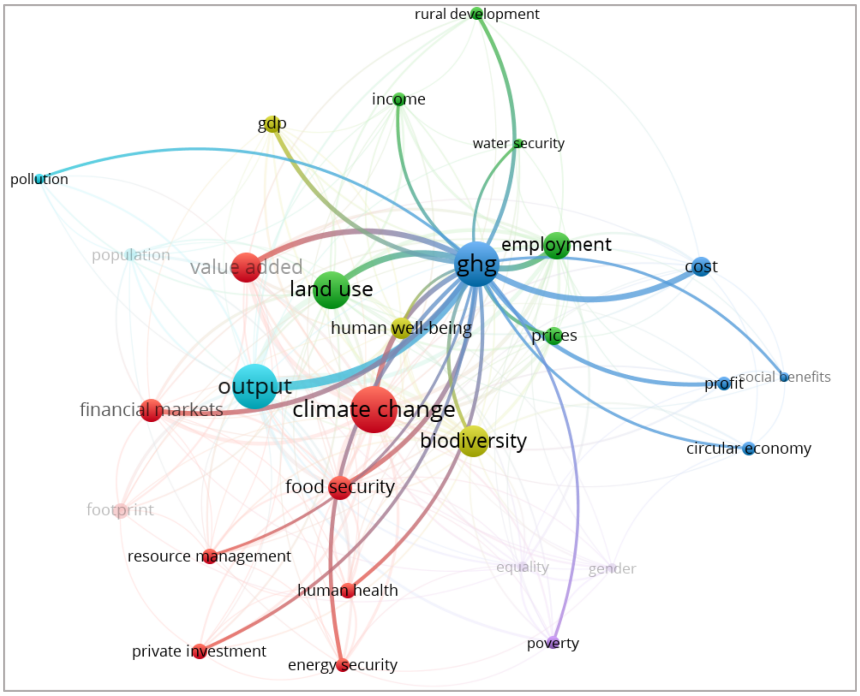


FIGURE 8 | Keyword network visualisation of the variable GHG. *Source:* Authors' elaboration with VOSViewer.

articles, namely GHG emissions and land use. Figure 8 illustrates the key links between environmental, economic and social variables and GHG. The most significant links are with the variables output, land use, value added and cost. Figure 9 shows the principal relations of the variable land use. The main links are with output, GHG, employment, value added and biodiversity. These linkages illustrate how environmental variables are predominantly connected to production-oriented economic indicators, reinforcing a growth-centred interpretation of bioeconomy impacts. Furthermore, Tables A1 and A2 present a comprehensive listing of specific articles from the sample that examine the variables GHG emissions and land use in the most frequently occurring sectors.

3.2.3 | Methodologies and Databases Used to Analyse the Bioeconomy

Different methodologies are employed in the documents within the sample. The most frequently mentioned methods include bioeconomic models, literature review, life-cycle assessment (LCA) (including life-cycle cost [LCC] and life-cycle sustainability assessment [LCSA]), computable general equilibrium (CGE) analysis, input–output (IO) models, multi-regional input–output (MRIO) and social accounting matrix (SAM) based models. These methodologies differ substantially in terms of system boundaries, geographical focus, data requirements,

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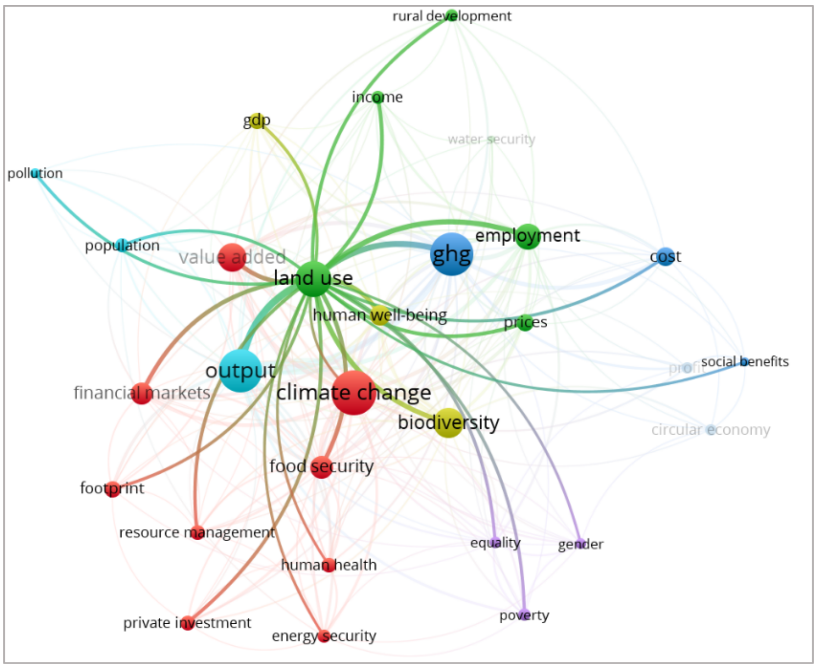


FIGURE 9 | Keyword network visualisation of the variable land use. *Source*: Authors' elaboration with VOSViewer.

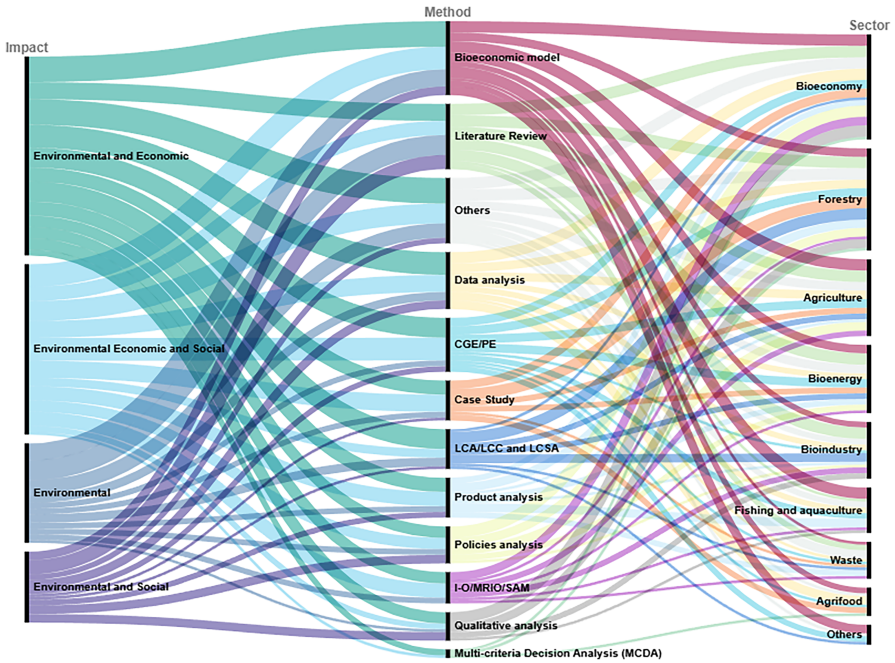


FIGURE 10 | Flow of articles across impacts, methods and sectors. *Source:* Authors' elaboration with RawGraphs 2.0.

and their capacity to capture indirect effects and trade-offs associated with bioeconomy activities.

As shown in Figure 10, when the analysis focuses on the environmental, economic and social impacts of the bioeconomy, the methods used are more diverse. However, when the focus is limited to environmental and economic aspects, bioeconomic models and LCA methods stand out. For studies addressing only environmental impacts, literature reviews are the most common approach, while analyses combining environmental and social impacts predominantly use qualitative methods and literature reviews. This pattern suggests that more integrated sustainability assessments tend to rely on modelling approaches capable of linking multiple dimensions, whereas narrower environmental assessments often adopt descriptive or review-based methodologies.

Once the methodologies have been identified, the databases used to analyse the bioeconomy and its impact are detailed. Bibliographic databases such as Scopus or WoS are the most commonly used for literature reviews. Papers employing other methodologies like IO and related methods (environmentally-extended

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TABLE 2 | Methodologies and databases employed for the analysis of the bioeconomy.

Impact	Methodology	Database	Year
Environmental and economic	EEIO	US Environmental Protection Agency	2002–2017
	Input–output	Eurostat, German Federal Statistical Office	2008–2016
	Input–output, MRIO	EXIOBASE	2011–2015
	Input–output, land use modelling	EXIOBASE, Eurostat, Faostat	1995–2011
	MCDA, input–output	Statistics Norway	
Environmental economic and social	Input–output	Northeast Fisheries Science Center bottom trawl survey, NEFSC commercial fisheries database	1963–2004
		DANE (Colombian statistical institute)	2017
		Statistical Offices of Slovakia, Czechia, Poland and Hungary	2015
		EXIOBASE	2007
	LCA, MRIO	EXIOBASE	
	MRIO CGE	EXIOBASE, FAO, IEA	1990–2018
	MRIO	EXIOBASE	
	SAM	Andalusia SAM from Instituto de Estadística y Cartografía de Andalucía	2016
Environmental	MRIO	EXIOBASE	1995–2015
	Input–output	FABIO	1986–2013

Source: Authors' elaboration.

input–output [EEIO], MRIO, CGE, SAM) commonly use databases such as EXIOBASE and food and agriculture biomass input–output (FABIO), or national statistical institutes such as Eurostat, the German Federal Statistical Office and the US Environmental Protection Agency. The choice of database is closely linked to the selected methodology and influences both the geographical coverage and the level of sectoral detail achievable in the analysis.

Table 2 represents a sample of methodologies and databases classified by impact and including the years of the study. Moreover, Table S1 provides a detailed listing of specific articles from the sample. Taken together, these results highlight that methodological and data choices are not neutral but play a decisive role in shaping how environmental impacts of the bioeconomy are quantified and interpreted.

3.2.4 | Identification of the SDGs Analysed

As mentioned in the introduction, the 17 SDGs (United Nations 2015) are closely related to the bioeconomy. Accordingly, some articles have analysed the impact of the bioeconomy on specific SDGs, such as Goal 2 on food security and sustainable agriculture, Goals 8, 9 and 12 focusing on sustainable economic growth and consumption, Goal 7 on ensuring accessible and sustainable energy, Goal 13 on combating climate change and Goal 15 focusing on biodiversity (Dietz et al. 2018; Shutes et al. 2017).

In this review, the SDG analysis does not aim to assess policy performance or measure progress towards specific goals, but rather to identify how and to what extent SDGs are referenced or incorporated in bioeconomy-related environmental impact studies. This allows an examination of the alignment between bioeconomy research and the broader sustainability agenda.

