RCMOS – Revista Científica Multidisciplinar O
Saber. ISSN: 2675-9128. São Paulo-SP.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

Advances and trends in research on agroforestry systems and environmental sustainability (2022–2026): a bibliometric analysis

Avanços e tendências da pesquisa sobre sistemas agroflorestais e sustentabilidade ambiental (2022–2026): uma análise bibliométrica

Avances y tendencias de la investigación sobre sistemas agroforestales y sostenibilidad ambiental (2022–2026): un análisis bibliométrico

Carlos Alexandre Cunha
Claudia Noleto Maciel Luz
Paulo Sérgio da Rocha
Karina Donizete Martins
Lidiane Rodriguez
Raimundo Nonato Casé de Brito
Roberto Mauro Guarda

Abstract:
This study analyzes the international scientific production on agroforestry systems and environmental sustainability published between 2022 and 2026. The research gathers 3,185 articles and reviews indexed in the Scopus and Web of Science databases and examines, with the bibliometrix package, annual evolution, journals, countries, collaboration, keywords and co-citation. Production grows from 499 documents in 2022 to 836 in 2025, and the partial year of 2026 already totals 867. India and Brazil lead production, while European countries concentrate international co-authorship. The Brazilian share remains close to eleven percent and stands out for its emphasis on soil quality, restoration and national biomes. Carbon terms increase their presence continuously, and climate adaptation and resilience terms advance without replacing them. Co-citation reveals three intellectual bases: ecosystem services, tropical biodiversity, and carbon and soil. The study concludes that the field is expanding, supported by synthesis works and by two climate fronts, mitigation and adaptation, and that term-based selection, without reading the records, limits the interpretation of citation indicators.

Keywords:
Agroforestry; Bibliometrix; Carbon stock; Scientific collaboration; Ecosystem services.

Resumo:
Este estudo analisa a produção científica internacional sobre sistemas agroflorestais e sustentabilidade ambiental publicada entre 2022 e 2026. A pesquisa reúne 3.185 artigos e revisões indexados nas bases Scopus e Web of Science e examina, com o pacote bibliometrix, a evolução anual, os periódicos, os países, a colaboração, as palavras-chave e a cocitação. A produção cresce de 499 documentos em 2022 para 836 em 2025, e o ano parcial de 2026 já soma 867. Índia e Brasil lideram a produção, enquanto países europeus concentram a coautoria internacional. A participação brasileira mantém-se próxima de onze por cento e distingue-se pela ênfase em qualidade do solo, restauração e biomas nacionais. Os termos de carbono ampliam sua presença de modo contínuo, e os de adaptação e resiliência climática avançam sem substituí-los. A cocitação revela três bases intelectuais: serviços ecossistêmicos, biodiversidade tropical e carbono e solo. O estudo conclui que o campo se expande apoiado em trabalhos de síntese e em duas frentes climáticas, mitigação e adaptação, e que a seleção por termos, sem leitura dos registros, limita a interpretação dos indicadores de citação.

Palavras-chave:
Agrofloresta; Bibliometrix; Estoque de carbono; Colaboração científica; Serviços ecossistêmicos.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

Resumen:
Este estudio analiza la producción científica internacional sobre sistemas agroforestales y sostenibilidad ambiental publicada entre 2022 y 2026. La investigación reúne 3.185 artículos y revisiones indizados en las bases de datos Scopus y Web of Science y examina, con el paquete bibliometrix, evolución anual, revistas, países, colaboración, palabras clave y cocitación. La producción crece de 499 documentos en 2022 a 836 en 2025, y el año parcial de 2026 ya suma 867. La India y Brasil lideran la producción, mientras que los países europeos concentran la coautoría internacional. La participación brasileña se mantiene cerca del once por ciento y se distingue por el énfasis en la calidad del suelo, restauración y biomas nacionales. Los términos de carbono expanden su presencia continuamente, y los de adaptación al clima y resiliencia avanzan sin reemplazarlos. La cocitación revela tres bases intelectuales: servicios ecosistémicos, biodiversidad tropical y carbono y suelo. El estudio concluye que el campo se expande en base a trabajos de síntesis y dos frentes climáticos, mitigación y adaptación, y que la selección por términos, sin leer los registros, limita la interpretación de los indicadores de citación.

Palabras clave:
Agroforestería; Bibliometrix; Existencias de carbono; Colaboración científica; Servicios ecosistémicos.

1 Introduction

Agricultural expansion and changes in land use challenge the conservation of natural resources. The agroforestry systems (AFSs), by integrating tree species, agricultural crops and, in certain configurations, livestock components, favor productive diversification and can contribute to biodiversity, soil quality, ecosystem services and climate adaptation (Mukhlis; Rizaludin; Hidayah, 2022; Köthke; Ahimbisibwe; Lippe, 2022).

The environmental benefits of SAFs, including carbon storage, soil conservation and water regulation, vary according to species, age, edaphoclimatic conditions and management. The unequal distribution of evidence between regions and results justifies the systematization of literature (Köthke; Ahimbisibwe; Lippe, 2022; Castle et al., 2022).

Bibliometric studies record the expansion of agroforestry agendas, climate and sustainability, but cut-off differences make it difficult to compare countries and themes (Montes-Escobar et al., 2023; Torres et al., 2023; Sharma et al., 2025; Urdánigo-Zambrano et al., 2026). The update until 2026, a partial year, allows to examine recent trends.

Bibliometrics allows to identify patterns of production, impact, collaboration, thematic and intellectual structure of a scientific field (Donthu et al., 2021; Aria; Cuccurullo, 2017).

