Global research trends of natural fibers: A bibliometric review from 2000 to 2023

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Abstract

Fibre crops represent a significant category of economically valuable plants, traditionally cultivated for their fibres but now increasingly recognized for diverse applications, including food, animal feed, cosmetics and medicine. Natural fibres offer a sustainable alternative to petroleum-based synthetics, contributing to their growing prominence in technological and industrial innovations. This bibliometric analysis reviews global research trends on natural fibres from 2000 to 2023, providing insights into author performance, journal impact, institutional contributions and country involvement. The study analyses 2027 publications, revealing a steady annual growth rate of 5.82 % in publications. Across 601 sources, peer-reviewed articles dominate, averaging 22.33 citations per article, with 80535 references indicating a robust scholarly discourse. The analysis highlights the international scope of fibre crop research, with contributions from 78 countries, led by China, India and the USA. China accounts for the highest number of single-country publications, while nations like Pakistan and the Netherlands exhibit strong international collaboration. A detailed keyword analysis reveals dominant themes, including cotton, mechanical properties and the rise of sustainable materials such as hemp and kenaf. These trends mirror the increasing demand for eco-friendly fibres and the industry's shift towards sustainable innovations across diverse sectors. This comprehensive analysis underscores the evolving significance of natural fibres in global research and their potential to contribute to a more sustainable future.

Keywords: bibliometric analysis; cotton; eco-friendly; fibre crops; natural fibres

Introduction

Fibre crops represent a significant category of economically valuable plants, including major crops such as cotton and jute, which are widely cultivated for their industrial and commercial applications, particularly in the textile sector Initially grown for their fibres, these crops have evolved to provide additional materials, including food, animal feed, cosmetics and medicine. Hemp (*Cannabis sativa*), once primarily cultivated for its strong fibres, is now also used for hemp seeds (as a food source), hemp oil (in cosmetics and dietary supplements) and even medicinal applications. South Asia and the United States are the primary global regions for fibre crop cultivation(1). Renewable and easily accessible natural fibres have the potential to enhance the technological properties of composite materials. particularly in industries such as automotive, construction and packaging, where they are used to produce lightweight, sustainable components. By improving the mechanical strength and thermoacoustic characteristics, they have emerged as viable alternatives to synthetic fibres(2). Previous works addressed the need for natural fibres to reduce reliance on petroleum-based synthetics, offering

sustainability, energy savings and wide availability (3). Bibliometric analysis is a valuable statistical tool to assess the scientific impact of authors, institutions and countries in a specific field over time(4 - 7). This article presents a bibliometric analysis of the evolving landscape of scientific enquiry into commercially significant fibre crops. This bibliometric investigation can serve as a crucial tool for pinpointing current focal points, evaluating research strengths and weaknesses, identifying informational voids and establishing key researchers for potential collaboration. It can not only guide research prioritisation and highlight emerging areas of study but also facilitate enhanced commercialisation efforts within the fibre industry.

Methodology

This bibliometric analysis examines publication trends in "Research Trends of Natural Fibres" using data retrieved from Scopus, the largest academic database managed by Elsevier (8, 9). Data collection occurred in June-August 2024 and the search command utilized in this study is described as follows: "TITLE-ABS-KEY ("Fiber crops" OR "Fibre crops" OR "Natural fibre" OR

"Natural fiber") AND PUBYEAR > 1999 AND PUBYEAR <= 2024 AND (LIMIT-TO (SUBJAREA, "AGRI")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (PUBSTAGE, "final")). This search yielded 2027 documents and bibliographic data were retrieved in CSV format. The bibliometrix R package (v4.2.3) was installed and executed in RStudio(10). The biblioshiny app, which is a part of the bibliometrix, was used for bibliometric analysis. Descriptive statistics, including percentages, averages and frequencies, were applied and the findings are presented in tabular and graphical formats. Only the documents indexed in Scopus were included in this study.