It is therefore essential to identify which SDGs are most frequently addressed by research on the bioeconomy and its environmental impacts. Figure 11 shows that the most common goals are Goal 13—Climate Action (52%), Goal 17—Partnerships for the Goals (50%) and Goal 8—Decent Work and Economic Growth (49%). This distribution suggests a strong emphasis on climate-related outcomes and governance-oriented frameworks, while other SDGs linked to social inclusion or inequality receive comparatively less attention. This pattern is consistent with broader evidence linking governance and environmental sustainability reported by Atta and Sharifi (2024).

Overall, these findings indicate that SDG coverage in bioeconomy research is uneven, reinforcing the dominance of climate action and economic growth narratives and pointing to potential gaps in the integration of other sustainability dimensions.

4 | Discussion

The bioeconomy plays a pivotal role in both the current and the imminent future of the economy and the environment, promoting initiatives for the green transition, the circular economy, the energy transition and environmental economics. It is noteworthy that interest in the bioeconomy has surged in recent years, with a substantial concentration of publications in the last decade, evidencing its growing scientific relevance.

While the bioeconomy is conceptually grounded in a comprehensive approach to sustainability encompassing economic, environmental and social dimensions, research has predominantly focused on assessing its environmental impact (Ferreira et al. 2022). This review confirms that environmental considerations represent the dominant analytical entry point in bioeconomy research. Nevertheless, despite the primary emphasis on environmental aspects in the literature searches, it is common

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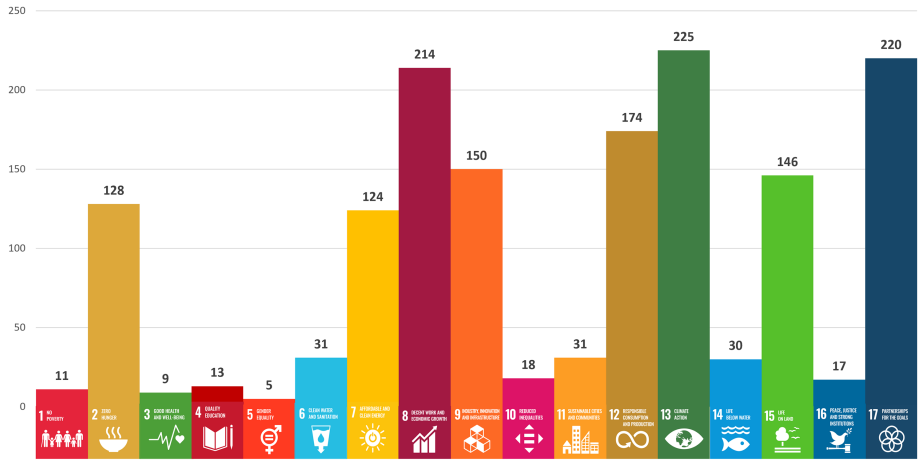


FIGURE 11 | Occurrence of the SDGs in the documents analysed. *Source:* Authors' elaboration.

for the research sampled to also include analyses of social and economic impacts. In fact, a significant proportion (36%) of the papers included in the study address all three impacts simultaneously, providing evidence of an emerging, though still uneven, integrated sustainability perspective on the bioeconomy.

4.1 | Methodological and Data Insights

In terms of the methodologies employed in the reviewed papers, the choice of method varies according to each study's specific objectives. However, the results of this review indicate that methodological choices are not neutral, as they shape both the type of environmental impacts assessed and the interpretation of sustainability outcomes. Similarly, the choice of databases employed in these studies plays a crucial role in determining the geographical scope, sectoral detail and types of variables that can be analysed (Valente et al. 2025).

The selection of databases is intricately linked to the methodologies employed, as researchers rely on specific data infrastructures to operationalise environmental, economic and social variables. As a result, methodological and data choices jointly influence the narratives that emerge regarding the environmental performance of the bioeconomy. Consequently, an understanding of the databases utilised is essential for contextualising both the scope and the limitations of the evidence base.

Overall, the relationship between methodologies and databases in bioeconomy research highlights the structural characteristics and constraints of the field, rather than merely reflecting technical preferences. Certain methods and databases privilege specific regions, sectors and impact pathways, which may contribute to the geographical and sectoral biases identified in the results.

In literature reviews focusing on the bioeconomy, the most commonly used databases include Scopus (Cerca et al. 2022; D'Amato, Gaio, and Semenzin 2020; Duque-Acevedo et al. 2020; Nakhate and van der Meer 2021) and WoS (Beuchelt and Nassl 2019; Gottinger et al. 2020; Velasco-Muñoz et al. 2021), which serve as primary sources for articles and provide broad disciplinary coverage. The predominance of these databases reinforces the role of peer-reviewed academic literature in shaping dominant perspectives on bioeconomy sustainability.

In studies that employ a multisectoral analysis of the bioeconomy and its environmental impact, researchers frequently utilise different modelling approaches, reflecting the complexity of capturing indirect effects, cross-sectoral linkages and trade-offs. These methodologies encompass IO analysis (Alviar et al. 2021; Brizga et al. 2019; Fay et al. 2019) and related methods such as EEIO analysis (Avelino et al. 2021), SAM-based models (Chabán-García and Hidalgo-Capitán 2023), MRIO (Egenolf et al. 2021), CGE modelling (Britz 2022) and partial equilibrium (PE) analysis (Hertel et al. 2013). Each of these approaches captures different dimensions of bioeconomy impacts, implying that results are method-dependent and not always directly comparable.

As previously indicated, these methodologies are directly related to the databases that researchers utilise, which are selected based on data availability, spatial resolution and sectoral coverage. EXIOBASE, for instance, is widely employed as a data source for multisectoral models due to its multi-regional and multi-sector structure, as illustrated by studies focusing on Europe (Vita et al. 2019), with a study based in Europe for 2007, Brizga et al. (2019) with research in the Baltic countries from 2011 to 2015 and Egenolf et al. (2021) with a study about Germany from 1995 to 2015. The FABIO database is employed in studies utilising CGE, as evidenced by Britz (2022), which analyses the impact of climate change, and IO, as demonstrated by Wang et al. (2023), which studies the impact of land use. The databases from the Global Trade Analysis Project (GTAP) and the Modular Applied General Equilibrium Tool (MAGNET) are employed for the analysis of different sectors (van Meijl et al. 2018) and different countries (Nong et al. 2020). Additionally, Supply and Use Tables (SUT) are employed for the analysis of specific countries, such as Germany (Jander 2022).

Furthermore, the data employed in these analyses are often drawn from official statistical sources, including national statistical offices and international organisations. Examples include studies using data from the US Environmental Protection Agency (Avelino et al. 2021) and Statistics Norway (Nørstebø et al. 2020), the German Federal Statistical Office (Jander 2022), Eurostat (Hennenberg et al. 2022; Jander 2022; Liobikiene et al. 2020; Philippidis et al. 2019), FAOSTAT (Hennenberg et al. 2022), the Colombia Statistical Institute (Alviar et al. 2021), and the Statistical Offices of Slovakia, Czechia, Poland and Hungary

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(Lazorcakova et al. 2022). While these sources enhance data reliability, they also contribute to uneven geographical coverage, reinforcing the dominance of data-rich regions in bioeconomy impact research.

4.2 | Environmental Impact Analysis of the Bioeconomy

Among the different topics related to the environment, a global perspective is particularly evident, with keywords such as climate change and biodiversity. These topics tend to be addressed either through aggregate indicators or through sector- and region-specific analyses, with some research focusing on specific variables such as GHG emissions or land use, which can be examined in greater detail and with explicit geographical disaggregation. This dual approach reflects both the global relevance of environmental challenges and the context-dependent nature of bioeconomy impacts.

4.2.1 | Bioeconomy and Greenhouse Gas Emissions

The articles that focus on GHG emissions primarily analyse the energy, forestry and bioindustry sectors. These studies focus on the potential of innovative sectors such as bioenergy (Angouria-Tsorochidou et al. 2022; Arsic et al. 2023; Kapoor et al. 2020) and the bioplastics industry (Spierling et al. 2018), rather than traditional sectors such as agriculture, agrifood and fisheries (see Table A1). This emphasis suggests that GHG-related bioeconomy research often frames the bioeconomy as a mitigation-oriented driver of decarbonisation, particularly in technology-intensive sectors.

In terms of the methodologies employed in research on GHG impacts, the literature reviews (Brosowski et al. 2016; Bugge et al. 2016; Khan et al. 2021) and the utilisation of different methods, such as LCA (Balcioglu et al. 2023; Sommerhuber et al. 2017; Spierling et al. 2018) or IO models (Alviar et al. 2021; Brizga et al. 2019; Fay et al. 2019; Vita et al. 2019) are particularly noteworthy. These methods enable the estimation of both direct and indirect emissions, but differ in their capacity to capture rebound effects, system boundaries and long-term structural changes.

The analysis of the GHG impact shows that data were obtained from a range of official agencies, such as Eurostat, the German Federal Statistical Office (Jander 2022), the Brazilian Steel Institute (de Souza and Pacca 2021), the Ministry of Agriculture and Rural development of the Colombian Government (Masum et al. 2021) and the Colombian Statistical Institute (Alviar et al. 2021), as well as from official databases such as the national SUT for Germany (Jander 2022), EXIOBASE (Jander 2022) and FABIO (Britz 2022). The reliance on official statistical sources enhances data robustness but also contributes to a stronger representation of regions with well-established data infrastructures.

Regarding geographical scope, the analysis of the GHG emissions is particularly extensive for the EU (Choi et al. 2019; Philippidis et al. 2019; Rowan and Casey 2021) and European countries such as Germany (Hahn et al. 2020), Greece (Kleftodimos et al. 2022; Kokkinos et al. 2020), France (Fernandez-Mena et al. 2020; Mosnier et al. 2019), Finland (Seppälä et al. 2019) and Italy (Blanc, Accastello, et al. 2019; Pergola et al. 2018). This geographical concentration reinforces the dominant role of Europe in shaping the empirical evidence on bioeconomy-related GHG impacts.

The results of the studies analysing how an expanding bioeconomy affects GHG emissions indicate that the bioenergy sector has a positive impact on the environment through decarbonisation and the circular economy. This is evidenced by studies conducted in the EU (Di Felice et al. 2018), Greece (Kokkinos et al. 2020) and India (Kapoor et al. 2020), as well as studies that examine the use of biofuels (Raghu et al. 2011) and bio-based materials (Philp 2015). However, these positive outcomes are often contingent on specific assumptions regarding feedstock sourcing, land use and technological efficiency, highlighting the importance of contextual factors and methodological choices.

