

Climate Change Impacts, Agro-Ecosystem Stress, and Adaptive Agricultural Strategies in South Asia: A Scopus Bibliometric Analysis (1997–2026)

Dipika Biswas¹

¹Department of Sociology, Begum Rokeya University, Rangpur, Bangladesh.

Email: dipika.biswas@soc.brur.ac.bd

Received:

January 12, 2026

Revised:

March 16, 2026

Accepted:

April 26, 2026

Published:

May 2, 2026

Corresponding Author:

Author Name*:

Dipika Biswas

Email*:

dipika.biswas@soc.brur.ac.bd

DOI:

10.63158/journalisi.v8i2.1574

© 2026 Journal of Information Systems and Informatics. This open access article is distributed under a (CC-BY License)



Abstract. This study presents a bibliometric analysis of research on climate change impacts, agro-ecosystem stress, and adaptive agriculture in South Asia from 1997 to 2026. Initially, 2,260 documents were retrieved mainly from the Scopus database, and 1,580 documents were selected after applying predefined screening criteria. Using bibliometric and informatics-based analytical tools, the study examines publication trends, collaboration networks, influential contributors, and thematic evolution in the field. The findings reveal a significant increase in scholarly output, particularly after 2015, indicating growing regional and global concern over climate-induced agricultural challenges. Keyword analysis highlights the dominance of climate change, drought, and resilience, reflecting a strong focus on ecological vulnerability, food security, and livelihood sustainability. Country-level analysis shows that India leads research production, followed by Pakistan, Bangladesh, and China. Major thematic clusters include climate resilience, sustainable agriculture, food security, and environmental stress management. Despite this growth, gaps remain in the integration of information systems, interdisciplinary collaboration, and region-specific adaptation strategies. This study provides a structured overview of the intellectual landscape and offers useful insights for researchers, policymakers, and practitioners working toward climate-resilient and sustainable agriculture in South Asia.

Keywords: Climate Change, Agro-Ecosystem Stress, Climate-Resilient Agriculture, Bibliometric Analysis, South Asia

1. INTRODUCTION

South Asia is generally acknowledged as one of the world's most climate-prone regions. It is facing an increasing number of environmental disasters such as cyclones, salinity intrusion, flash floods, riverbank erosion and drought[1], [2]. These climate-induced ecological crisis produce significant dangers to agricultural systems, degrading food security, rural means of support and environmental sustainability. Heat wave, irregular precipitation patterns, whimsical weather events are already restructuring agricultural productivity, degrading natural resource sources, especially soil and water[3], [4].

As a consequence, agro-ecosystems across the region are becoming flimsier, with increased vulnerability to environmental stress and limited adaptive capacity[5], [6]. Simultaneously, agriculture is adversely affected by climate change and play a role in its progression. Although agricultural activities namely livestock production, high yield farming and fertilizer and pesticides use is primary sources of greenhouse Gas emission, can be easily unstable due to such as heat stress and water unavailability[7]. This dual role reinforces the urgency of maintaining adaptive and sustainable agricultural strategies[8], [9]. The goal of these strategies is to lessen negative environmental impacts while sustaining production rate[10].

In these circumstances, the past two decades have experienced a noticeable growth of research at the intersection of climate change, agro-ecosystem stress, and agricultural stress adaptation[11], [12], [13], [14]. Emerging dimensions of research such as climate-smart agriculture (CSA), agroecology, and sustainable intensification of farming, stress on capacity-building, resource optimization and emission reduction to protect environment[9], [15], [16]. Recent studies have further extended the analytical scope from on farm- practices to agri-food systems, integrating supply chain resilience, renewable energy usages and digital technologies such as artificial intelligence (AI), the Internet of Things (IoT), and precision agriculture[17], [18]. In parallel, ecosystem-based viewpoints call attention to the value of biodiversity and ecosystem services in reserving soil fertility, pollination, and natural pest control regulation[19], [20], [21]. Despite this rising body of literature, the knowledge structure remains scattered. Existing bibliometric studies tend to focus either on global patterns or on limited defined themes such as crop productivity or climate adaptation. As a result, they often ignore the interconnected patterns among

climate impacts, ecosystem stress, and adaptive agricultural challenges[5], [22]. Besides, South Asia despite its extreme vulnerability to climate hazards persists understudied in systematic knowledge mapping[23]. This fractured status of the discipline reduces the ability to identify organized research trajectories, thematic consolidation and research gaps necessary for informed policy and practice.