Given this context, this article aimed to analyze the international scientific production on agroforestry systems and environmental sustainability from 2022 to 2026, based on publications indexed in Scopus and Web of Science databases. Specifically, we sought to: (i) evaluate the temporal evolution and impact of publications; (ii) identify the main journals, countries and research themes; (iii) analyze scientific collaboration networks and compare Brazilian production with that of other countries; (iv) characterize the intellectual basis of the field through co-citation; and (v) recognize the main trends and gaps in the literature.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

2 Methodology

2.1 Characterization of the research

Quantitative and descriptive bibliometric research, based on selection, unification, standardization and metadata analysis of international publications on SAFs and environmental sustainability.

2.2 Databases, period and search strategy

The collection was carried out in Scopus (Elsevier) and Web of Science (Clarivate) databases, chosen by multidisciplinary coverage and the availability of complete metadata for bibliometric studies. The time frame was from 2022 to 2026. The searches and exports were made on September 19, 2026. As 2026 was underway at the time of collection, its data are partial and were not compared directly with those of full years. There was no language restriction, but the descriptors were written in English.

The strategy combined two blocks of terms. The first refers to agroforestry systems (agrophorestry, "agrophorestry system" or "agrophorestriestry systems"). The second brings together five dimensions of environmental sustainability, "soil quality", "carbon stock", biodiversity or "ecosystem services". In Scopus, the two blocks were applied to the TITLE-ABS-KEY field, which covers title, abstract and keywords of the author and indexed, with PUBYEAR filters > 2021, PUBYEAR < 2027 and type of document article or review. In the Web of Science, the search retrieved the records of the first block, and the second was applied after exportation, by local filter: the records that contained at least one of the five thematic terms in the title, in the abstract, in the author's keywords or in the Keywords Plus, without distinction between capitals and tiny ones. This filter approximates the thematic criterion applied in Scopus, but does not reproduce it exactly, because the fields surveyed differ between the bases.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

2.3 Inclusion and exclusion criteria

Were included: (i) original articles and review articles; (ii) documents published between 2022 and 2026; and (iii) documents containing a term of agroforestry systems and at least one of the five thematic terms in the title, abstract or keywords. Were excluded: (i) duplicate records, within each base and among the bases; (ii) documents outside the period, including early access records with year of publication 2027; (iii) other types of document, such as editorial material, corrections, retractions, abstracts of events, letters, reviews and articles from annals; and (iv) in the Web of Science, records without any of the five thematic terms. The thematic relevance depended on the search strategy and filter by terms, without individual reading of titles, abstracts or complete texts. Table 1 presents the selection flow.

Table 1 – Flow of selection of records by database.

Stage	Scopus	Web of Science
Exported records	2.565	6.689
After period filter (2022–2026) and type filter (article or review)	2.565	6.516
After thematic filter (five terms)	2.565	2.726
Single documents after internal duplicate removal	2.546	2.722
Present in both bases	2.083	2.083
Exclusive of the base	463	639

Source: Scopus and Web of Science. Developed by the author. In Scopus, the period, type of document and thematic terms were already included in the search. The unified corpus brings together 3,185 documents (2,083 + 463 + 639).

2.4 Unification and standardization of records

Scopus records were exported in CSV format, with all available fields, including the cited references. The Web of Science were exported in spreadsheets with complete registration, without the cited references. All processing was done in the R environment. Scopus was imported with the convert2df function of the bibliometrix package (Aria; Cuccurullo, 2017), and Web of Science spreadsheets were readxl and converted to the bibliometrix tag fields.

The identification of duplicates used the DOI, in tiny ones, as the main key and, in the absence thereof, the normalized title (without accents, punctuation and distinction of capitals) combined with the year. The same rule was applied within each base and between the bases. When a document appeared in both, Scopus was kept, because it contained the cited references, and the largest number of citations between the two bases was adopted, since each one has citations with its own criteria.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

The metadata were standardized before the analysis. The names of the journals were converted to capitals, without information between parentheses and without punctuation, to unite variants of the same title. In the thematic analyzes, only the keywords of the author were used, with grouping variants by dictionary of synonyms (e.g. agrophorestry systems in agroforestry; carbon storage and carbon stocks in carbon stock); Keywords Plus was not used, because there is only in the Web of Science. The countries were extracted from the field of affiliations, counting each country once per document, with unification of variants and maintenance of countries with at least three occurrences (107 countries). No analyses were made by author or institution: the standardization of names without unique identifier grouped homonyms, and the heterogeneity of the field of affiliations between the bases did not allow to identify institutions reliably.

2.5 Analysis procedures

The analyzes were organized into five dimensions. The first, of scientific performance, comprised the production and citations per year, the distribution by type of document and language, the most productive journals and countries and the most cited documents. The bibliometrix provided the general indicators of the corpus, such as annual growth rate, number of co-authors per document and proportion of international co-authorship. As 2026 is partial and the most recent documents had less time to accumulate citations, these were used only in a descriptive way.

The second dimension, of scientific collaboration, was based on the collaboration network between the 30 most productive countries, built with the biblioNetwork function from the affiliations of the authors. The proportion of documents with international co-authorship per country and per year and the frequency of pairs of countries were also calculated. The production with the participation of authors affiliated to Brazil was compared to that of other countries regarding collaboration, citations, type of document, language, journals and keywords.