A review of studies on the bioindustry indicates that the bioeconomy is frequently framed as transforming sustainability challenges into opportunities for environmental improvement, particularly in industrial applications (Blanc, Massaglia, et al. 2019; Pätäri et al. 2016). Furthermore, the bioindustry sector suggests that the substitution of fossil-based synthetic products with bio-based alternatives can mitigate environmental impacts and may be positively perceived by environmentally conscious consumers (Ali 2017). Nevertheless, the extent to which these benefits materialise depends on production processes, scale effects and upstream resource constraints. Moreover, the bioplastic industry has the potential to contribute to the achievement of 'net-zero' targets (Ni et al. 2021), although the literature also acknowledges ongoing uncertainties related to lifecycle emissions and end-of-life management.

4.2.2 | Bioeconomy and Land Use

In analysing the impact of land use, the sectors of agriculture (Abhilash 2021; Janssen et al. 2010) and forestry (Haggar et al. 2004; Primmer et al. 2021) stand out, in contrast with more innovative sectors such as bioindustry or biochemistry, which exert less direct pressure on land use (see Table A2). This reflects the land-intensive nature of primary bioeconomy activities and highlights land use as a critical constraint for sustainability transitions in these sectors. For the purpose of analysis, a variety of methods have been employed, including the use of bioeconomic models (Lungarska and Chakir 2018; Mouysset et al. 2014), case studies (Cudlínová et al. 2020; Goh 2020), literature reviews (Bayne and Renwick 2021; D'Amato, Bartkowski, and Droste 2020) and LCA (Carauta et al. 2021; Martin et al. 2018). These methodological differences influence how land-use changes and associated impacts are conceptualised and quantified.

Additionally, the analysis of land use impacts has mainly focused on Europe as a region (Ben Fradj et al. 2016; Englund et al. 2020) and Brazil (de Souza Ferreira Filho 2013; Escobar and Britz 2021), reflecting both their relevance in global land-use dynamics and the concentration of available data and research capacity in these regions. This geographical focus should therefore be interpreted

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with caution, as it does not imply that other regions are less significant in terms of biodiversity or land-use pressures.

The results of studies examining the impact of the bioeconomy on land use indicate that bioeconomic agricultural production helps mitigate the adverse effects of modern intensive agriculture, including the loss of natural habitats, soil depletion, water pollution and human health damage (Sattler et al. 2010). Furthermore, in relation to land and soil conservation, tenants tend to overexploit land resources more than landowners, which in turn influences land-use policy (Foudi 2012). Additionally, the combination of afforestation with agricultural land use has been demonstrated to enhance the net present value (Yemshanov et al. 2015). These findings suggest that land tenure arrangements and land-use planning play a critical role in shaping the environmental outcomes of bioeconomy strategies.

Nevertheless, some studies indicate that there are still risks associated with the land use impact of uncontrolled bioeconomic experiments, which can be mitigated through the use of virtual experimentation (Berger and Troost 2014). Moreover, land-use change, forest degradation and soil degradation are affected by complex interactions across ecological, economic and institutional dimensions, making it difficult to establish unambiguous cause–effect relationships. As a result, generalisations regarding the land-use benefits of the bioeconomy should be approached with caution (Upadhyay et al. 2006).

In the context of forestry, there is evidence that bioeconomic initiatives can be used to prevent forest degradation (Sankhayan et al. 2003). Other studies conclude that, in terms of agroforestry policies, the planting of certain species should be avoided under specific conditions (Haggar et al. 2004). Moreover, the transition to bioeconomic practices in land use and forestry can contribute to emission reductions, but not to the extent required to achieve climate-neutral net-zero targets (Krug 2018). This reinforces the view that land-based bioeconomy strategies involve inherent trade-offs between production, conservation and climate objectives.

4.3 | Integrating the Social and Economic Dimensions

In contrast, most articles related to the bioeconomy that adopt an economic perspective demonstrate that despite an environmental focus, the economic analysis is predominantly presented alongside variables such as output (O'Brien et al. 2017; Omer et al. 2007), GDP (Eyvindson et al. 2018; Giampietro 2019) or financial-market analysis (Lotze-Campen et al. 2010). The articles reviewed conclude that several methods exist for integrating the bioeconomy and sustainability into different production processes, such as poultry farming (Castellini et al. 2012), cereal production (Omer et al. 2007), tomato cultivation (Boccia et al. 2019) and bioenergy production (Lotze-Campen et al. 2010). Additionally, there are articles related to degrowth (Ramcilovic-Suominen 2023), which represent a specific approach to the transition of the economy towards a more neutral growth or equilibrium. However, the data indicate that most of the articles are related to maintaining a trend of economic growth (Khan et al. 2021), while policies and economic projects are incorporating environmental considerations.

An analysis of the social implications of bioeconomy studies reveals that employment, food security and human well-being represent key variables of interest. Although social dimensions are the least frequently addressed pillar of sustainability, the current environmental crisis and growing awareness of sustainability challenges have increased attention to social outcomes associated with bioeconomy transitions. This has, in turn, highlighted the role of public policies in regulating and supporting sustainable private investment. It is notable that social impact, the third and least frequently mentioned dimension of the sustainability triad (environmental, economic and social), is nevertheless a recurrent concern in the literature. This is evidenced by the fact that employment and food security, two key social issues, feature in approximately 8% and 7% of the total articles, respectively.

Notable articles on this topic include Cortignani and Dono (2018), which examines the positive impacts of integrating the bioeconomy into the Common Agricultural Policy (CAP) of the EU; Elomina and Pülzl (2021), which presents insights from a research project on EU forest policy, suggesting that forests could serve as a solution to climate change; and Reidsma et al. (2015); whose study highlights the limitations of crop models in accounting for the full range of climate change impacts and emphasise the importance of technological innovation, policy reform and price mechanisms in influencing agricultural practices. Together, these contributions illustrate that social and economic dimensions are increasingly recognised as integral to bioeconomy sustainability yet remain unevenly integrated compared to environmental considerations.

5 | Conclusions and Policy Implications

The SLR conducted in this paper provides a structured and critical contribution that clarifies and organises the state-of-the-art regarding the environmental impacts of the bioeconomy. The main objective of this literature review was to understand the current state of research focusing on analyses concerning the environmental impact of the bioeconomy, while examining how analytical choices shape the interpretation of sustainability outcomes.

The environmental impact of the bioeconomy has been investigated from multiple perspectives, including specific sectors (e.g., bioplastics, bioenergy, agriculture, forestry), environmental variables (e.g., land use, pollution, soil and water degradation) and global concepts (e.g., climate change, sustainability, the green economy and the energy transition). Accordingly, this review aims to provide a comprehensive overview of the current research landscape examining the bioeconomy and its environmental consequences, highlighting dominant patterns, gaps and structural biases in the literature.

The analysis presented in this paper demonstrates a growing interest in the field of bioeconomy research and the analyses of its impact, as evidenced by the increasing number of publications each year. Although the trend mainly concerns the analysis of environmental impacts, there is also a growing

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emphasis on exploring the economic and social dimensions within the bioeconomy framework. This suggests an emerging, though still uneven, move towards more holistic sustainability assessments.

Most of the articles focus on global concepts such as climate change, reflecting reinforced societal and policy concerns regarding sustainability and the promotion of environmental priorities in public decision-making. The results show that GHG emissions and land use are the most studied specific variables, followed by less frequently studied variables such as ecological footprint and pollution. Notably, analyses of innovative sectors, particularly bioenergy and bioplastics, dominate studies addressing emission-related impacts, whereas traditional sectors such as agriculture and fisheries remain comparatively underrepresented in this context.

It is important to highlight that studies focusing on GHG emissions tend to frame the bioeconomy as an opportunity for change and improvement rather than as a source of environmental risk. Consequently, the bioeconomy is often shown as a driver of economic development and decarbonisation, with subsectors such as bioplastics, biofuels and bio-based materials identified as having significant growth and mitigation potential. However, this optimistic narrative is highly context-dependent and sensitive to methodological assumptions, system boundaries and data availability. In contrast, when land-use impacts are analysed, the literature presents a more cautious picture. Most studies focus on traditional sectors such as agriculture and forestry, while innovative sectors receive less attention in land-use assessments.

The impact of the focus on land use in the agricultural sectors has been most extensively studied in European countries and Brazil. Conversely, research on the forestry sector has been especially notable in Germany, France and the Nordic region, reflecting both the availability of detailed data and the strong research and policy interest in bioeconomy strategies in these contexts, where robust national bioeconomy policies have been implemented. Studies examining the impact of the bioeconomy on land use conclude that bioeconomic approaches to agricultural production and forest policy can contribute to reducing the negative environmental effects of current economic systems. Nevertheless, these improvements remain insufficient and entail residual environmental risks that vary according to production systems, land-use practices and governance planning.

The principal methodologies employed in the reviewed articles include LCA, literature reviews, multisectoral models such as IO and SAM models and dynamic models such as CGE models. The selection of methods depends on the specific objectives of each study. Literature reviews synthesise existing knowledge, LCA quantifies product-level environmental impacts and multisectoral or dynamic models capture economy-wide interactions and indirect effects. Accordingly, these modelling approaches are particularly suited to the analysis of public policy interventions, whereas LCA is more appropriate for evaluating private-sector initiatives and product-level strategies.

Regarding data sources, literature reviews primarily rely on bibliographic databases such as Scopus and WoS. In contrast, LCA and multisectoral modelling studies depend heavily on national statistical offices and specialised databases such as EXIOBASE and FABIO. These data choices influence geographical coverage and sectoral detail, contributing to the observed concentration of studies in data-rich regions.

In light of these conclusions, future research should further explore key environmental variables, particularly GHG emissions and land use, using hybrid analytical frameworks that combine life cycle and economy-wide approaches. Comparative studies across countries and sectors would further enhance understanding of global bioeconomy dynamics and support the development of targeted policy interventions for sustainable transformation. Policymakers should adopt multi-level strategies that link bioeconomic innovation with environmental safeguards and social inclusion. This includes strengthening land governance, encouraging data transparency, and promoting circular and region-specific bioeconomic models capable of addressing local resource constraints and trade-offs.

This study provides a comprehensive overview of the current framework and future challenges associated with the promotion of the bioeconomy (Ortega Carrasco et al. 2025). Consequently, it contributes to both the scientific and policy-making communities by informing evidence-based decision-making on bioeconomy development. It should be noted, however, that the study is subject to limitations, as it focuses exclusively on peer-reviewed publications (articles and reviews) and does not include grey literature such as policy reports or institutional documents, which may capture emerging practices and policy innovations not yet reflected in academic research.

Author Contributions

Javier Coca: methodology, writing – original draft, formal analysis, data curation. **Valeria Ferreira:** conceptualization, validation, writing – original draft, writing – review and editing, visualization, formal analysis, supervision. **Laia Pié:** conceptualization, supervision, formal analysis, writing – review and editing, validation, methodology.

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Conflicts of Interest

The authors declare no conflicts of interest.