Results

Publication overview

The data in Table 1 provide a clear overview of the research trends in natural fibres from 2000 to 2023. A total of 2027 documents, published across 601 sources including journals and books, reflect a growing academic and industrial interest in this field with an annual growth rate of 5.82 %. The average document age of 10.1 years indicates that the field is well established, continuing to build on foundational research. Each document receives an average of 22.33 citations, underscoring its relevance and impact within the scholarly community. With 80535 references, the literature exhibits a rich and complex discourse, supported by a wide range of research topics, as reflected in the 9820 keywords plus and 5332 author keywords. The involvement of 6283 authors, including 173 who contributed single-authored documents out of 210 single-authored papers, points to a strong preference for collaborative research. This is further emphasised by the average of 4.37 co-authors per document and an 18.06 % rate of international co-authorship, highlighting the global and interdisciplinary collaboration driving advancements in the study of natural fibres.

Type of document

The data on document types (Table 1) show that peer-reviewed articles dominate natural fibre research, with 1610 entries, highlighting the field's strong focus on continuous academic enquiry. Books (24) and book chapters (128) were less common, indicating the presence of more specialised and comprehensive content. Conference papers with 85 entries underscored the importance of sharing preliminary findings at academic gatherings. Reviews (143) reflect an active interest in summarising and synthesising existing research. Other types, such as notes (18), short surveys (13), reports (2) and editorials (1), are less frequent and represent niche explorations or updates

within the field. This diverse distribution of document types shows a dynamic and evolving research landscape in fibre crops and natural fibres.

Publication and citation trends

The publication and citation trends of natural fibres from 2000 to 2023 have shown significant fluctuations and patterns (Fig. 1a, Table 2). Initially, approximately 50 documents were published annually in 2000, but the numbers varied, with a notable decline from 47 documents in 2008 to 37 documents in 2010. From 2011 onwards, there has been a steady increase, with a sharp rise after 2015 and a peak of 180 documents in 2023. This sudden rise could be attributed to the ongoing research on the potential of renewable resources.

In terms of citation trends, the average number of citations per document peaked at 49.38 in 2010, signifying a high impact from the research conducted that year. This increase is largely attributed to highly cited papers, who received 320 citations and who received 300 citations (11, 12). In recent years, the average number of citations per article has declined, likely because newer publications have less time to accumulate citations. However, there were notable peaks in citations, such as in 2012 (3.47 citations per year) and 2017 (3.53 citations per year), reflecting the rapid recognition of papers from those years. Despite the increase in the number of publications, the decreasing number of years per publication suggests that the long-term impact of recent studies remains unfolding. This reflects the evolving nature of research on natural fibres as they continue to grow and develop.

Journal participation and top journals

A total of 601 sources has contributed to the publication on natural fibres, reflecting a broad and diverse academic interest. The analysis of journal performance showed significant variations in impact and citation metrics across these journals (Table 3). Fig. 1b and Fig. 1c highlight that *Industrial Crops and Products* is the leading journal in this field, with 283 articles out of a total of 2027 documents, far surpassing the others. This journal has a high h-index of 61, a g-index of 101 and a total citation count of 13097, making it a key player in natural fibre research since 2000. Its substantial impact indicates its prominence and relevance in the field.

Other important journals include the *Journal of the Textile Institute* (62 articles) and *Wool Record* (59 articles), which specifically focus on fibre-related research. Additionally, *International Woodfibre Report* and *Nordic Pulp and Paper Research Journal* demonstrate the importance of natural fibres

Table 1. Overview of research trends and document types relevant to publications in natural fibres (2000-2023)