The third dimension, of thematic structure, used the author's keywords. The frequency of the terms, the co-occurrence network of the 50 most frequent terms (normalização por associação e layout de Fruchterman e Reingold, 1991), the thematic map (250 terms, minimum frequency of 5, without reduction to radical and three labels per group), which classifies groups according to centrality and density, and topics in trend per year (Aria; Cuccurullo, 2017). To circumvent the concentration of documents in the final years, it was also calculated the annual proportion of documents with at least one term of four thematic groups defined by the authors (carbon, adaptation and resilience, biodiversity and soil), in relation to the documents with keywords of the author in each year.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

The fourth dimension, of intellectual structure, consisted in the analysis of cocitation, made only with the 2,546 Scopus documents, because the Web of Science records did not contain the cited references. Each reference received its own key, composed by the surname of the first author, by the year and by the first 45 letters and numbers of the title, which allowed to gather variants of the same work. References that do not belong to the literature on the subject were excluded, such as statistical programs and packages and normative acts. The 30 most cited references composed a cocitation matrix, from which the network was obtained, and the groups were detected by Louvain's algorithm (Blondel et al., 2008).

The fifth dimension was a thematic core indicator, created to measure the effect of the absence of reading screening. The documents were separated into two groups: those in which an agroforestry term appears in the title or keywords of the author and those in which it appears only in the abstract or indexed keywords.

2.6 Tools

The R, version 4.6.2 (R Core Team, 2026), and the bibliometrix (version 5.5.0) and igraph (version 2.3.4) packages were used, in addition to dplyr, stringr, ggplot2, readxl and openxlsx. Bibliometric analysis was performed on November 9, 2026. The complementary analyzes (annual production per base, citations per year, journal concentration, annual frequency of keywords, comparison between Brazil and other countries, pairs of countries and thematic core indicator) were calculated from the unified corpus in Python, with the pandas library (version 3.0.5).

3 Results and discussion

3.1 An overview of the corpus and annual production

The final corpus gathered 3,185 documents published between 2022 and 2026, of which 2,743 are original articles (86.1%) and 442 are review articles (13.9%). The documents are distributed in 812 journals and were signed by 13.949 authors, with an average of 5.94 co-authors per document. Only 91 papers (2.9%) have unique authorship, and 40.66% involve international co-authorship.

English predominates (96.8%), followed by Spanish (40 documents), French (23) and Portuguese (17). The search in English and the coverage of bases can contribute to this asymmetry.

Annual production increased from 499 documents in 2022 to 836 in 2025, after a drop of 12.6% in 2023. The years 2025 and 2026 (partial) concentrate 53.5% of the corpus (Table 2).

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

Table 2 – Production and citations per year of publication.

Year	Documents	In Scopus	In Web of Science	Citations	Citations per document	Uncited (%)
2022	499	368	439	10.479	21,0	2,6
2023	436	337	381	8.559	19,6	3,9
2024	547	433	461	6.373	11,7	5,9
2025	836	683	698	4.401	5,3	16,4
2026 (partial)	867	725	743	748	0,9	66,4
Total	3.185	2.546	2.722	30.560	9,6	24,3

Source: Scopus and Web of Science. Developed by the author. The columns by base include the documents present in both bases.

The concentrated increase from 2025 is consistent with the expansion of the field described in longer period surveys (Sharma et al., 2025; Maciel et al., 2026; Urdánigo-Zambrano et al., 2026). Part of this growth, however, may reflect the overall increase in the volume of scientific publications and the expansion of the coverage of the bases, and not just the specific interest in the subject. The available data do not allow to separate these effects.

The corpus accumulated 30,560 citations, with an average of 9,6 and a median of 4 citations per document. The difference between mean and median indicates asymmetric distribution: 775 documents (24.3%) have not yet been cited, while 23 received 100 citations or more. As expected in a recent cut, citations decrease from the oldest years to the youngest, and two thirds of 2026 documents have not yet been cited. The reviews have disproportionate weight on the impact: they are 13.9% of documents, but concentrate 30.4% of citations (9.284), with an average of 21.0 citations per document, compared to 7.8 in the original articles.

3.2 Journals

Agrophorestry Systems leads the production, with 382 documents (12.0% of the corpus), followed by Sustainability (81) and Forests (78), according to Table 3.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

Table 3 – Fifteen journals with the highest number of documents and respective citations.

Journal	Documents	Citations	Citations per document
Agroforestry Systems	382	2.190	5,7
Sustainability	81	1.808	22,3
Forests	78	902	11,6
Agriculture, Ecosystems and Environment	76	1.050	13,8
Trees, Forests and People	69	489	7,1
Land	66	567	8,6
Journal of Environmental Management	51	611	12,0
Frontiers in Sustainable Food Systems	43	707	16,4
Agricultural Systems	41	531	13,0
Scientific Reports	40	477	11,9
Science of the Total Environment	36	939	26,1
Biodiversitas	32	176	5,5
Plant Science Today	28	33	1,2
Agronomy	27	540	20,0
Land Use Policy	27	372	13,8

Source: Scopus and Web of Science. Developed by the author.

The 15 most productive journals concentrate 33.8% of the corpus; 462 out of 812 published only one document. The dispersion in three zones (14, 112 and 686 journals) is compatible with Bradford's Law (Bradford, 1934). Volume and impact do not coincide: the citation averages depend on age and type of documents.

3.3 Countries and scientific collaboration

India (424), Brazil (348), United States (302), Germany (281) and China (273) lead the production by affiliation (Table 4). Each country is counted once per document, admitting multiple countries per publication.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

Table 4 – Fifteen countries with the highest number of documents, participation as the corresponding author's country and international collaboration.

Country	Documents (affiliation)	Documents (corresponding author)	International co-authorship (%)	Citations per document
India	424	394	16,5	9,0
Brazil	348	293	28,0	6,9
United States	302	139	45,3	11,7
Germany	281	163	60,1	15,6
China	273	215	22,3	10,3
Indonesia	242	180	25,6	6,4
Ethiopia	225	181	29,8	8,9
United Kingdom	218	113	69,9	14,2
France	201	87	62,1	14,5
Spain	190	99	49,5	9,4
Italy	150	86	38,4	9,7
Mexico	135	111	21,6	5,7
Switzerland	122	44	79,5	11,3
Colombia	115	77	40,3	–
The Netherlands	113	37	67,6	14,1

Source: Scopus and Web of Science. Elaborated by the author with the bibliometrix package (R). The last three columns refer to the documents in which the country is the corresponding author. Colombia's citation value is not included in the output of the package, which lists the twenty most cited countries.