References

Abhilash, P. 2021. "Restoring the Unrestored: Strategies for Restoring Global Land During the Un Decade on Ecosystem Restoration (Un-der)." *Land* 10, no. 2: 1–17. https://doi.org/10.3390/land10020201.

Ali, J., T. Rasheed, M. Afreen, et al. 2021. "Modalities for Conversion of Waste to Energy — Challenges and Perspectives." *Science of the Total Environment* 795: 148865.

Ali, S. 2017. "The Ecology of Diamond Sourcing: From Mined to Synthetic Gems as a Sustainable Transition." *Journal of Bioeconomics* 19, no. 1: 115–126. https://doi.org/10.1007/s10818-016-9241-8.

Alviar, M., A. García-Suaza, L. Ramírez-Gómez, and S. Villegas-Velásquez. 2021. "Measuring the Contribution of the Bioeconomy: The

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Case of Colombia and Antioquia." *Sustainability (Switzerland)* 13, no. 4: 1–26. https://doi.org/10.3390/su13042353.

Andriamanantena, N. A., C. Gaufreteau, J.-S. Ay, and L. Doyen. 2024. "Climate-Dependent Scenarios of Land Use for Biodiversity and Ecosystem Services in the New Aquitaine Region." *Regional Environmental Change* 24, no. 1: 18.

Angouria-Tsorochidou, E., D. Teigiserova, and M. Thomsen. 2022. "Environmental and Economic Assessment of Decentralized Bioenergy and Biorefinery Networks Treating Urban Biowaste." *Resources, Conservation and Recycling* 176: 105898.

Arsic, M., C. O'Sullivan, A. Wasson, D. Antille, and W. Clarke. 2023. "Beyond Waste-To-Energy: Bioenergy Can Drive Sustainable Australian Agriculture by Integrating Circular Economy With Net Zero Ambitions." *Detritus* 23: 28–34.

Atta, N., and A. Sharifi. 2024. "A Systematic Literature Review of the Relationship Between the Rule of Law and Environmental Sustainability." *Sustainable Development* 32, no. 6: 7051–7068. https://doi.org/10.1002/sd.3087.

Avelino, A., P. Lamers, Y. Zhang, and H. Chum. 2021. "Creating a Harmonized Time Series of Environmentally-Extended Input-Output Tables to Assess the Evolution of the US Bioeconomy—A Retrospective Analysis of Corn Ethanol and Soybean Biodiesel." *Journal of Cleaner Production* 321: 128890. https://doi.org/10.1016/j.jclepro.2021.128890.

Bais-Moleman, A., R. Sikkema, M. Vis, P. Reumerman, M. Theurl, and K. Erb. 2018. "Assessing Wood Use Efficiency and Greenhouse Gas Emissions of Wood Product Cascading in the European Union." *Journal of Cleaner Production* 172: 3942–3954. https://doi.org/10.1016/j.jclepro.2017.04.153.

Balcioglu, G., H. K. Jeswani, and A. Azapagic. 2023. "A Sustainability Assessment of Utilising Energy Crops for Heat and Electricity Generation in Turkey." *Sustainable Production and Consumption* 41: 134–155.

Baležentis, T., D. Streimikiene, T. Zhang, and G. Liobikiene. 2019. "The Role of Bioenergy in Greenhouse Gas Emission Reduction in EU Countries: An Environmental Kuznets Curve Modelling." *Energy Policy* 133: 110919.

Barberà-Mariné, M., L. Fabregat-Aibar, V. Ferreira, and A. Terceño. 2024. "One Step Away From 2030: An Assessment of the Progress of Sustainable Development Goals (SDGs) in the European Union." *European Journal of Development Research* 36: 1372–1397. https://doi.org/10.1057/s41287-024-00641-0.

Barra, C., and P. Falcone. 2024a. "Institutional Quality and Bioeconomy Performance in European Countries: Unveiling the Evidence." *Ecological Economics* 220: 108188.

Barra, C., and P. Falcone. 2024b. "Does Institutional Quality Matter for Bioeconomy Performance? Insights From Italian Regions." *Economic Change and Restructuring* 57, no. 6: 250.

Bauer, F., T. D. Nielsen, L. J. Nilsson, et al. 2021. "Plastics and Climate Change Breaking Carbon Lock-Ins Through Three Mitigation Pathways." *One Earth* 4, no. 5: 611–616.

Bayne, K., and A. Renwick. 2021. "Beyond Sustainable Intensification: Transitioning Primary Sectors Through Reconfiguring Land-Use." *Sustainability* 13, no. 6: 3225. https://doi.org/10.3390/su13063225.

Beisenbina, M., L. Fabregat-Aibar, M. Barberà-Mariné, and M. Sorrosal-Forradellas. 2023. "The Burgeoning Field of Sustainable Investment: Past, Present and Future." *Sustainable Development* 31, no. 3: 1923–1941. https://doi.org/10.1002/sd.2422.

Ben Fradj, N., P. Jayet, and P. Aghajanzadeh-Darzi. 2016. "Competition Between Food, Feed, and (Bio)fuel: A Supply-Side Model Based Assessment at the European Scale." *Land Use Policy* 52: 195–205. https://doi.org/10.1016/j.landusepol.2015.12.027.

Berger, T., and C. Troost. 2014. "Agent-Based Modelling of Climate Adaptation and Mitigation Options in Agriculture." *Journal of Agricultural Economics* 65, no. 2: 323–348. https://doi.org/10.1111/1477-9552.12045.

Beuchelt, T., and M. Nassl. 2019. "Applying a Sustainable Development Lens to Global Biomass Potentials." *Sustainability (Switzerland)* 11, no. 18: 5078. https://doi.org/10.3390/su11185078.

Bhattarai, G., P. Srivastava, L. Marzen, D. Hite, and U. Hatch. 2021. "Assessment of Economic and Water Quality Impacts of Land Use Change Using a Simple Bioeconomic Model." *Environmental Management* 67, no. 4: 724–737.

Blanc, S., C. Accastello, E. Bianchi, et al. 2019. "An Integrated Approach to Assess Carbon Credit From Improved Forest Management." *Journal of Sustainable Forestry* 38, no. 1: 31–45. https://doi.org/10.1080/10549811.2018.1494002.

Blanc, S., S. Massaglia, F. Brun, C. Peano, A. Mosso, and N. Giuggioli. 2019. "Use of Bio-Based Plastics in the Fruit Supply Chain: An Integrated Approach to Assess Environmental, Economic, and Social Sustainability." *Sustainability* 11, no. 9: 2475. https://doi.org/10.3390/su11092475.

Boccia, F., P. Di Donato, D. Covino, and A. Poli. 2019. "Food Waste and Bio-Economy: A Scenario for the Italian Tomato Market." *Journal of Cleaner Production* 227: 424–433. https://doi.org/10.1016/j.jclepro.2019.04.180.

Briassoulis, D., A. Pikasi, and M. Hiskakis. 2021. "End-of-waste life: Inventory of Alternative End-of-use Recirculation Routes of Bio-based Plastics in the European Union Context." *Waste Management* 134: 100397: 148–168.

Briner, S., C. Elkin, and R. Huber. 2013. "Evaluating the Relative Impact of Climate and Economic Changes on Forest and Agricultural Ecosystem Services in Mountain Regions." *Journal of Environmental Management* 129: 414–422. https://doi.org/10.1016/j.jenvman.2013.07.018.

Britz, W. 2022. "Disaggregating Agro-Food Sectors in the GTAP Data Base." *Journal of Global Economic Analysis* 7, no. 1: 44–75. https://svn1.agp.uni-bonn.de/svn/cgebox/.

Brizga, J., A. Miceikienė, and G. Liobikienė. 2019. "Environmental Aspects of the Implementation of Bioeconomy in the Baltic Sea Region: An Input-Output Approach." *Journal of Cleaner Production* 240: 118238. https://doi.org/10.1016/j.jclepro.2019.118238.

Brosowski, A., D. Thrän, U. Mantau, et al. 2016. "A Review of Biomass Potential and Current Utilisation – Status Quo for 93 Biogenic Wastes and Residues in Germany." *Biomass & Bioenergy* 95: 257–272. https://doi.org/10.1016/j.biombioe.2016.10.017.

Bruckner, M., T. Häyhä, S. Giljum, et al. 2019. "Quantifying the Global Cropland Footprint of the European Union's Non-Food Bioeconomy." *Environmental Research Letters* 14, no. 4: 045011. https://doi.org/10.1088/1748-9326/ab07f5.

Bugge, M., T. Hansen, and A. Klitkou. 2016. "What Is the Bioeconomy? A Review of the Literature." *Sustainability* 8, no. 7: 691. https://doi.org/10.3390/su8070691.

Carauta, M., C. Troost, I. Guzman-Bustamante, et al. 2021. "Climate-Related Land Use Policies in Brazil: How Much Has Been Achieved With Economic Incentives in Agriculture?" *Land Use Policy* 109: 105618. https://doi.org/10.1016/j.landusepol.2021.105618.

Castellini, C., A. Boggia, C. Cortina, et al. 2012. "A Multicriteria Approach for Measuring the Sustainability of Different Poultry Production Systems." *Journal of Cleaner Production* 37: 192–201. https://doi.org/10.1016/j.jclepro.2012.07.006.

Cattaneo, C., J. Marull, and E. Tello. 2018. "Landscape Agroecology. The Dysfunctionalities of Industrial Agriculture and the Loss of the Circular Bioeconomy in the Barcelona Region, 1956–2009." *Sustainability* 10, no. 12: 4722.

10991719, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/sd.71421 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [29/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Castro, L. M., F. Härtl, S. Ochoa, B. Calvas, L. Izquierdo, and T. Knoke. 2020. "Integrated Bio-Economic Models as Tools to Support Land-Use Decision Making: A Review of Potential and Limitations." *Journal of Bioeconomics* 22, no. 3: 153–183.

Cerca, M., A. Sosa, E. Gusciute, and F. Murphy. 2022. "Strategic Planning of Bio-Based Supply Chains: Unlocking Bottlenecks and Incorporating Social Sustainability Into Biorefinery Systems." *Sustainable Production and Consumption* 34: 219–232.

Chabán-García, O., and A. Hidalgo-Capitán. 2023. "Green Economy and Green Jobs: A Multisectoral Analysis by Means of Spain's Social Accounting Matrix." *Brazilian Journal of Political Economy* 43: 380–397.

Chakrapani, G., M. Zare, and S. Ramakrishna. 2022. "Biomaterials From the Value-Added Food Wastes." *Current Opinion in Biomedical Engineering* 23: 100397.