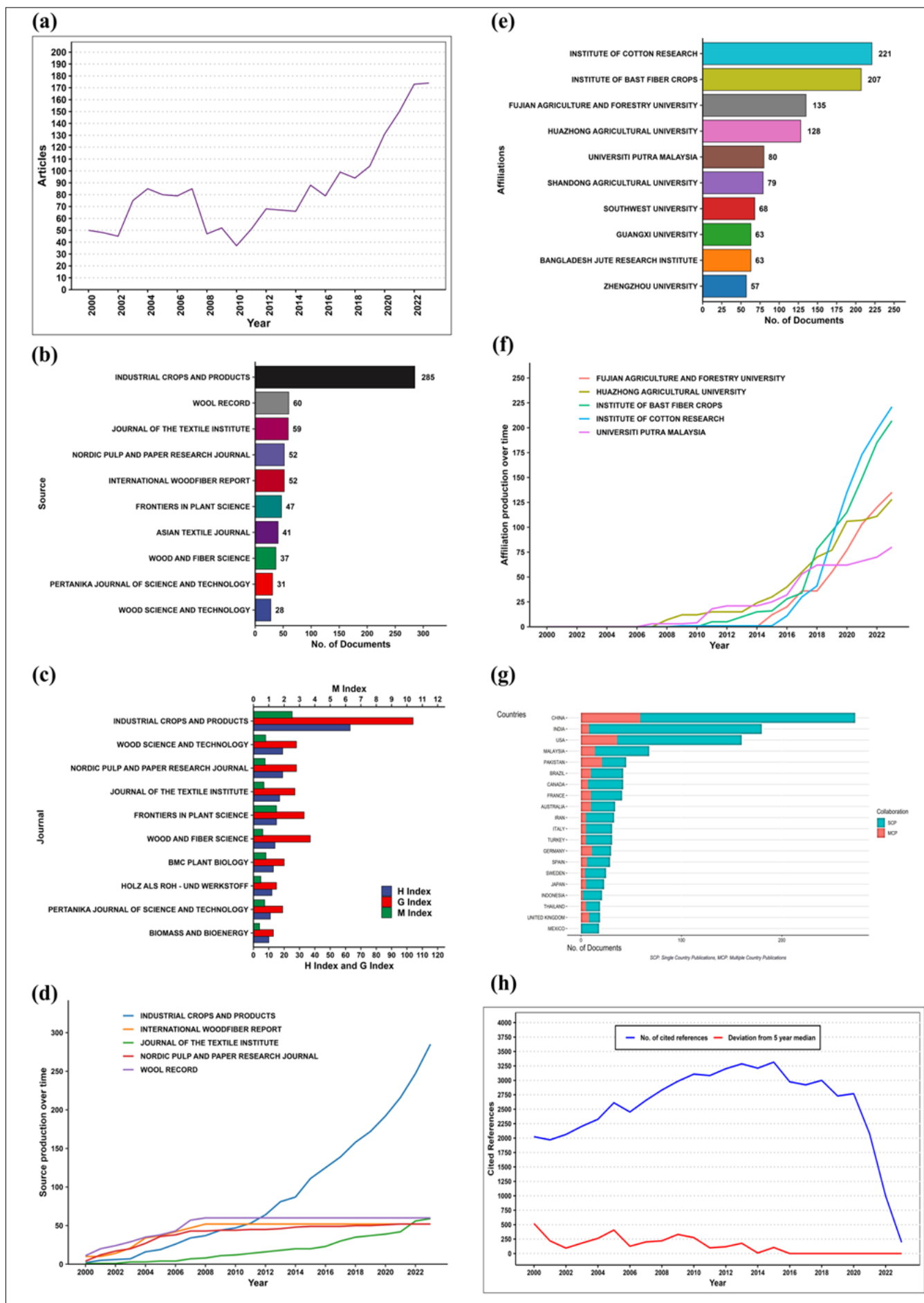| Description	Results	Document types	Number
Timespan	2000:2023	Article	1610
Sources (Journals, Books, etc.)	601	Book	24
Documents	2027	Book chapter	128
Annual growth rate (%)	5.82	Conference paper	85
Document average age (years)	10.1	Conference review	1
Average citations per document	22.33	Editorial	1
References	80535	Erratum	2
Keywords plus (ID)	9820	Note	18
Author's keywords (DE)	5332	Report	2
Authors	6283	Review	143
Authors of single-authored docs	173	Short survey	13
Single-authored documents	210		
Co-authors per document	4.37		
International co-authorship (%)	18.06		

Fig. 1. (a) Publication trend relevant to natural fibres (b) Journal's participation relevant to publications in natural fibres (c) Top 10 journals in publication on natural fibres and their impact factors (d) Top 5 journal's production over time in the field of natural fibres (e) Institutional participation in the publication on natural fibres (f) Affiliation production over time (g) Country contribution to natural fibres publication (h) Reference Publication Year Spectroscopy (RPYS).