This study overcomes these limitations by offering a coherent, region-specific bibliometric research on climate change impacts, agro-ecosystem stress, and adaptive agriculture in South Asia spanning from 1997 to 2026. The originality of this work reflected in three key contributions. First, it makes a unified analytical framework that combinedly examines climate impacts, ecosystem stress, and agricultural adaptation, rather than treating them as separated domains. Second, it delivers a specific regional synthesis for South Asia. Simultaneously it tries to enable a more context-sensitive understanding of research dynamics in a highly vulnerable yet unexplored region. Third, it deliberately embeds bibliometric analysis within an Information Systems and Informatics (IS/I) perspective, emphasizing data-driven knowledge structuring, computational mapping[4], [24].

From an IS/I perspective, the exponential growth of scientific publications demands advanced analytical approaches to categorized and interpret complicated and large amount of bibliographic data. Bibliometric methods, supported by informatics tools such as Bibliometrix (R) and network visualization techniques, facilitate structured exploration of publication trends, collaboration patterns, and thematic flourishing[22] What's more, these strategies transform unsorted scholarly data into usable knowledge, thereby invigorating pragmatic decision-making around digital knowledge management[25]. In this context, bibliometric analysis is not only a descriptive tool but a core informatics methodology for comprehending the evolution of cross-disciplinary research topics[26]. Whilst digital technologies such as AI, IoT, and precision agriculture are widely discussed as solutions to climate-related agricultural stresses, their representation and incorporation within the intellectual structure of the literature remain inadequately explored[27]. This gap underscores the necessity for an informatics-driven meta-analysis that not only portray organized research outputs but also reveals the degree to which data-driven and digital paradigms are devising the field.

Accordingly, this study adopts a bibliometric and informatics-based analytical framework to investigate the evolution of research on climate change, agro-ecosystem stress, and adaptive agriculture in South Asia. Specifically, it aims to: (i) analyze temporal publication trends; (ii) identify key research themes, influential contributors, and collaboration networks; and (iii) detect emerging topics using computational mapping and network analysis system. By incorporating environmental research with Information Systems and Informatics, this study enhancing this discipline methodologically. It provides a detailed understanding of the intellectual overview showing the importance of data-driven approaches in addressing complex socio-ecological stresses. The findings are expected to corroborate researchers, policymaking body, and professionals in advancing climate-resilient and sustainable agricultural systems in South Asia through more informed, data driven methods.

2. METHODS

This study employed a hybrid methodological approach by combining quantitative bibliometric analysis with qualitative interpretation of thematic patterns. The quantitative component was used to measure publication growth, citation structure, authorship patterns, country-level contributions, and collaboration networks. Meanwhile, the qualitative component was applied to interpret the intellectual development, emerging themes, and research directions related to climate change impacts, agro-ecosystem stress, and adaptive agricultural strategies in South Asia. This combined approach is suitable for mapping a broad and multidisciplinary research field because it allows the study to identify both measurable publication trends and the conceptual meaning behind those trends [19].

The main objective of this methodological design was to systematically examine the evolution of research on agro-ecosystem stress, climate change impacts, and adaptive agricultural strategies in South Asia. The analysis focused on identifying major publication trends, influential sources, key contributors, collaboration patterns, and emerging thematic areas within the literature [3]. The study relied on secondary bibliographic data retrieved from the Scopus database. As shown in Figure 1, the overall data identification, screening, eligibility assessment, and final inclusion process followed

a PRISMA-based Scopus indexing methodology. This process ensured that the final dataset was selected in a transparent, systematic, and reproducible manner.