Choi, H. S., and S. K. Entenmann. 2021. "Land in the EU for Perennial Biomass Crops From Freed-Up Agricultural Land: A Sensitivity Analysis Considering Yields, Diet, Market Liberalization and World Food Prices." *GCB Bioenergy* 13, no. 4: 606–623.

Choi, H. S., H. Grethe, S. K. Entenmann, M. Wiesmeth, M. Blesl, and M. Wagner. 2019. "Potential Trade-Offs of Employing Perennial Biomass Crops for the Bioeconomy in the EU by 2050: Impacts on Agricultural Markets in the EU and the World." *GCB Bioenergy* 11, no. 3: 483–504. https://doi.org/10.1111/gcbb.12596.

Clauser, N. M., G. González, C. M. Mendieta, J. Kruyeniski, M. C. Area, and M. E. Vallejos. 2021. "Biomass Waste as Sustainable Raw Material for Energy and Fuels." *Sustainability* 13, no. 7: 3817.

Cortignani, R., and G. Dono. 2018. "Agricultural Policy and Climate Change: An Integrated Assessment of the Impacts on an Agricultural Area of Southern Italy." *Environmental Science and Policy* 81: 26–35. https://doi.org/10.1016/j.envsci.2017.12.003.

Cudlínová, E., V. Sobrinho, M. Lapka, and L. Salvati. 2020. "New Forms of Land Grabbing due to the Bioeconomy: The Case of Brazil." *Sustainability (Basel, Switzerland)* 12, no. 8: 3395. https://doi.org/10.3390/SU12083395.

D'Adamo, I., P. Falcone, E. Imbert, and P. Morone. 2022. "Exploring Regional Transitions to the Bioeconomy Using a Socio-Economic Indicator: The Case of Italy." *Economia Politica* 39, no. 3: 989–1021.

D'Adamo, I., P. Falcone, and P. Morone. 2020. "A New Socio-Economic Indicator to Measure the Performance of Bioeconomy Sectors in Europe." *Ecological Economics* 176: 106724.

Damania, R., and P. L. Scandizzo. 2023. "The Serengeti Ecosystem — Burden or Bounty?" *World Development* 161: 106118.

D'Amato, D., B. Bartkowski, and N. Droste. 2020. "Reviewing the Interface of Bioeconomy and Ecosystem Service Research." *Ambio* 49, no. 12: 1878–1896. https://doi.org/10.1007/s13280-020-01374-0.

D'Amato, D., M. Gaio, and E. Semenzin. 2020. "A Review of LCA Assessments of Forest-Based Bioeconomy Products and Processes Under an Ecosystem Services Perspective." *Science of the Total Environment* 706: 135859. https://doi.org/10.1016/j.scitotenv.2019.135859.

de Jong, S., J. van Stralen, M. Londo, R. Hoefnagels, A. Faaij, and M. Junginger. 2018. "Renewable Jet Fuel Supply Scenarios in the European Union in 2021–2030 in the Context of Proposed Biofuel Policy and Competing Biomass Demand." *GCB Bioenergy* 10, no. 9: 661–682. https://doi.org/10.1111/gcbb.12525.

de Souza Ferreira Filho, J. 2013. "Food Security, the Labor Market, and Poverty in the Brazilian Bio-Economy." *Agricultural Economics* 44, no. SUPPL1: 85–93. https://doi.org/10.1111/agec.12053.

de Souza, J., and S. Pacca. 2021. "Carbon Reduction Potential and Costs Through Circular Bioeconomy in the Brazilian Steel Industry." *Resources, Conservation and Recycling* 169: 105517. https://doi.org/10.1016/j.resconrec.2021.105517.

Dees, J. P., W. J. Sagues, E. Woods, H. M. Goldstein, A. J. Simon, and D. L. Sanchez. 2021. "Leveraging the Bioeconomy for Carbon Drawdown." *Environmental Research Letters* 16, no. 11: 114035.

Di Felice, L., M. Ripa, and M. Giampietro. 2018. "Deep Decarbonisation From a Biophysical Perspective: GHG Emissions of a Renewable Electricity Transformation in the EU." *Sustainability* 10, no. 10: 3685. https://doi.org/10.3390/su10103685.

Dietz, T., J. Börner, J. Förster, and J. von Braun. 2018. "Governance of the Bioeconomy: A Global Comparative Study of National Bioeconomy Strategies." *Sustainability (Switzerland)* 10, no. 9: 3190. https://doi.org/10.3390/su10093190.

Duque-Acevedo, M., L. Belmonte-Ureña, F. Cortés-García, and F. Camacho-Ferre. 2020. "Agricultural Waste: Review of the Evolution, Approaches and Perspectives on Alternative Uses." *Global Ecology and Conservation* 22: e00902. https://doi.org/10.1016/j.gecco.2020.e00902.

Egenolf, V., G. Vita, M. Distelkamp, F. Schier, R. Hüfner, and S. Bringezu. 2021. "The Timber Footprint of the German Bioeconomy-State of the Art and Past Development." *Sustainability* 13, no. 7: 3878. https://doi.org/10.3390/su13073878.

Elomina, J., and H. Pülzl. 2021. "How Are Forests Framed? An Analysis of EU Forest Policy." *Forest Policy and Economics* 127: 102448. https://doi.org/10.1016/j.forpol.2021.102448.

Englund, O., P. Börjesson, G. Berndes, et al. 2020. "Beneficial Land Use Change: Strategic Expansion of New Biomass Plantations Can Reduce Environmental Impacts From EU Agriculture." *Global Environmental Change* 60: 101990. https://doi.org/10.1016/j.gloenvcha.2019.101990.

Erickson, E. D., P. A. Tominac, and V. M. Zavala. 2021. "Biogas Production in United States Dairy Farms Incentivized by Electricity Policy Changes." *Applied Energy* 293: 116938.

Escobar, N., and W. Britz. 2021. "Metrics on the Sustainability of Region-Specific Bioplastics Production, Considering Global Land Use Change Effects." *Resources, Conservation and Recycling* 167: 105345. https://doi.org/10.1016/j.resconrec.2020.105345.

Escobar, N., S. Haddad, J. Börner, and W. Britz. 2018. "Land Use Mediated GHG Emissions and Spillovers From Increased Consumption of Bioplastics." *Environmental Research Letters* 13, no. 12: 125005. https://doi.org/10.1088/1748-9326/aaeafb.

European Commission. 2012. "Review of the 2012 European Bioeconomy Strategy." https://doi.org/10.2777/086770.

European Commission. 2018. "A Sustainable Bioeconomy for Europe: Strengthening the Connection Between Economy, Society and the Environment Updated Bioeconomy Strategy." https://doi.org/10.2777/478385.

European Commission. 2019. "European Green Deal."

European Commission. 2025. *A Strategic Framework for a Competitive and Sustainable EU Bioeconomy*.

Eyvindson, K., A. Repo, and M. Mönkkönen. 2018. "Mitigating Forest Biodiversity and Ecosystem Service Losses in the Era of Bio-Based Economy." *Forest Policy and Economics* 92: 119–127. https://doi.org/10.1016/j.forpol.2018.04.009.

Fay, G., G. DePiper, S. Steinback, R. Gamble, and J. Link. 2019. "Economic and Ecosystem Effects of Fishing on the Northeast US Shelf." *Frontiers in Marine Science* 6, no. MAR: 133. https://doi.org/10.3389/fmars.2019.00133.

Federal Government of Germany. 2020. "National Bioeconomy Strategy."

Fernandez-Mena, H., G. MacDonald, S. Pellerin, and T. Nesme. 2020. "Co-Benefits and Trade-Offs From Agro-Food System Redesign for Circularity: A Case Study With the FAN Agent-Based Model." *Frontiers in Sustainable Food Systems* 4: 41. https://doi.org/10.3389/fsufs.2020.00041.

10991719, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/sd.71421 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [29/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Ferreira, V., L. Fabregat-Aibar, L. Pié, and A. Terceño. 2022. "Research Trends and Hotspots in Bioeconomy Impact Analysis: A Study of Economic, Social and Environmental Impacts." In *Environmental Impact Assessment Review*, vol. 96, 106842. Elsevier Inc. https://doi.org/10.1016/j.eiar.2022.106842.

Ferreira, V., L. Pié, and A. Terceño. 2018. "A Systematic Literature Review of Bio, Green and Circular Economy Trends in Publications in the Field of Economics and Business Management." *Sustainability* 10, no. 11: 4232. https://doi.org/10.3390/su10114232.

Fisch, C., and J. Block. 2018. "Six Tips for Your (Systematic) Literature Review in Business and Management Research." *Management Review Quarterly* 68, no. 2: 103–106. https://doi.org/10.1007/s11301-018-0142-x.

Foudi, S. 2012. "The Role of Farmers' Property Rights in Soil Ecosystem Services Conservation." *Ecological Economics* 83: 90–96. https://doi.org/10.1016/j.ecolecon.2012.08.015.

Giampietro, M. 2019. "On the Circular Bioeconomy and Decoupling: Implications for Sustainable Growth." *Ecological Economics* 162: 143–156. https://doi.org/10.1016/j.ecolecon.2019.05.001.

Gobierno de España. 2016. "Estrategia española de Bioeconomía."

Goh, C. S. 2020. "Transforming Exploitative Land-Based Economy: The Case of Borneo." *Environmental Development* 33: 100487. https://doi.org/10.1016/j.envdev.2019.100487.

Goritz, N., J. von Pfister, M. Proestou, and P. H. Feindt. 2026. "Characterizing Bioeconomy Policy Instruments: A Global Comparative Analysis of Bioeconomy Strategies." *Journal of Environmental Policy & Planning* 28, no. 2: 344–367.

Gottinger, A., L. Ladu, and R. Quitzow. 2020. "Studying the Transition Towards a Circular Bioeconomy—A Systematic Literature Review on Transition Studies and Existing Barriers." *Sustainability* 12, no. 21: 1–27. https://doi.org/10.3390/su12218990.

Grossauer, F., and G. Stoeglehner. 2020. "Bioeconomy—A Systematic Literature Review on Spatial Aspects and a Call for a New Research Agenda." *Land* 9, no. 10: 374.

Guillet, T., and L. Mouysset. 2022. "Productive Versus Environmental Objectives of Agricultural Policies Dealing With Climate Change: A French Case Study." *Ecological Economics* 194: 107338.

Gusenbauer, M., and N. Haddaway. 2020. "Which Academic Search Systems Are Suitable for Systematic Reviews or Meta-Analyses? Evaluating Retrieval Qualities of Google Scholar, PubMed, and 26 Other Resources." *Research Synthesis Methods* 11, no. 2: 181–217. https://doi.org/10.1002/jrsm.1378.