Table 2. Average citation per article by year relevant to publications in natural fibres

Year	No. of Articles	Mean total citations per article	Mean total citations per Year	Citable aears
2000	49	23.69	0.95	25
2001	48	26.29	1.1	24
2002	45	34.27	1.49	23
2003	75	21.37	0.97	22
2004	85	39.32	1.87	21
2005	79	28.09	1.4	20
2006	79	36.57	1.92	19
2007	85	25.19	1.4	18
2008	47	20.72	1.22	17
2009	52	32.02	2.0	16
2010	37	49.38	3.29	15
2011	51	22.12	1.58	14
2012	68	45.13	3.47	13
2013	67	31.87	2.66	12
2014	65	31.97	2.91	11
2015	87	27.76	2.78	10
2016	78	27.15	3.02	9
2017	99	28.23	3.53	8
2018	94	21.6	3.09	7
2019	103	18.28	3.05	6
2020	132	12.89	2.58	5
2021	150	11.07	2.77	4
2022	172	6.79	2.26	3
2023	180	2.49	1.25	2

Table 3. Top 10 journals in and their metrics relevant to publications in natural fibres

Journal	h index	g index	m index	Total citations	No. of publication	Publication year start
Industrial Crops and Products	61	101	2.44	13097	283	2000
Nordic Pulp and Paper Research Journal	19	27	0.76	936	52	2000
Wood Science and Technology	18	28	0.75	980	28	2001
Journal of the Textile Institute	16	26	0.64	856	62	2000
Frontiers in Plant Science	14	32	1.40	1076	47	2015
Wood And Fiber Science	14	37	0.60	1376	37	2002
Bmc Plant Biology	12	19	0.75	908	19	2009
Holz Als Roh - Und Werkstoff	12	15	0.48	415	15	2000
Biomass And Bioenergy	10	13	0.4	1022	13	2000

in the wood and paper industries. *Nordic Pulp and Paper Research Journal* and *Wood Science and Technology* showed robust performance, each with an h-index of approximately 19 and a g-index exceeding 25, underscoring their consistent impact through substantial citation counts and publishing activity.

On the other hand, newer journals such as *3 Biotech*, which started in 2016, have lower metrics with an h-index of 3 and fewer total citations, reflecting their emerging influence. Similarly, journals such as *Acta Horticulturae* and *African Journal of Biotechnology* have lower performance indicators, with h-index values of around three, indicating modest citation influence within their scientific communities. The diversity of journals, including those with fewer articles, points to a broad range of specialised topics being covered within the field, from agricultural practices to technological innovations, highlighting both regional and global scientific interest.

Journal production over time

Fig. 1d illustrates the publication trends from 2000 to 2023 across key journals involved in industrial crops, textiles, wood and plant sciences. *Industrial Crops and Products* started with just two articles in 2000 and steadily grew, reaching 38 articles by 2023, reinforcing its dominance in the field. Conversely, journals such as *Wool Record* and *International Wood fiber Report* started with 10 articles each in 2000 but have since dropped to zero publications in recent years, suggesting a reduced academic or industrial focus on these topics. Meanwhile, the *Journal of the Textile Institute* peaked at 14 publications in 2022, indicating a continued interest in textiles, although the numbers have fluctuated over the years. Overall, this trend underscores

growing academic and industrial interest in plant science research, particularly concerning sustainable and renewable resources. At the same time, there has been a notable decline in the wool and wood fibre sectors, possibly reflecting the changing priorities in both academia and industry over the last two decades.