The group of leading countries coincides with that of previous surveys of a longer period, but in another order. Montes-Escobar et al. (2023), when analyzing 1993–2022, found United States, India, Brazil, United Kingdom and Germany in the top five positions, and Sharma et al. (2025), for 1980–2024, United States, India and Brazil. In the 2022–2026 cut, India and Brazil outperform the United States, which suggests a recent gain in participation of these two countries. The comparison is only indicative, as the studies differ in bases, search strategies and counting criteria.

Tropical and subtropical countries, such as India, Brazil, Indonesia, Ethiopia and Mexico, present international co-authorship from 16.5% to 29.8%, while Germany, United Kingdom, France, Switzerland and the Netherlands record 60.1% to 79.5%, according to the corresponding author's criterion, which constitutes only an approximation of scientific leadership.

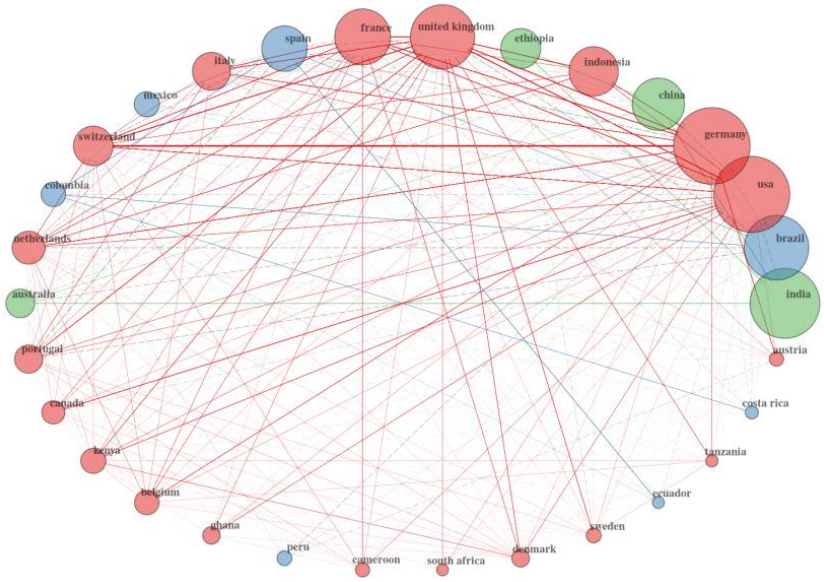
The international co-authorship of the corpus, measured by the presence of more than one country in affiliations, fell from 43.2% in 2022 and 45.1% in 2024 to 37.6% in 2025 and 38.0% in 2026. The recent increase in production came, therefore, mainly from works of national authorship.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

The collaboration network among the 30 most productive countries formed three groups (Figure 1). The largest, with 19 countries, brings together United Kingdom, France, Germany, United States, Italy, Switzerland, the Netherlands, Portugal, Belgium, Denmark, Sweden, Austria and Canada, in addition to Indonesia, Kenya, Ghana, Cameroon, Tanzania and South Africa. The second, with seven countries, connects Brazil to Spain, Mexico, Colombia, Peru, Ecuador and Costa Rica. The third brings together India, China, Ethiopia and Australia. In number of documents, the most frequent pairs are Germany and Switzerland (47), Brazil and United States (38), United Kingdom and United States (33), Switzerland and United Kingdom (31) and Germany and the United Kingdom (31).

Figure 4. Collaboration network among the 30 most productive countries. The size of the nodes indicates the production, and the colors, the clusters.



Source: Scopus and Web of Science. Elaborated by the author with the bibliometrix package (R).

The composition of the groupings suggests regional and linguistic affinities, with partnerships between countries in the Global North and tropical groups (Gallo et al., 2024; Pauletto et al., 2025), without allowing to infer their causes.

3.4 Brazilian production compared to other countries

Brazil participates in 348 documents (10.9%), being the corresponding author's country in 293. Its annual participation ranged from 10.0% to 11.9%. Table 5 compares the groups.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

Table 5 - Indicators of documents with and without participation of authors affiliated to Brazil.

Indicator	Brazil	Other countries
Documents	348	2.825
International co-authorship (%)	39,4	41,0
Citations per document (average)	8,2	9,8
Citations by document (median)	3	4
Documents without citation (%)	26,4	23,9
Review articles (%)	11,5	14,2
Documents in English (%)	94,5	97,1

Source: Scopus and Web of Science. Developed by the author. Twelve documents without identified country were not included.

The average citations of Brazilian documents (8.2) are lower than the others (9.8). The difference is associated with the type of collaboration: Brazilian documents with international co-authorship receive an average of 10.7 citations, compared to 6.7 of those exclusively national. The same pattern occurs in the corpus as a whole (12.6 and 7.6) and is compatible with the association between international collaboration and greater number of citations per publication described for institutions from five continents (DUARTE; SANTOS; RODRIGUES, 2025). These are descriptive differences, without statistical test, which do not allow to attribute the cause of citations to collaboration.