Haddad, S., W. Britz, and J. Börner. 2019. "Economic Impacts and Land Use Change From Increasing Demand for Forest Products in the European Bioeconomy: A General Equilibrium Based Sensitivity Analysis." *Forests* 10, no. 1: 52. https://doi.org/10.3390/f10010052.

Haggar, J., M. Sosa, B. Díaz, G. Hernández, J. Contreras, and C. Uc. 2004. "Adaptation of Agroforestry Systems in South-Eastern Mexico Through Integration of Farmer and Bioeconomic Evaluations." *International Journal of Agricultural Sustainability* 2, no. 3: 154–166. https://doi.org/10.1080/14735903.2004.9684575.

Hahn, A., N. Szarka, and D. Thrän. 2020. "German Energy and Decarbonization Scenarios: "Blind Spots" With Respect to Biomass-Based Carbon Removal Options." *Frontiers in Energy Research* 8: 130. https://doi.org/10.3389/fenrg.2020.00130.

Hasan, M., M. Z. Abedin, M. B. Amin, M. Nekmahmud, and J. Oláh. 2022. "Sustainable Biofuel Economy: A Mapping Through Bibliometric Research." *Sustainability* 14, no. 9: 5651.

Helming, K., K. Daedlow, C. Paul, et al. 2018. "Managing Soil Functions for a Sustainable Bioeconomy—Assessment Framework and State of the Art." *Land Degradation & Development* 29, no. 9: 3112–3126.

Hennenberg, K., S. Gebhardt, F. Wimmer, et al. 2022. "Germany's Agricultural Land Footprint and the Impact of Import Pattern Allocation." *Sustainability* 14, no. 1: 105. https://doi.org/10.3390/su14010105.

Hertel, T., J. Steinbuks, and U. Baldos. 2013. "Competition for Land in the Global Bioeconomy." *Agricultural Economics (United Kingdom)* 44, no. SUPPL1: 129–138. https://doi.org/10.1111/agec.12057.

Hiedanpää, J., S. Ramcilovik-Suominen, and M. Salo. 2021. "Neoliberal Pathways to the Bioeconomy: Forest Land Use Institutions in Chile, Finland, and Laos." *Forest Policy and Economics* 131: 102559.

Hoefnagels, R., M. Banse, V. Dornburg, and A. Faaij. 2013. "Macro-Economic Impact of Large-Scale Deployment of Biomass Resources for Energy and Materials on a National Level-A Combined Approach for the Netherlands." *Energy Policy* 59: 727–744. https://doi.org/10.1016/j.enpol.2013.04.026.

Humblot, P., D. Leconte-Demarsy, P. Clerino, S. Szopa, J.-F. Castell, and P.-A. Jayet. 2022. "Assessment of Ozone Impacts on Farming Systems: A Bio-Economic Modeling Approach Applied to the Widely Diverse French Case." *European Review of Agricultural Economics* 49, no. 2: 433–465.

Immerzeel, B., J. E. Vermaat, A. Juutinen, E. Pouta, and J. Artell. 2021. "Appreciation of Nordic Landscapes and How the Bioeconomy Might Change That: Results From a Discrete Choice Experiment." *Landscape and Urban Planning* 214: 104192.

Jander, W. 2022. "Advancing Bioeconomy Monitorings: A Case for Considering Bioplastics." *Sustainable Production and Consumption* 30: 255–268. https://doi.org/10.1016/j.spc.2021.11.033.

Janssen, S., K. Louhichi, A. Kanellopoulos, et al. 2010. "A Generic Bio-Economic Farm Model for Environmental and Economic Assessment of Agricultural Systems." *Environmental Management* 46, no. 6: 862–877. https://doi.org/10.1007/s00267-010-9588-x.

Juliá, R., and F. Duchin. 2007. "Land Use Change and Global Adaptations to Climate Change." *Ecological Economics* 61, no. 2-3: 297–307.

Kalogiannidis, S., D. Kalfas, E. Loizou, and F. Chatzitheodoridis. 2022. "Forestry Bioeconomy Contribution on Socioeconomic Development: Evidence From Greece." *Sustainability* 14, no. 22: 14739.

Kapoor, R., P. Ghosh, M. Kumar, et al. 2020. "Valorization of Agricultural Waste for Biogas Based Circular Economy in India: A Research Outlook." *Bioresource Technology* 304: 123036. https://doi.org/10.1016/j.biortech.2020.123036.

Kgathi, D., K. Mfundisi, G. Mmopelwa, and K. Mosepele. 2012. "Potential Impacts of Biofuel Development on Food Security in Botswana: A Contribution to Energy Policy." *Energy Policy* 43: 70–79. https://doi.org/10.1016/j.enpol.2011.12.027.

Khan, N., K. Sudhakar, and R. Mamat. 2021. "Role of Biofuels in Energy Transition, Green Economy and Carbon Neutrality." *Sustainability (Switzerland)* 13, no. 22: 12374. https://doi.org/10.3390/su132212374.

Kleftodimos, G., L. Kyrgiakos, C. Kleisiari, A. Tagarakis, and D. Bochtis. 2022. "Examining Farmers' Adoption Decisions Towards Precision-Agricultural Practices in Greek Dairy Cattle Farms." *Sustainability* 14, no. 1: 411. https://doi.org/10.3390/su14010411.

Kokkinos, K., V. Karayannis, and K. Moustakas. 2020. "Circular Bio-Economy via Energy Transition Supported by Fuzzy Cognitive Map Modeling Towards Sustainable Low-Carbon Environment." *Science of the Total Environment* 721: 137754. https://doi.org/10.1016/j.scitotenv.2020.137754.

Kraus, S., M. Breier, and S. Dasí-Rodríguez. 2020. "The Art of Crafting a Systematic Literature Review in Entrepreneurship Research." *International Entrepreneurship and Management Journal* 16, no. 3: 1023–1042. https://doi.org/10.1007/s11365-020-00635-4.

Kraus, S., M. Breier, W. Lim, et al. 2022. "Literature Reviews as Independent Studies: Guidelines for Academic Practice." *Review of*

10991719, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/sd.71421 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [29/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Managerial Science 16, no. 8: 2577–2595. https://doi.org/10.1007/s11846-022-00588-8.

Krug, J. 2018. "Accounting of GHG Emissions and Removals From Forest Management: A Long Road From Kyoto to Paris." *Carbon Balance and Management* 13, no. 1: 1. https://doi.org/10.1186/s13021-017-0089-6.

Lap, T., R. Benders, F. van der Hilst, and A. Faaij. 2021. "BECCS as Climate Mitigation Option in a Brazilian Low Carbon Energy System: Estimating Potential and Effect of Gigatonne Scale CO2 Storage." *International Journal of Greenhouse Gas Control* 112: 103498.

Lazorcakova, E., L. Dries, J. Peerlings, and J. Pokrivcak. 2022. "Potential of the Bioeconomy in Visegrad Countries: An Input-Output Approach." *Biomass and Bioenergy* 158: 106366. https://doi.org/10.1016/j.biombioe.2022.106366.

Li, J., J. Coca-Stefaniak, T. Nguyen, and A. Morrison. 2024. "Sustainable Tourist Behavior: A Systematic Literature Review and Research Agenda." *Sustainable Development* 32, no. 4: 3356–3374.

Liobikiene, G., X. Chen, D. Streimikiene, and T. Balezentis. 2020. "The Trends in Bioeconomy Development in the European Union: Exploiting Capacity and Productivity Measures Based on the Land Footprint Approach." *Land Use Policy* 91: 104375. https://doi.org/10.1016/j.landusepol.2019.104375.

Lochhead, K., S. Ghafghazi, P. Havlik, et al. 2021. "Price Trends and Volatility Scenarios for Designing Forest Sector Transformation." *Forest Policy and Economics* 125: 102403.

Lotze-Campen, H., A. Popp, T. Beringer, et al. 2010. "Scenarios of Global Bioenergy Production: The Trade-Offs Between Agricultural Expansion, Intensification and Trade." *Ecological Modelling* 221, no. 18: 2188–2196. https://doi.org/10.1016/j.ecolmodel.2009.10.002.

Lungarska, A., and R. Chakir. 2018. "Climate-Induced Land Use Change in France: Impacts of Agricultural Adaptation and Climate Change Mitigation." *Ecological Economics* 147: 134–154. https://doi.org/10.1016/j.ecolecon.2017.12.030.

Mahlich, L., C. Jung, and R. Schaldach. 2022. "The Biodiversity Footprint of German Soy-Imports in Brazil." *Sustainability* 14, no. 19: 12792.

Marin-Zapata, S., J. Román-Calderón, C. Robledo-Ardila, and M. Jaramillo-Serna. 2022. "Soft Skills, Do We Know What We Are Talking About?" *Review of Managerial Science* 16, no. 4: 969–1000. https://doi.org/10.1007/s11846-021-00474-9.

Martin, M., F. Røyne, T. Ekvall, and Å. Moberg. 2018. "Life Cycle Sustainability Evaluations of Bio-Based Value Chains: Reviewing the Indicators From a Swedish Perspective." *Sustainability (Basel, Switzerland)* 10, no. 2: 547. https://doi.org/10.3390/su10020547.

Martín-Martín, A., M. Thelwall, E. Orduna-Malea, and E. Delgado López-Cózar. 2021. "Google Scholar, Microsoft Academic, Scopus, Dimensions, Web of Science, and Opencitations' COCI: A Multidisciplinary Comparison of Coverage via Citations." *Scientometrics* 126, no. 1: 871–906.

Masini, E., A. Barbati, M. Bencardino, M. Carlucci, P. Corona, and L. Salvati. 2022. "Paths to Change: Bio-Economic Factors, Geographical Gradients and the Land-Use Structure of Italy." *Sustainability* 14, no. 3: 1735.

Masson-Delmotte, V., P. Zhai, Y. Chen, et al. 2021. "The Physical Science Basis Summary for Policymakers Technical Summary Frequently Asked Questions Glossary Part of the Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." Edited by. https://www.ipcc.ch.

Masum, M., P. Dwivedi, and R. De La Torre. 2021. "Assessing Economic and Environmental Feasibility of Wood-Based Electricity Generation in South America: A Case Study From Colombia." *Forest Policy and Economics* 124: 102381. https://doi.org/10.1016/j.forpol.2020.102381.

Ministry of Environment. 2014. "Sustainable Growth From Bioeconomy."

Moher, D., A. Liberati, J. Tetzlaff, and D. Altman. 2009. "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement." *BMJ* 339, no. 7716: 332–336. https://doi.org/10.1136/bmj.b2535.

Moreira, J. B., T. D. Santos, J. H. Duarte, P. Q. M. Bezerra, M. G. de Morais, and J. A. V. Costa. 2021. "Role of Microalgae in Circular Bioeconomy: From Waste Treatment to Biofuel Production." *Clean Technologies and Environmental Policy* 23, no. 10: 2753–2767.