Author participation, citation and their impact factors in natural fibres publication

In the field of natural fibre research, a total of 6283 authors have contributed, with several standing out based on their citation impact and productivity. Notably, the field is highly collaborative, with 89.64 % of publications resulting from multi-author collaborations, while only 10.36 % were single-author efforts. Table 4 shows the top 10 authors in the domain based on key bibliometric indicators. Among them, Zhang L was the most influential, boasting an h-index of 11 and a g-index of 26, with total citations accounting for 1063. These metrics indicate that Zhang L's work is both highly cited and widely acknowledged in the field, marking him as a leading researcher in natural fibres. Another notable author who began publishing in 2016 but has quickly risen to prominence with an h-index of 12 and an impressive m-index of 1.33. This indicates a rapid accumulation of citations relative to the length of his career, signifying that his research has had a strong impact over a short period. Other prominent contributors include Xu J and Li J, with h-indices of 13 and 12, respectively. Their work has garnered significant citations, showcasing their influence in advancing the understanding of natural fibres. The g-index of these researchers further underscores their productivity as their publications

Table 4. Top 10 author participation, citation and their impact factors relevant to publications in natural fibres

Author	H index	G index	M index	Total citations	No. of publication	Publication year start
Xu J	13	18	0.65	373	18	2005
Li J	12	23	1.00	573	23	2013
Wang X	12	22	0.75	491	26	2009
Wang Y	12	20	1.33	442	24	2016
Qi J	11	17	1.00	315	19	2014
Zhang L	11	26	0.57	1063	26	2006
Zhang X	11	22	0.64	488	22	2008
Li X	10	17	0.47	351	17	2004
Li Y	10	16	0.62	512	16	2009

continue to attract widespread scholarly attention. These data not only highlight the leading figures in the field but also emphasise the importance of collaboration and citation dynamics in the development of natural fibre research. Identifying these key players can aid in forming research partnerships and driving future innovation in this area.

Institutional participation in natural fibres research

Fig. 1e and Fig. 1f depict the contributions of various institutions to the field of natural fibre research, both in terms of the total number of articles published and their production trends over time. The Institute of Cotton Research leads the field with 225 articles, followed closely by the Institute of Bast Fiber Crops that published 207 articles by 2023. Initially, they contributed only a few articles annually, starting with one article per year between 2009 and 2014, but experienced a significant increase in output, highlighting their significant role in research and development within the sector.

Other prominent contributors include Fujian Agriculture and Forestry University (135 articles) and Huazhong Agricultural University (128 articles). Both institutions consistently expanded their research contributions, highlighting their commitment to developing sustainable materials and innovations in the field. Notably, University Putra Malaysia entered the field in 2007 with just three articles but steadily grew to publish 80 articles by 2023. Likewise, Huazhong Agricultural University, which began publishing in 2008, increased its output from seven articles to 128 by 2023, indicating a sustained and growing research interest in natural fibres. These trends reflect a global interest in fibre research, with institutions across various countries contributing significantly to the development of sustainable practices and materials. The continued expansion of research output underscores the increasing importance of natural fibres in diverse applications ranging from agriculture to industrial use.

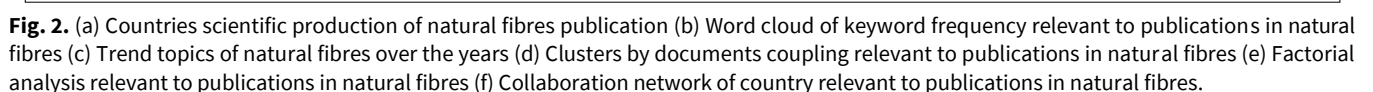### Country contribution and scientific production to natural fibres publication