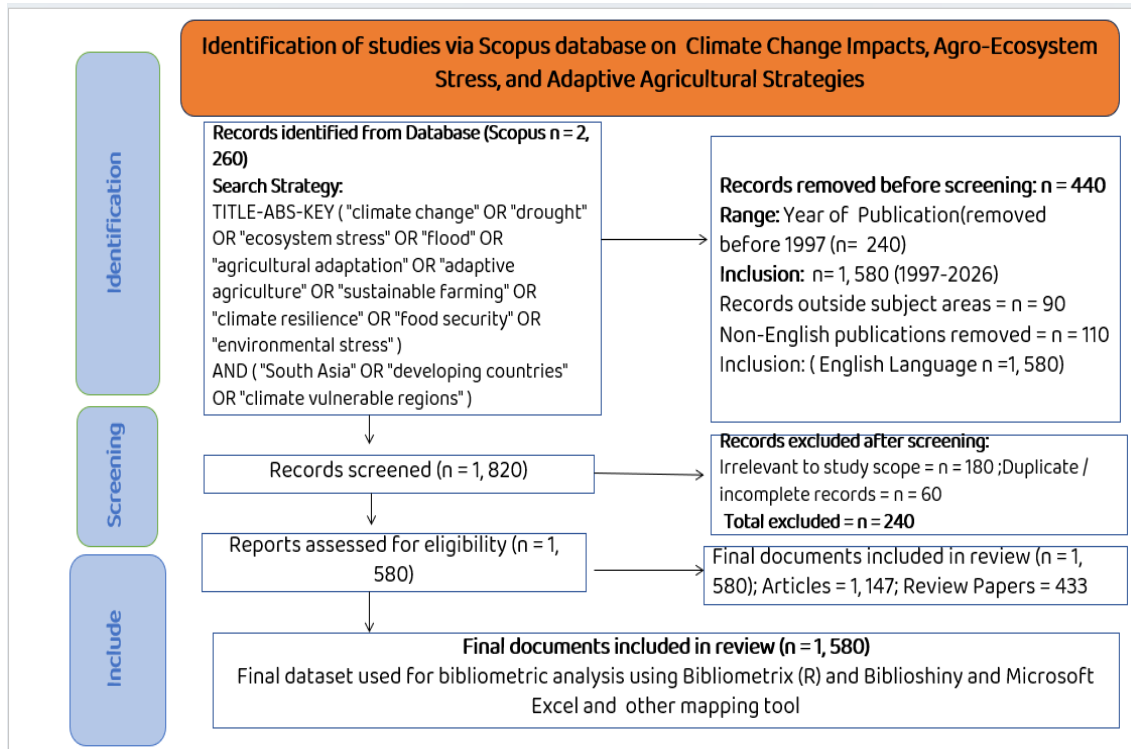


Figure 1: PRISMA based Scopus Indexing Methodology Scopus Database (January 14, 2026)

2.1. Bibliometric Analysis Approach

Bibliometric analysis is a widely used quantitative method for examining large volumes of scientific literature in a structured and measurable way. It enables researchers to transform scattered academic publications into meaningful indicators, such as annual scientific production, citation performance, keyword co-occurrence, author productivity, institutional contribution, and country-level collaboration. This approach is particularly useful for identifying research trends, knowledge structures, intellectual connections, and thematic developments within a specific field [28].

In this study, bibliometric analysis was applied to investigate how research on climate change impacts, agro-ecosystem stress, and adaptive agriculture in South Asia has developed over time. The method helped identify the most active authors, journals, institutions, and countries, as well as the major themes that have shaped this research

area. The bibliometric approach also supported the detection of emerging research hotspots, especially those related to climate resilience, drought, food security, environmental stress, and sustainable farming. Therefore, this method provided a systematic basis for understanding both the growth and direction of the field. Figure 1 presents the PRISMA-based workflow used to guide the literature selection process. The figure shows how records were identified from Scopus, screened according to predefined eligibility criteria, and refined into the final dataset used for bibliometric analysis. By applying this structured workflow, the study minimized selection bias and ensured that only relevant and high-quality publications were included.

2.2. Selection of Database and Search Strategy

The Scopus database was selected as the primary source of bibliographic data because it provides broad coverage of peer-reviewed literature across science, agriculture, environmental studies, social sciences, and multidisciplinary research fields. Scopus is also widely used in bibliometric studies because it offers structured metadata, including author information, affiliations, keywords, abstracts, citations, source titles, publication years, and document types. These metadata are essential for conducting reliable bibliometric mapping and network analysis [19].