Mosnier, C., W. Britz, T. Julliere, et al. 2019. "Greenhouse Gas Abatement Strategies and Costs in French Dairy Production." *Journal of Cleaner Production* 236: 117589. https://doi.org/10.1016/j.jclepro.2019.07.064.

Mosquera-Losada, M. R., J. J. Santiago-Freijanes, M. Rois-Díaz, et al. 2018. "Agroforestry in Europe: A Land Management Policy Tool to Combat Climate Change." *Land Use Policy* 78: 444–454.

Mouysset, L., L. Doyen, and F. Jiguet. 2014. "From Population Viability Analysis to Coviability of Farmland Biodiversity and Agriculture." *Conservation Biology* 28, no. 1: 187–201. https://doi.org/10.1111/cobi.12184.

Mouysset, L., C. Rais Assa, J.-S. Ay, F. Jiguet, R. Lorrilière, and L. Doyen. 2021. "Bioeconomic Impacts of Agroforestry Policies in France." *Land Use Policy* 109: 105658.

Nakhate, P., and Y. van der Meer. 2021. "A Systematic Review on Seaweed Functionality: A Sustainable Bio-Based Material." *Sustainability* 13, no. 11: 6174. https://doi.org/10.3390/su13116174.

Nelson, K., T. Nguyen, J. Francois, and S. Ojha. 2023. "Rural Sustainability Methods, Drivers, and Outcomes: A Systematic Review." *Sustainable Development* 31, no. 3: 1226–1249. https://doi.org/10.1002/sd.2471.

Ni, Y., G. Richter, O. Mwabonje, A. Qi, M. Patel, and J. Woods. 2021. "Novel Integrated Agricultural Land Management Approach Provides Sustainable Biomass Feedstocks for Bioplastics and Supports the UK'S "Net-Zero" Target." *Environmental Research Letters* 16, no. 1: 014023. https://doi.org/10.1088/1748-9326/abcf79.

Nong, D., N. Escobar, W. Britz, and J. Börner. 2020. "Long-Term Impacts of Bio-Based Innovation in the Chemical Sector: A Dynamic Global Perspective." *Journal of Cleaner Production* 272: 122738. https://doi.org/10.1016/j.jclepro.2020.122738.

Nørstebø, V., S. O. Krøgli, M. Debella-Gilo, et al. 2020. "Identifying Suitable Bioeconomic Cluster Sites-Combining GIS-MCDA and Operational Research Methods." *Environmental Modeling & Assessment* 25: 689. https://doi.org/10.1007/s10666-020-09694-x.

O'Brien, M., D. Wechsler, S. Bringezu, and R. Schaldach. 2017. "Toward a Systemic Monitoring of the European Bioeconomy: Gaps, Needs and the Integration of Sustainability Indicators and Targets for Global Land Use." *Land Use Policy* 66: 162–171. https://doi.org/10.1016/j.landusepol.2017.04.047.

OECD. 2009. *The Bioeconomy to 2030*. OECD. https://doi.org/10.1787/9789264056886-en.

Ollinaho, O. I., and M. Kröger. 2021. "Separating the Two Faces of "Bioeconomy": Plantation Economy and Sociobiodiverse Economy in Brazil." *Journal of Peasant Studies* 48, no. 5: 1013–1035.

Omer, A., U. Pascual, and N. Russell. 2007. "Biodiversity Conservation and Productivity in Intensive Agricultural Systems." *Journal of Agricultural Economics* 58, no. 2: 308–329.

Ortega Carrasco, P., F. Iannone, V. Ferrón Vílchez, and F. Testa. 2025. "Green Public Procurement as an Effective Way for Sustainable Development: A Systematic Literature Review and Bibliometric Analysis." *Sustainable Development* 33, no. 2: 2364–2391.

Page, M., J. McKenzie, P. Bossuyt, et al. 2021. "The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews." *BMJ* 372: n71. https://doi.org/10.1136/bmj.n71.

Palander, T. S., and A. Hietanen. 2014. "Management Planning Method for Sustainable Energy Production From Forest Biomass: Development

10991719, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/sd.71421 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [29/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

of an Optimization System and Case Study for a Finnish Energy Plant." *Journal of Sustainable Bioenergy Systems* 4, no. 2: 125–136.

Pätäri, S., A. Tuppura, A. Toppinen, and J. Korhonen. 2016. "Global Sustainability Megaforces in Shaping the Future of the European Pulp and Paper Industry Towards a Bioeconomy." *Forest Policy and Economics* 66: 38–46. https://doi.org/10.1016/j.forpol.2015.10.009.

Pergola, M., A. Gialdini, G. Celano, et al. 2018. "An Environmental and Economic Analysis of the Wood-Pellet Chain: Two Case Studies in Southern Italy." *International Journal of Life Cycle Assessment* 23, no. 8: 1675–1684. https://doi.org/10.1007/s11367-017-1374-z.

Philippidis, G., M. Sartori, E. Ferrari, and R. M'Barek. 2019. "Waste Not, Want Not: A Bio-Economic Impact Assessment of Household Food Waste Reductions in the EU." *Resources, Conservation and Recycling* 146: 514–522. https://doi.org/10.1016/j.resconrec.2019.04.016.

Philp, J. 2015. "Balancing the Bioeconomy: Supporting Biofuels and Bio-Based Materials in Public Policy." *Energy and Environmental Science* 8, no. 11: 3063–3068. https://doi.org/10.1039/c5ee01864a.

Popp, A., S. Domptail, N. Blaum, and F. Jeltsch. 2020. "Landuse Experience Does Qualify for Adaptation to Climate Change." *Global Environmental Change* 65: 102172.

Primmer, E., L. Varumo, T. Krause, et al. 2021. "Mapping Europe's Institutional Landscape for Forest Ecosystem Service Provision, Innovations and Governance." *Ecosystem Services* 47: 101225. https://doi.org/10.1016/j.ecoser.2020.101225.

Pryshliak, N., V. Bondarenko, S. Sokoliuk, and O. Brovarets. 2021. "The Formation of a Bioenergy Cluster for the Production of Biofuels From Agricultural Crops and Waste: The Experience of Ukraine [Powstanie Klastra Bioenergetycznego Do Produkcji Biopaliw z Upraw Rolnych i odpadów: doświadczenia Ukrainy]." *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnych i Agrobiznesu* 23, no. 3: 127–141.

Raghu, S., J. Spencer, A. Davis, and R. Wiedenmann. 2011. "Ecological Considerations in the Sustainable Development of Terrestrial Biofuel Crops." *Current Opinion in Environmental Sustainability* 3, no. 1–2: 15–23. https://doi.org/10.1016/j.cosust.2010.11.005.

Rahman, Z., and S. Kamboj. 2017. "Customer Participation in Brand Communities on Social Media: A Systematic Literature Review." *International Journal of Web Based Communities* 13, no. 4: 1. https://doi.org/10.1504/IJWBC.2017.10008794.

Ramcilovic-Suominen, S., and H. Pülzl. 2018. "Sustainable Development – A 'Selling Point' of the Emerging EU Bioeconomy Policy Framework?" *Journal of Cleaner Production* 172: 4170–4180.

Ramcilovic-Suominen, S. 2023. "Envisioning Just Transformations in and Beyond the EU Bioeconomy: Inspirations From Decolonial Environmental Justice and Degrowth." *Sustainability Science* 18, no. 2: 707–722. https://doi.org/10.1007/s11625-022-01091-5.

Reidsma, P., J. Wolf, A. Kanellopoulos, et al. 2015. "Climate Change Impact and Adaptation Research Requires Integrated Assessment and Farming Systems Analysis: A Case Study in the Netherlands." *Environmental Research Letters* 10, no. 4: 045004. https://doi.org/10.1088/1748-9326/10/4/045004.

Rowan, N., and O. Casey. 2021. "Empower Eco Multiactor HUB: A Triple Helix 'Academia-Industry-Authority' Approach to Creating and Sharing Potentially Disruptive Tools for Addressing Novel and Emerging New Green Deal Opportunities Under a United Nations Sustainable Development Goals Framework." *Current Opinion in Environmental Science & Health* 21: 100254. https://doi.org/10.1016/j.coesh.2021.100254.

Ruben, R., and A. Van Ruijven. 2001. "Technical Coefficients for Bio-Economic Farm Household Models: A Meta-Modelling Approach With Applications for Southern Mali." *Ecological Economics* 36, no. 3: 427–440.

Sánchez-Vergara, J., M. Orel, V. Ferreira, and A. Rus. 2023. "Bracing Community in Rural Coworking: Emerging Trends and Categories." *Journal of Place Management and Development* 17: 345–368. https://doi.org/10.1108/JPMD-06-2023-0065.

Sankhayan, P., N. Gurung, B. Sitaula, and O. Hofstad. 2003. "Bio-Economic Modeling of Land Use and Forest Degradation at Watershed Level in Nepal." *Agriculture, Ecosystems & Environment* 94: 105–116.

Sanz-Hernández, A., E. Esteban, P. Marco, and G. Soriano. 2021. "Forest Bioeconomy in the Media Discourse in Spain." *Forest Policy and Economics* 128: 102476.

Sattler, C., U. Nagel, A. Werner, and P. Zander. 2010. "Integrated Assessment of Agricultural Production Practices to Enhance Sustainable Development in Agricultural Landscapes." *Ecological Indicators* 10, no. 1: 49–61. https://doi.org/10.1016/j.ecolind.2009.02.014.

Schuler, J., and C. Sattler. 2010. "The Estimation of Agricultural Policy Effects on Soil Erosion—An Application for the Bio-economic Model MODAM." *Land Use Policy* 27, no. 1: 61–69.

Seppälä, J., T. Heinonen, T. Pukkala, et al. 2019. "Effect of Increased Wood Harvesting and Utilization on Required Greenhouse Gas Displacement Factors of Wood-Based Products and Fuels." *Journal of Environmental Management* 247: 580–587. https://doi.org/10.1016/j.jenvman.2019.06.031.

Shahid, M. K., A. Batool, A. Kashif, et al. 2021. "Biofuels and Biorefineries: Development, Application and Future Perspectives Emphasizing the Environmental and Economic Aspects." *Journal of Environmental Management* 297: 113268.

Shutes, L., G. Philippidis, R. M'Barek, T. Ronzon, E. Ferrari, and H. Van Meijl. 2017. "SDGs in the Global Magnet Model for Policy Coherence Analysis Highlights."

Singh, N., O. A. Ogunseitan, M. H. Wong, and Y. Tang. 2022. "Sustainable Materials Alternative to Petrochemical Plastics Pollution: A Review Analysis." *Journal of Hazardous Materials* 423: 127157.