Fig. 1g illustrates the global research output on natural fibres, showing significant variations across countries in terms of both volume and collaboration patterns. In total, 78 countries contributed to the 2027 articles analysed. Most of these articles came from single-country publications (SCP), totalling 1728, while multi-country publications (MCP) amounted to 478. China, India and the USA lead total research output, underscoring their strong positions in this sector. China boasts the largest number of articles but with an MCP ratio of 21.5 %, indicating a moderate level of international collaboration. The USA, while third in publication volume, had the highest MCP ratio at 22.4 %, indicating a strong emphasis on international collaboration Despite its large output, India shows a significantly lower MCP ratio of 4.4 %, suggesting that its research efforts are more

nationally focused, with less reliance on international collaborations. Countries with smaller research outputs, such as Luxembourg, Cameroon and Morocco, have shown a very high or complete reliance on international collaboration (MCP ratio of 100 % for several smaller nations). This could indicate a strategy or necessity for partnering with other countries to enhance their research capabilities. In terms of collaboration, Pakistan and the Netherlands stand out with higher MCP ratios of 47.8 % and 58.3 %, respectively. This suggests a strong inclination towards international research collaboration, despite their smaller total outputs compared to global leaders such as China and the USA.

Fig. 2a reflects a diverse global distribution, with contributions spanning across various continents, highlighting the global nature of the natural fibre industry. China has a remarkable frequency of 2372, which likely refers to the number of author affiliations or appearances across publications, rather than the total number of distinct articles. This figure far surpasses other nations and highlights China's extensive involvement and recurring contribution in natural fibre research India followed with 1045 papers and the USA ranked third with 897 papers. Together, these three countries account for a substantial portion of the global research output in this field. The mid-level contributors include Malaysia (403), Pakistan (294) and Brazil (267).

Reference Publication Year Spectroscopy (RPYS)

RPYS is an analytical method employed to identify the historical origins and major discoveries within research fields, offering a timeline of significant developments(13). In the case of natural fibre research from 2000 to 2023, the RPYS reveals distinct trends, providing insight into the evolution of this field over time. As depicted in Fig. 1h, natural fibre research saw a steady rise in publications, beginning with 2073 documents in 2000 and reaching a peak of 3434 documents in 2015. This era marked a period of expansion and growing interest with advancements in sustainable materials and eco-friendly technologies. The year 2000 stood out, with 544 citations, while 2005 had 421 citations, representing key moments of significant scientific contributions that shaped the trajectory of the field. However, post-2015, the number of publications began to decline, with a significant decrease observed in 2022 (1162 publications) and 2023 (241 publications). This downturn may be attributed to factors such as shifting research priorities, reduced funding in the sector, or delays in indexing recent publications particularly for 2023, where the lower count might reflect incomplete database coverage rather than an actual drop in output This decline was mirrored by a drop in citations, with a downward trend beginning in 2016. The lowest citation count occurred in 2023, with 1986 citations, illustrating a recent decline in research activity and recognition. Interestingly, 2018 and 2020 maintained

Fig. 2. (a) Countries scientific production of natural fibres publication (b) Word cloud of keyword frequency relevant to publications in natural fibres (c) Trend topics of natural fibres over the years (d) Clusters by documents coupling relevant to publications in natural fibres (e) Factorial analysis relevant to publications in natural fibres (f) Collaboration network of country relevant to publications in natural fibres.

relatively stable publication numbers, but net citations during these years were notably zero, suggesting that while research continued to be published, it did not generate substantial citation impact. Overall, the RPYS data illustrate an initial phase of dynamic growth and increasing interest in natural fibre research, driven by a surge in sustainable innovation and scientific discovery. However, this period of expansion has led to a decline in both publications and citations, suggesting a potential shift in the field's focus or broader research priorities.