The thematic agenda is the point in which Brazilian production is most distinguished. Soil quality appears in 7.7% of the Brazilian documents with keywords and in 1.3% of the others; Brazil accounts for 26 of the 62 occurrences of the term in the corpus. Atlantic Forest (7.1%, without occurrence in the others), soil organic matter (3.6% to 0.4%), deforestation (3.0% to 1.3%), Amazon (2.7% to 0.1%), ecological restoration (2.4% to 0.5%) and family farming (2.1% to 0.1%). In the opposite direction, carbon sequestration (3.3% to 6.5%), climate change (3.6% to 6.3%) and ecosystem services (7.4% to 10.3%) are less frequent.

The Brazilian profile converges with Schuler et al. (2022), which identified emphasis on the Atlantic Forest and soil quality. However, soil quality integrated the search and geographic terms are naturally concentrated in Brazil.

3.5 Most cited documents

Table 6 presents the ten most cited documents. Among the first 20, 13 are reviews; together, the 20 concentrate 12.8% of citations. Several address broad themes, in which SAFs are just one of the practices examined.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

Table 6 – Ten most cited documents of the corpus.

First author and year	Title	Journal	Type	Citations
Beillouin, 2023	A global meta-analysis of soil organic carbon in the Anthropocene	Nature Communications	Article	462
Fahad, 2022	Agroforestry systems for soil health improvement and maintenance	Sustainability	Review	444
Habib-ur-Rahman, 2022	Impact of climate change on agricultural production; issues, challenges, and opportunities in Asia	Frontiers in Plant Science	Review	416
Nguyen, 2023	Security risks from climate change and environmental degradation: implications for sustainable land use transformation in the Global South	Current Opinion in Environmental Sustainability	Review	366
Khangura, 2023	Regenerative agriculture—a literature review on the practices and mechanisms used to improve soil health	Sustainability	Review	336
Kabato, 2025	Towards climate-smart agriculture: strategies for sustainable agricultural production, food security, and greenhouse gas reduction	Agronomy	Review	211
Castle, 2022	Evidence for the impacts of agroforestry on ecosystem services and human well- being in high-income countries: a systematic map	Environmental Evidence	Article	151
Mihrete, 2025	Crop diversification for ensuring sustainable agriculture, risk management and food security	Global Challenges	Review	134
Rasmussen, 2024	Joint environmental and social benefits from diversified agriculture	Science	Article	131
Burgess, 2022	The deployment of intercropping and agroforestry as adaptation to climate change	Crop and Environment	Review	126

Source: Scopus and Web of Science. Developed by the author. For documents present in both bases, the largest number of citations was adopted. The documents of this table are the object of analysis and do not integrate the list of references.

To measure this effect, the documents were separated according to the position of the term agroforestry. In 2,046 documents (64,2%), an agroforestry term appears in the author's title or keywords. In the other 1,139 (35.8%), it appears only in the abstract or keywords indexed by the databases. This second group is proportionally higher among the exclusive Web of Science documents (342 out of 639, or 53.5%) than those present in both databases (611 out of 2.083, or 29.3%), which is consistent with the broader thematic filter applied to that base.

The two groups have the same median, of 4 citations, and close averages (9.3 and 10.2), but the second weighs more at the top of the distribution: 9 of the 20 most cited documents and 35 of the 100 most cited belong to it. The presence of the term in the title does not guarantee relevance, as shown by an article on agroforestry waste management that is among the 20 most cited, with 121 citations. For these reasons, citation indicators do not

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

measure directly the influence of agroforestry research, and the absence of reading screening should be considered in the interpretation of the entire corpus.

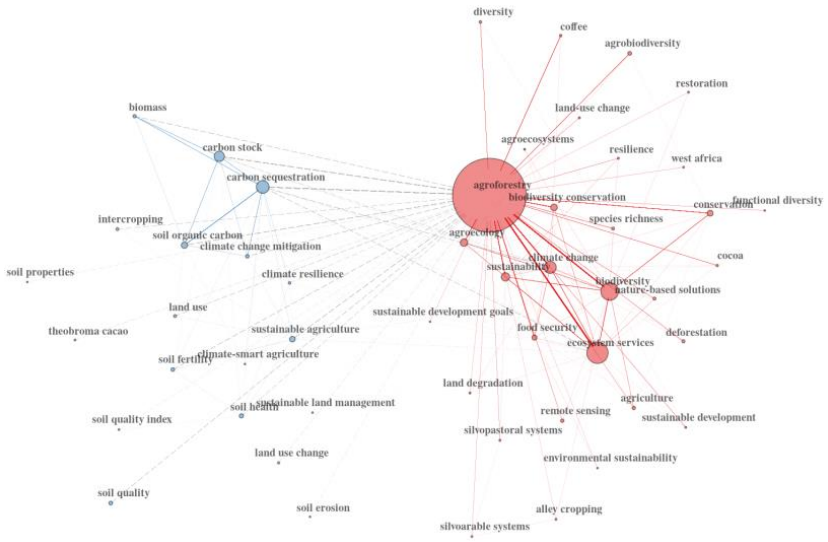
3.6 Keywords and co-occurrence network

Among 7,923 different keywords, agrophorestry (1.086), ecosystem services (306), biodiversity (246), carbon sequestration (189), climate change (183) and carbon stock (157) stand out.

The interpretation of these frequencies requires caution, because part of them stems from the cut itself. The term agrophorestry and four of the five thematic terms of the search strategy (biodiversity, ecosystem services, carbon stock and soil quality) were a condition of entry into the corpus, so that their position in the ranking does not measure, separately, the interest of the area. The terms that did not integrate the search are more informative and, still, are among the most frequent: carbon sequestration, climate change, agroecology, soil organic carbon, food security and soil health.

The co-occurrence network of the 50 most frequent keywords is organized in two blocks around agrophorestry (Figure 2). The first, more numerous, connects the term to biodiversity, ecosystem services, conservation, agroecology, food security and crops such as cocoa and coffee. The second group groups the terms carbon stock, carbon sequestration, soil organic carbon and biomass, of quality and health of the soil and climatically intelligent agriculture.