Sommerhuber, P., J. Wenker, S. Rüter, and A. Krause. 2017. "Life Cycle Assessment of Wood-Plastic Composites: Analysing Alternative Materials and Identifying an Environmental Sound End-Of-Life Option." *Resources, Conservation and Recycling* 117: 235–248. https://doi.org/10.1016/j.resconrec.2016.10.012.

Spierling, S., E. Knüpffer, H. Behnsen, et al. 2018. "Bio-Based Plastics - A Review of Environmental, Social and Economic Impact Assessments." *Journal of Cleaner Production* 185: 476–491. https://doi.org/10.1016/j.jclepro.2018.03.014.

Spiertz, H. 2012. "Challenges for Crop Production Research in Improving Land Use, Productivity and Sustainability." *International Journal of Agricultural Sustainability* 10, no. 3: 183–193.

Stegmann, P., M. Londo, and M. Junginger. 2020. "The Circular Bioeconomy: Its Elements and Role in European Bioeconomy Clusters." *Resources, Conservation and Recycling: X* 6: 100029. https://doi.org/10.1016/j.rcrx.2019.100029.

The White House. 2012. "National Bioeconomy Blueprint."

Többen, J. R., M. Distelkamp, B. Stöver, S. Reuschel, L. Ahmann, and C. Lutz. 2021. "Global Land Use Impacts of Bioeconomy: An Econometric Input–Output Approach." *Sustainability* 13, no. 23: 13190.

Tranfield, D., D. Denyer, and P. Smart. 2003. "Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review." *British Journal of Management* 14, no. 3: 207–222. https://doi.org/10.1111/1467-8551.00375.

Troxler, D., and A. Zabel. 2022. "Clearing Forests to Make Way for a Sustainable Economy Transition in Switzerland." *Environmental Science & Policy* 136: 541–551.

Tsiropoulos, I., R. Hoefnagels, M. van den Broek, M. K. Patel, and A. P. C. Faaij. 2017. "The Role of Bioenergy and Biochemicals in CO_2 Mitigation

10991719, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/sd.71421 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [29/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Through the Energy System – A Scenario Analysis for the Netherlands." *GCB Bioenergy* 9, no. 9: 1452–1469.

United Nations. 2015. "Transforming Our World: The 2030 Agenda for Sustainable Development."

Upadhyay, T., B. Solberg, and P. Sankhayan. 2006. "Use of Models to Analyse Land-Use Changes, Forest/Soil Degradation and Carbon Sequestration With Special Reference to Himalayan Region: A Review and Analysis." *Forest Policy and Economics* 9, no. 4: 349–371. https://doi.org/10.1016/j.forpol.2005.10.003.

Valente, M., F. Caviggioli, and L. Agostini. 2025. "Space Economy and Sustainability: A Systematic Review." *Sustainable Development* 33, no. 4: 4922–4959.

van Meijl, H., I. Tsiropoulos, H. Bartelings, et al. 2018. "On the Macro-Economic Impact of Bioenergy and Biochemicals – Introducing Advanced Bioeconomy Sectors Into an Economic Modelling Framework With a Case Study for The Netherlands." *Biomass and Bioenergy* 108: 381–397. https://doi.org/10.1016/j.biombioe.2017.10.040.

Varela Pérez, P., B. E. Greiner, and M. von Cossel. 2022. "Socio-Economic and Environmental Implications of Bioenergy Crop Cultivation on Marginal African Drylands and Key Principles for a Sustainable Development." *Sustainability* 14, no. 21: 14387.

Velasco-Muñoz, J., J. Mendoza, J. Aznar-Sánchez, and A. Gallego-Schmid. 2021. "Circular Economy Implementation in the Agricultural Sector: Definition, Strategies and Indicators." *Resources, Conservation and Recycling* 170: 105618. https://doi.org/10.1016/j.resconrec.2021.105618.

Venkatramanan, V., S. Shah, S. Prasad, A. Singh, and R. Prasad. 2021. "Assessment of Bioenergy Generation Potential of Agricultural Crop Residues in India." *Circular Economy and Sustainability* 1, no. 4: 1315–1339.

Vita, G., J. Lundström, E. Hertwich, et al. 2019. "The Environmental Impact of Green Consumption and Sufficiency Lifestyles Scenarios in Europe: Connecting Local Sustainability Visions to Global Consequences." *Ecological Economics* 164: 106322. https://doi.org/10.1016/j.ecolecon.2019.05.002.

Wam, H. K., N. Bunnefeld, N. Clarke, and O. Hofstad. 2021. "Conflicting Interests of Ecosystem Services: Multi-Criteria Modelling and Indirect Evaluation of Trade-Offs Between Monetary and Non-Monetary Measures." *Ecosystem Services* 49: 101268.

Wang, S., B. Chen, Z. Sun, et al. 2023. "The Booming Non-Food Bioeconomy Drives Large Share of Global Land-Use Emissions." *Global Environmental Change* 83: 102760. https://doi.org/10.1016/j.gloenvcha.2023.102760.

Welfle, A. J., A. Almena, M. N. Arshad, et al. 2020. "Sustainability of Bioenergy – Mapping the Risks & Benefits to Inform Future Bioenergy Systems." *Biomass and Bioenergy* 142: 105754.

Williams, R., L. Clark, W. Clark, and D. Raffo. 2021. "Re-Examining Systematic Literature Review in Management Research: Additional Benefits and Execution Protocols." *European Management Journal* 39, no. 4: 521–533. https://doi.org/10.1016/j.emj.2020.09.007.

World Commission on Environment and Development. 1987. "Report of the World Commission on Environment and Development: Our Common Future Towards Sustainable Development 2. Part II. Common Challenges Population and Human Resources 4."

Yaashikaa, P. R., P. Senthil Kumar, A. Saravanan, S. Karishma, and G. Rangasamy. 2022. "A Biotechnological Roadmap for Decarbonization Systems Combined Into Bioenergy Production: Prelude of Environmental Life-Cycle Assessment." *Fuel* 314: 123048.

Yemshanov, D., G. McCarney, G. Hauer, M. Luckert, J. Unterschultz, and D. McKenney. 2015. "A Real Options-Net Present Value Approach to Assessing Land Use Change: A Case Study of Afforestation in Canada." *Forest Policy and Economics* 50: 327–336. https://doi.org/10.1016/j.forpol.2014.09.016.

Zander, P., J. C. J. Groot, E. Josien, et al. 2009. "Farm Models and Economic Valuation in the Context of Multifunctionality: A Review of Approaches From France, Germany, The Netherlands and Portugal." *Ecological Economics* 68, no. 6: 1555–1566.

Zeug, W., K. R. G. Yupanqui, A. Bezama, and D. Thrän. 2021. "Holistic and Integrated Life Cycle Sustainability Assessment of Prospective Biomass to Liquid Production in Germany." *Sustainability* 13, no. 2: 464.

Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Detailed listing of specific articles from the sample.

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Appendix A

TABLE A1 | Articles analysing the variable GHGs in the bioenergy and bioindustry sectors.

Impact	Authors (year)
Bioenergy	
Environmental and economic	Raghu et al. (2011)
	Damania and Scandizzo (2023), Tsiropoulos et al. (2017)
	Pergola et al. (2018), Palander and Hietanen (2014)
	Kokkinos et al. (2020)
	Khan et al. (2021)
	Angouria-Tsorochidou et al. (2022), Pryshliak et al. (2021)
	Balcioglu et al. (2023), Kalogiannidis et al. (2022), Lap et al. (2021), Moreira et al. (2021)
Environmental, economic and social	J. Ali et al. (2021), Kapoor et al. (2020)
	Clauser et al. (2021), Masum et al. (2021), Venkatramanan et al. (2021)
	Arsic et al. (2023), Erickson et al. (2021), Hasan et al. (2022), Welfle et al. (2020)
Environmental	Di Felice et al. (2018)
	Baležentis et al. (2019)
	Hahn et al. (2020)
	Yaashikaa et al. (2022)
Environmental and social	Philp (2015)
Bioindustry	
Environmental and economic	Pätäri et al. (2016)
	Ali (2017)
	Escobar et al. (2018)
	Briassoulis et al. (2021)
	de Souza and Pacca (2021), Escobar and Britz (2021), Ni et al. (2021)
Environmental, economic and social	Jander (2022)
	Dees et al. (2021), Zeug et al. (2021)
	Spierling et al. (2018)
	Blanc, Massaglia, et al. (2019)
	Bauer et al. (2021)
Environmental	Shahid et al. (2021)
	Chakrapani et al. (2022), Singh et al. (2022)

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TABLE A2 | Articles analysing the variable land use in the agriculture and forestry sectors.

Impact	Authors (year)
Agriculture	
Environmental and economic	Bhattarai et al. (2021)
	Popp et al. (2020)
	Sattler et al. (2010)
	Briner et al. (2013)
	Mosquera-Losada et al. (2018)
	Choi and Entenmann (2021)
	Cudlínová et al. (2020), Liobikiene et al. (2020)
	Mahlich et al. (2022)
Environmental, economic and social	Ruben and Van Ruijven (2001)
	Zander et al. (2009)
	Janssen et al. (2010), Schuler and Sattler (2010)
	Foudi (2012)
	Humblot et al. (2022), Juliá and Duchin (2007)
	Helming et al. (2018), Masini et al. (2022)
	Mouysset et al. (2021)
	Goh (2020)
	Bayne and Renwick (2021), Carauta et al. (2021)
	Guillet and Mouysset (2022), Többen et al. (2021), Varela Pérez et al. (2022)
Environmental	Upadhyay et al. (2006)
	Hertel et al. (2013), Spiertz (2012)
	Berger and Troost (2014)
	Ben Fradj et al. (2016)
	Cattaneo et al. (2018)
	Englund et al. (2020)
Environmental and social	Mouysset et al. (2014)
	Castro et al. (2020), Lungarska and Chakir (2018)
	Abhilash (2021)
	Andriamanantena et al. (2024), Immerzeel et al. (2021)
	Grossauer and Stoeglehner (2020)
Forestry	
Environmental and economic	Haggar et al. (2004)
	Bhattarai et al. (2021)
	Briner et al. (2013)
	Yemshanov et al. (2015)
	Lochhead et al. (2021), Wam et al. (2021)
	Krug (2018)
	Hiedanpää et al. (2021)
Environmental, economic and social	Sankhayan et al. (2003)
	Upadhyay et al. (2006)
	Mouysset et al. (2021)
	Sanz-Hernández et al. (2021)
	Többen et al. (2021)
	Ollinaho and Kröger (2021)
Environmental	Troxler and Zabel (2022)
Environmental and social	Primmer et al. (2021)
	Andriamanantena et al. (2024), Immerzeel et al. (2021)

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