Keywords frequency and trend topics over the years

The analysis of keyword frequency and trending topics in natural fibre research reveals significant insights into the dominant themes and evolving interests over the years (Fig. 2b). Cotton emerged as the most frequently mentioned keyword, with 103 occurrences, underscoring its central role in the textile industry and natural fibre research. Mechanical properties also receive substantial attention, with 94 mentions, highlighting the critical focus on understanding the strength, flexibility and durability of fibres for applications in both textiles and bio composites. Other fibres, such as kenaf (51), hemp (39) and jute (31), are also prominently featured, reflecting their growing importance as sustainable and versatile materials. Fig. 2c illustrates the trending topics in natural fibre research over the years. Hemp, kenaf and cotton stood out, with hemp peaking in 2014 due to their versatility and environmental benefits and gained attention as a sustainable fibre source from 2011 to 2018. Cotton has maintained its high activity in the textile industry from 2014 to 2020. Natural fibres sustained interest from 2012 to 2020, emphasising eco-friendly alternatives. Research has focused on mechanical properties such as strength and stiffness to enhance durability. Chemical composition studies, especially those on lignin, from 2006 to 2019, underscored the structural insights. Emerging research areas include thermal properties and responses to environmental stressors, reflecting the global push towards sustainability and the adaptation of natural fibres to various industrial applications. This analysis highlights the dynamic and evolving nature of natural fibre research, moving from traditional applications to innovative, sustainability-focused developments.

Bibliometric coupling of documents

Fig. 2d presents a scientific mapping that highlights the most essential papers by their impact (horizontal axis) and interrelatedness (centrality, vertical axis). The analysis focused on documents and selected the top 219 from a total of 2027, based on a minimum threshold where each selected document shared at least 10 % of its references with others in its cluster indicating strong thematic linkage. The impact of each document is determined by the number of local citations. Consequently, 5 clusters emerged based on the centrality and impact of each topic represented by different colours. The size of each cluster node is proportional to the number of documents contained. Pink cluster (1) is characterised by a centrality of 0.377, an impact of 2.258 and includes 41 documents located in the upper right quadrant. These documents are essential and closely related to the theme of fibre crops and natural fibres, with key contributions from earlier studies (14, 15). The Blue cluster (2), with a centrality of 0.403, an impact of 2.635 and 69 documents situated in the upper left quadrant, are similarly highly essential and very related to the theme, featuring notable papers (16, 17). The Green cluster (3) has a centrality of 0.417 and

an impact of 1.996 and comprises 20 papers, including some early findings (18) located in the central left quadrant, these documents are related to the topic but are less essential. Orange cluster (4) has a centrality of 0.369, an impact of 1.959 and includes 29 papers, with contributions from early researchers (19) found in the lower right quadrant, these papers are central but less related to the theme. Finally, the purple cluster 5, with a centrality of 0.438 and an impact of 1.875 and 43 papers, including early results (20), are positioned in the lower left quadrant. These documents are less essential and less related to the topic of fibre crops and natural fibres but may feature emerging terms that are useful to the theme.

Factorial analysis of keywords

The factorial analysis of keywords in natural fibre research reveals distinct dimensions (Dim 1 and Dim 2) that organise the relationships between various terms within the field (Fig. 2e). Dim 1 appears to distinguish keywords primarily based on their association with agricultural aspects such as "cotton", "fibre crops" and specific fibres like "kenaf" and "hemp". This dimension also encompasses terms related to material properties such as "mechanical properties", "cellulose" and "tensile strength", suggesting a focus on the physical characteristics and applications of natural fibres. In contrast, Dim 2 seems to differentiate keywords based on environmental factors and technological applications, including terms like "drought", "salinity", "thermal properties" and "chemical treatment". These dimensions collectively organise the keywords into clusters that reflect their thematic similarities and research contexts, emphasising the interdisciplinary nature of fibre crops and natural fibre research. This analysis provides valuable insights into how different aspects of research within this domain are interconnected and prioritised, highlighting key areas of focus and interest in the scientific community.

Co-citation network of authors

The co-citation network analysis of authors in natural fibre research reveals the existence of three distinct clusters, each characterised by different central figures and citation patterns. Table 5 summarises the top five authors from each of the three clusters identified in the co-citation network. It specifies the number of articles in each cluster and provides the following key metrics: betweenness, closeness and PageRank. Betweenness indicates the role of authors within the network, closeness measures the efficiency of nodes in information transport and PageRank reflects the prestige and influence of the publications. High PageRank publications are deemed high quality and are considered "must cite" works in the research domain.