Figure 2 – Co-occurrence network of the 50 most frequent keywords.



Source: Scopus and Web of Science. Elaborated by the author with the bibliometrix package (R).

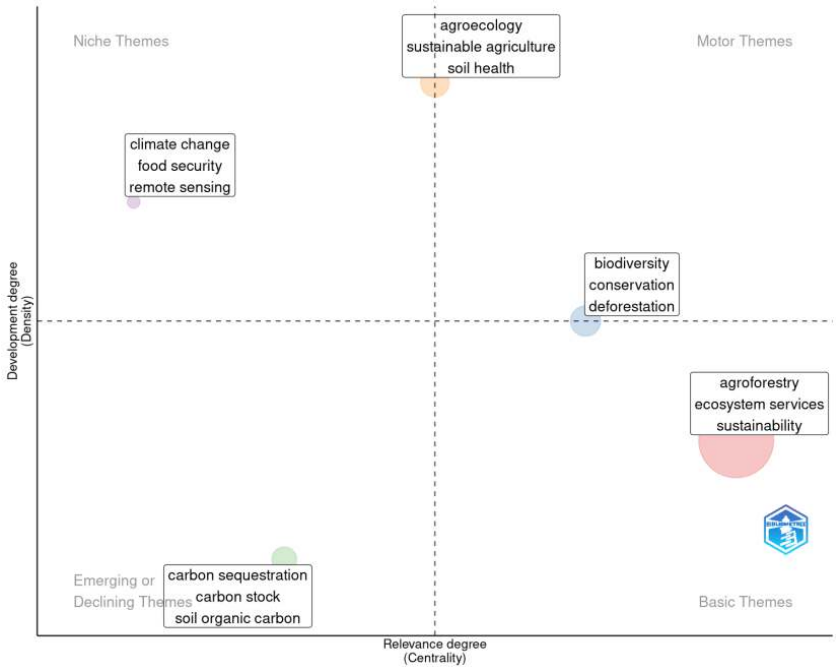
Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

3.7 Thematic structure and trends

The thematic map identifies five groups according to centrality and density (Figure 3). The basic themes are transversal; no group fully occupies the motor quadrant.

Figure 3 – Thematic map of the author's keywords (minimum frequency 5).



Source: Scopus and Web of Science. Elaborated by the author with the bibliometrix package (R).

Two results contradict what the frequency of terms would suggest. The first is the position of the carbon group in the quadrant of emerging or declining themes, although carbon sequestration and carbon stock are among the six most frequent keywords. As the map represents the entire period in a single cut, it does not distinguish the two situations. The annual frequency of the terms solves the doubt: the proportion of documents with at least one carbon term grew continuously, from 10.5% in 2022 to 16.6% in 2026 (Table 7). It is, therefore, an emerging theme, not in decline. The low density indicates that this set, although growing, uses little cohesive vocabulary, and the low centrality, which is linked little to other themes, which is consistent with the separate block observed in the cooccurrence network.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

Table 7 - Annual proportion of documents with at least one term from each thematic group (% of documents with the author's keywords).

Group of terms	Documents	2022	2023	2024	2025	2026 (partial)
Carbon	433	10,5	12,0	13,9	15,2	16,6
Adaptation and resilience	137	3,2	3,8	3,4	4,5	6,2
Biodiversity	481	17,3	14,7	16,4	18,3	12,6
Soil	213	5,5	6,0	8,0	6,9	7,7

Source: Scopus and Web of Science. Developed by the author. Carbon: carbon sequestration, carbon stock, soil organic carbon, biomass and climate change mitigation. Adaptation and resilience: climate change adaptation, climate adaptation, climate resilience, climate-smart agriculture, resilience and adaptation. Biodiversity: biodiversity conservation, conservation, species richness and agrobiodiversity. Soil: soil health, soil quality, soil fertility, soil quality index and soil properties.

Table 7 confirms the advance of terms of adaptation and resilience, which practically doubled their participation, from 3.2% to 6.2%. It also shows that this advance did not occur to the detriment of carbon, which grew in all years and remains about three times more frequent. The isolated term that most gained space was carbon sequestration, from 2.5% in 2022 to 9.1% in 2026. The climate agenda of agroforestry systems thus seems to expand on both fronts, mitigation and adaptation, and not migrate from one to another, which is consistent with the view that these two functions are complementary in these systems (Mbow et al., 2014; Maciel et al., 2026).

3.8 Intellectual basis: co-citation

The cocitation analysis, restricted to Scopus, identified three groups among the 30 most cited references (Table 8).

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

Table 8 – Thirty references most cited by the corpus (Scopus), number of documents that cite them and cocitation group.