Cluster 1 includes authors such as Bledzki AK, Mohanty AK, Baley C, Bourmaud A and Faruk O. Among these, Mohanty AK has a notably high betweenness centrality (3.85), indicating a critical role in the flow of information between other authors in the network. Faruk O leads in PageRank (0.02), which signifies a higher level of influence and citation frequency, positioning him as a key figure in this research. Cluster 2 is dominated by authors such as Zhang J, Li X and Li Y, with Zhang J standing out due to a remarkably high betweenness centrality score of 129.94 far exceeding others like Li X (3.85). This suggests that Zhang J plays a key bridging role across multiple subfields or collaborative groups, acting as a major connector in the research network. Zhang J also holds the highest PageRank (0.03), indicating strong overall influence within the author collaboration structure This

Table 5. Co-citation network of authors relevant to publications in natural fibres

Node	Cluster	Betweenness	Closeness	PageRank	Number of articles
Bledzki Ak	1	0.57	0.01	0.03	
Mohanty Ak	1	3.85	0.01	0.02	
Baley C	1	0.19	0.01	0.02	10
Bourmaud A	1	1.40	0.01	0.02	
Faruk O	1	1.56	0.01	0.02	
Zhang J	2	129.94	0.02	0.03	
Li X	2	101.49	0.02	0.03	
Li Y	2	58.78	0.01	0.02	15
Wang Y	2	51.86	0.01	0.02	
Zhang Y	2	34.18	0.01	0.02	
Wendel JF	3	7.71	0.01	0.03	
Paterson AH	3	11.61	0.01	0.04	
Yang Z	3	14.95	0.01	0.03	23
Li F	3	16.68	0.01	0.04	
Zhang T	3	19.59	0.01	0.04	

indicates that Zhang J is a central and highly cited figure in this field. Cluster 2 exhibited a more hierarchical citation structure with stronger ties and higher citation impacts than Cluster 1. Cluster 3 features authors such as Paterson AH and Zhang T. Zhang T hold the highest PageRank (0.04) and betweenness centrality (19.59), indicating strong citation relevance and connections among the various research streams. Overall, these clusters depict varying degrees of author influence and citation impact within the field of natural fibre research, reflecting different research emphases and network structures.

Countries collaboration network

Fig. 2f highlights global research collaborations in natural fibres, with darker blue shades indicating a higher research output. China, the USA and India are the most prominent contributors, as shown by their deep blue colour and extensive network of connections with other nations, particularly North America, Europe and Asia. Thicker lines between these countries emphasise stronger research partnerships, notably between China and the USA as well as among European countries. In contrast, lighter blue countries like Australia, Brazil and South Africa contribute less overall but still engage in notable international collaborations. Smaller contributors, particularly in Africa and South America, rely heavily on partnerships with more research-intensive nations, as indicated by their significant connections on the map. Overall, the map reflects the global nature of natural fibre research, with China, the USA and Europe driving much of the progress through international collaboration.

Conclusion

This bibliometric study analysed 2027 documents indexed in the Scopus database from 2000 to 2023, focusing on natural fibres. The findings indicate a growing scientific trend, supported by the contribution of 601 sources with 45263 citations and an annual growth rate of 5.82 %. Widely accepted bibliometric tools such as Biblioshiny (from the Bibliometrix R package) and VOS viewer have been employed for data extraction and analysis, contributing to significant research advancements in the field. These methods have helped highlight the considerable impact of collaborative efforts on productivity among authors, institutions and countries Additionally, this study provided relevant information on natural fibres, made available sources more accessible and explained the collaboration between countries and authors. Ultimately, this study provides guidance for researchers and for future research projects.

Acknowledgements

Authors' contributions

Conceptualization was done by PG and SS. KV and HT performed the data screening. Formal analysis was done by AD, AK and AG. SS and VSM prepared the methodology. Software part was handled by SS, PG and KV. HT, AD and VSM supervised the work. Visualization was done by AK, AG, PG and SS. PG, KV, HT and VSM prepared the original draft. Writing the review and editing were done by AK, AG, AD and VSM. All the authors significantly contributed to this study. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

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