No.	Reference (authors, year and title)	Documents	Group
1	Jose, 2009. Agroforestry for ecosystem services and environmental benefits: an overview	249	1
2	Torralba et al., 2016. Do European agroforestry systems enhance biodiversity and ecosystem services? A meta-analysis	166	1
3	Tscharntke et al., 2011. Multifunctional shade-tree management in tropical agroforestry landscapes – a review	116	2
4	Walkley e Black, 1934. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method	116	3
5	Fahad et al., 2022. Agroforestry systems for soil health improvement and maintenance	113	1
6	Albrecht e Kandji, 2003. Carbon sequestration in tropical agroforestry systems	95	3
7	Nair, Kumar e Nair, 2009. Agroforestry as a strategy for carbon sequestration	95	3
8	Chave et al., 2014. Improved allometric models to estimate the aboveground biomass of tropical trees	92	3
9	Lorenz e Lal, 2014. Soil organic carbon sequestration in agroforestry systems. A review	87	3
10	Myers et al., 2000. Biodiversity hotspots for conservation priorities	84	2
11	Bhagwat et al., 2008. Agroforestry: a refuge for tropical biodiversity?	81	2
12	Zomer et al., 2016. Global tree cover and biomass carbon on agricultural land: the contribution of agroforestry to global and national carbon budgets	81	3
13	Montagnini e Nair, 2004. Carbon sequestration: an underexploited environmental benefit of agroforestry systems	79	3
14	Feliciano et al., 2018. Which agroforestry options give the greatest soil and above ground carbon benefits in different world regions?	76	3
15	Mbow et al., 2014. Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa	75	3
16	Nair, 1993. An introduction to agroforestry	75	1
17	Niether et al., 2020. Cocoa agroforestry systems versus monocultures: a multi-dimensional meta-analysis	74	2
18	Muchane et al., 2020. Agroforestry boosts soil health in the humid and sub-humid tropics: a meta-analysis	71	3
19	Shi et al., 2018. Agroforestry systems: meta-analysis of soil carbon stocks, sequestration processes, and future potentials	70	3
20	Kuyah et al., 2019. Agroforestry delivers a win-win solution for ecosystem services in sub-Saharan Africa. A meta-analysis	69	1
21	Castle et al., 2022. Evidence for the impacts of agroforestry on ecosystem services and human well-being in high-income countries: a systematic map	63	1
22	De Beenhouwer, Aerts e Honnay, 2013. A global meta-analysis of the biodiversity and ecosystem service benefits of coffee and cacao agroforestry	63	2
23	Mbow et al., 2014. Agroforestry solutions to address food security and climate change challenges in Africa	63	1
24	Clough et al., 2011. Combining high biodiversity with high yields in tropical agroforests	62	2

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

No.	Reference (authors, year and title)	Documents	Group
25	Cairns et al., 1997. Root biomass allocation in the world's upland forests	61	3
26	Chave et al., 2005. Tree allometry and improved estimation of carbon stocks and balance in tropical forests	59	3
27	De Stefano e Jacobson, 2018. Soil carbon sequestration in agroforestry systems: a meta-analysis	59	3
28	Duffy et al., 2021. Agroforestry contributions to smallholder farmer food security in Indonesia	58	1
29	Quandt, Neufeldt e Gorman, 2023. Climate change adaptation through agroforestry: opportunities and gaps	56	1
30	Blaser et al., 2018. Climate-smart sustainable agriculture in low-to-intermediate shade agroforests	55	2

Source: Scopus. Developed by the author. Titles and years according to the field of references cited in the records. The references of this table are object of analysis and, with the exception of those cited in the text, do not integrate the list of references.

The co-citation distinguishes three bases: ecosystem services and general framework (9 references), tropical biodiversity (7) and carbon and soil (14). This structure converges with the co-occurrence, indicating relatively distinct lines of research, without demonstrating absence of integration.

3.9 Study limitations

The results must be interpreted in the light of six limitations. The first is the language of descriptors: the search restricted to terms in English tends to underestimate production in Portuguese and Spanish, which is relevant in a field in which Brazil and other Latin American countries have expressive participation. The second is the difference between the bases: the fields searched in Scopus and the Web of Science are not equivalent, and the thematic filter applied to the Web of Science after exportation does not exactly reproduce the logic of Scopus search.

The third is the absence of individual reading of records. The thematic relevance depended only on the presence of the terms, and in 35.8% of the documents the term agroforestry does not appear in the title or in the author's keywords. The fourth is the short time frame and with incomplete final year, which limits the conclusions on trends. The fifth concerns the unperformed analyzes, by author and by institution, due to the lack of unique identifiers and heterogeneity of the affiliation field. The sixth is that the Web of Science records were exported without the cited references, which restricted the cocitation analysis to Scopus documents and prevented the bibliographic coupling with both bases.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

4 Final considerations

Scientific production on agroforestry systems and environmental sustainability grew significantly between 2022 and 2026, with an increase of 67.5% in the complete years and concentration of more than half of the documents in 2025 and 2026. The growth occurred in the two bases consulted and came mainly from works of national authorship, which reduced the proportion of international co-authorship. The impact, measured descriptively by citations, focuses on reviews and other synthesis works.

Production is distributed between two profiles of countries. India, Brazil, Indonesia and Ethiopia produce a lot and collaborate little with the outside world, while European countries and the United States often appear as partners in works led by other countries. Brazil occupies the second position, maintains stable participation, close to 11%, and presents its own agenda, focused on soil quality, restoration and national biomes, with less presence of the climatic framework that predominates in international literature.

As for the themes, the carbon terms continuously expanded their presence and those of climate adaptation and resilience practically doubled, without replacing each other. The climate agenda of agroforestry systems expands, therefore, on two fronts, mitigation and adaptation. The cocitation showed three intellectual bases, ecosystem services, tropical biodiversity and carbon and soil, the latter being the largest and supported by common methodological references. Biodiversity and carbon studies remain, however, little connected to each other, which constitutes a gap for research that jointly evaluates these benefits.

The main contribution of the study is to offer an updated picture of the field, with data up to 2026 and with the comparison between Brazilian and international production. Its main limitation is the selection by terms, without reading the records, which recommends caution in interpreting citation indicators. It is recommended that future works expand the descriptors for Portuguese and Spanish, include regional bases, adopt title and abstract screening, analyze the thematic evolution by sub-periods and repeat the analysis when 2026 is complete.

References

ARIA, M.; CUCCURULLO, C. bibliometrix: an R-tool for comprehensive science mapping analysis. Journal of Informetrics, v. 11, n. 4, p. 959-975, 2017. DOI: https://doi.org/10.1016/j.joi.2017.08.007.

BLONDEL, V. D.; GUILLAUME, J.-L.; LAMBIOTTE, R.; LEFEBVRE, E. Fast unfolding of communities in large networks. Journal of Statistical Mechanics: Theory and Experiment, v. 2008, n. 10, P10008, 2008. DOI: https://doi.org/10.1088/1742-5468/2008/10/P10008.

BRADFORD, S. C. Sources of information on specific subjects. Engineering, v. 137, p. 85-86, 1934.

CASTLE, S. E.; MILLER, D. C.; MERTEN, N.; ORDONEZ, P. J.; BAYLIS, K. Evidence for the impacts of agroforestry on ecosystem services and human wellbeing in high-income

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

countries: a systematic map. Environmental Evidence, v. 11, n. 1, art. 10, 2022. DOI: https://doi.org/10.1186/s13750-022-00260-4.

DONTHU, N.; KUMAR, S.; MUKHERJEE, D.; PANDEY, N.; LIM, W. M. How to conduct a bibliometric analysis: an overview and guidelines. Journal of Business Research, v. 133, p. 285-296, 2021. DOI: https://doi.org/10.1016/j.jbusres.2021.04.070.

DUARTE, I.; SANTOS, H. G. G.; RODRIGUES, M. L. A general analysis of the impact of international collaboration on the citation indices of scientific publications from 60 institutions across five continents. Anais da Academia Brasileira de Ciências, v. 97, n. 1, e20241035, 2025. DOI: https://doi.org/10.1590/0001- 3765202520241035.

FRUCHTERMAN, T. M. J.; REINGOLD, E. M. Graph drawing by force-directed placement. Software: Practice and Experience, v. 21, n. 11, p. 1129-1164, 1991. DOI: https://doi.org/10.1002/spe.4380211102.

GALLO, A. S.; GERVAZIO, W.; CHRISTOFOLETTI, J. H.; MAGALHÃES, L. P.; OLIVEIRA, R. E. Agroforestry systems, adaptation and resilience in agricultural landscapes: a bibliometric analysis. Agroforestry Systems, v. 98, n. 7, p. 2649- 2666, 2024. DOI: https://doi.org/10.1007/s10457-024-01061-z.

KÖTHKE, M.; AHIMBISIBWE, V.; LIPPE, M. The evidence base on the environmental, economic and social outcomes of agroforestry is patchy—an evidence review map. Frontiers in Environmental Science, v. 10, art. 925477, 2022. DOI: https://doi.org/10.3389/fenvs.2022.925477.

MACIEL, E. R. F. et al. Scientific trends on agroforestry and climate change: a scientometric analysis (2014–2024). Agroforestry Systems, v. 100, n. 6, art. 165, 2026. DOI: https://doi.org/10.1007/s10457-026-01552-1.

MBOW, C.; SMITH, P.; SKOLE, D.; DUGUMA, L.; BUSTAMANTE, M. Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. Current Opinion in Environmental Sustainability, v. 6, p. 8-14, 2014. DOI: https://doi.org/10.1016/j.cosust.2013.09.002.

MONTES-ESCOBAR, K. et al. Trends in agroforestry research from 1993 to 2022: a topic model using Latent Dirichlet Allocation and HJ-Biplot. Mathematics, v. 11, n. 10, art. 2250, 2023. DOI: https://doi.org/10.3390/math11102250.

MUKHLIS, I.; RIZALUDIN, M. S.; HIDAYAH, I. Understanding socio-economic and environmental impacts of agroforestry on rural communities. Forests, v. 13, n. 4, art. 556, 2022. DOI: https://doi.org/10.3390/f13040556.

PAULETTO, D. et al. Adoption and diversity of agroforestry systems in the Amazon biome: a bibliometric overview. Land, v. 14, n. 3, art. 524, 2025. DOI: https://doi.org/10.3390/land14030524.

R CORE TEAM. R: a language and environment for statistical computing. Vienna: R Foundation for Statistical Computing, 2026. Disponível em: https://www.Rproject.org/. Acesso em: Set/2026.

SCHULER, H. R.; ALARCON, G. G.; JONER, F.; SANTOS, K. L.; SIMINSKI, A.; SIDDIQUE, I. Ecosystem services from ecological agroforestry in Brazil: a systematic map of scientific evidence. Land, v. 11, n. 1, art. 83, 2022. DOI: https://doi.org/10.3390/land11010083.

SHARMA, U.; SHARMA, S.; SANKHYAN, N.; SHARMA, S.; SHARMA, S. A global review of agroforestry research and policy directions: addressing ecological and

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano VII, v.1 2026 | submissão: 14/11/2026 | aceito: 21/11/2026 | publicação: 26/11/2026

socioeconomic challenges through systematic review and bibliometric analysis. Forest Policy and Economics, v. 181, art. 103639, 2025. DOI: https://doi.org/10.1016/j.forpol.2025.103639.

TORRES, B.; HERRERA-FEIJOO, R.; TORRES, Y.; GARCÍA, A. Global evolution of research on silvopastoral systems through bibliometric analysis: insights from Ecuador. Agronomy, v. 13, n. 2, art. 479, 2023. DOI: https://doi.org/10.3390/agronomy13020479.

URDÁNIGO-ZAMBRANO, J.; TORRES, B.; DE-PABLOS-HEREDERO, C.; HERRERA-FEIJOO, R. J.; SINCHE CHELE, F.; GARCÍA, A. Environmental, climatic, and production perspectives in agroforestry research: reassessing the position of rural livelihoods through bibliometric analysis. Land, v. 15, n. 9, art. 1571, 2026. DOI: https://doi.org/10.3390/land15091571.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.