As illustrated in Figure 1, the search and screening process was conducted systematically to identify publications related to climate change impacts, agro-ecosystem stress, and adaptive agricultural strategies in South Asia. The search strategy combined climate-related, agriculture-related, and regional keywords. The main search terms included "Climate Change," "Drought," "Ecosystem Stress," "Flood," "Agricultural Adaptation," "Adaptive Agriculture," "Sustainable Farming," "Climate Resilience," "Food Security," and "Environmental Stress." These terms were combined with regional terms such as "South Asia," "Developing Countries," and "Climate Vulnerable Regions." The use of combined keywords helped ensure that the retrieved documents were aligned with both the thematic and geographical scope of the study.

The initial search produced 2,260 records from Scopus. After applying the inclusion and exclusion criteria presented in Table 1, a total of 1,580 documents were retained for final bibliometric analysis. The inclusion criteria focused on English-language peer-reviewed journal articles and review papers published between 1997 and 2026. Documents outside

the study scope, non-English publications, conference papers, books, book chapters, and other publication types were excluded to maintain consistency and reliability. As indicated in Table 1, 680 records were excluded during the screening process, including records removed before and after eligibility assessment.

Table 1. Search criteria, inclusion and exclusion criteria

Category	Inclusion Criteria	Exclusion Criteria
Keywords	"Climate Change" OR "Drought" OR "Ecosystem Stress" OR "Flood" OR "Agricultural Adaptation" OR "Adaptive Agriculture" OR "Sustainable Farming" OR "Climate Resilience" OR "Food Security" OR "Environmental Stress" AND "South Asia" OR "Developing Countries" OR "Climate Vulnerable Regions"	Publications outside the thematic and regional scope
Search result	Initial records retrieved from Scopus: n = 2,260	—
Publication stage	Final publications included: n = 1,580	Records excluded before/after screening: n = 440; records excluded after further assessment: n = 240; total excluded: n = 680
Document type	Peer-reviewed articles: n = 1,147; review papers: n = 433	Conference papers: n = 86; books: n = 27; book chapters: n = 547; others: n = 20
Timespan	1997–2026	Publications outside the selected period
Language	English	Non-English publications
Final selection	1,580 documents	680 excluded records

The final dataset included 1,147 research articles and 433 review papers. This selection was considered appropriate because journal articles and review papers generally provide complete methodological details, validated findings, and strong academic relevance. Therefore, the final dataset offered a reliable foundation for analyzing long-term publication trends, intellectual structure, and collaboration patterns in the selected research field.

2.3. Document Type Analysis

Document type analysis was conducted to understand the publication structure of the retrieved literature. As shown in Figure 2, the initial Scopus search contained several types of academic documents, including journal articles, review papers, book chapters, conference papers, books, and other minor publication formats. However, after the screening process, only peer-reviewed journal articles and review papers were included in the final dataset. This decision was made to ensure methodological consistency and to maintain the academic quality of the bibliometric analysis.

As presented in Table 2, the final dataset consisted of 1,580 documents, including 1,147 journal articles and 433 review papers. Journal articles represented the largest share, accounting for 72.6% of the final dataset. This dominance indicates that original peer-reviewed research remains the primary channel for disseminating knowledge on climate change impacts, agro-ecosystem stress, and adaptive agriculture in South Asia. It also suggests that the field is strongly driven by empirical studies, case-based investigations, modeling approaches, and evidence-based agricultural and environmental research.

Review papers accounted for 27.4% of the final dataset, as shown in Table 2. The presence of a substantial number of review papers indicates growing academic interest in synthesizing existing knowledge, identifying research gaps, and developing broader theoretical and policy-oriented discussions. This is important because climate change and agro-ecosystem stress are multidisciplinary issues that require integrated understanding across agriculture, ecology, environmental science, food security, and regional development.

Figure 2 further highlights the difference between the broader set of retrieved document types and the final included document types. While book chapters, conference papers,

books, and other short-format documents were present in the initial search results, these documents were excluded from the final analysis. Their exclusion helped ensure that the bibliometric dataset remained focused on full-length, peer-reviewed, and methodologically robust publications. Overall, the distribution shown in Figure 2 and Table 2 confirms that the final dataset is article-driven and suitable for systematic bibliometric evaluation.

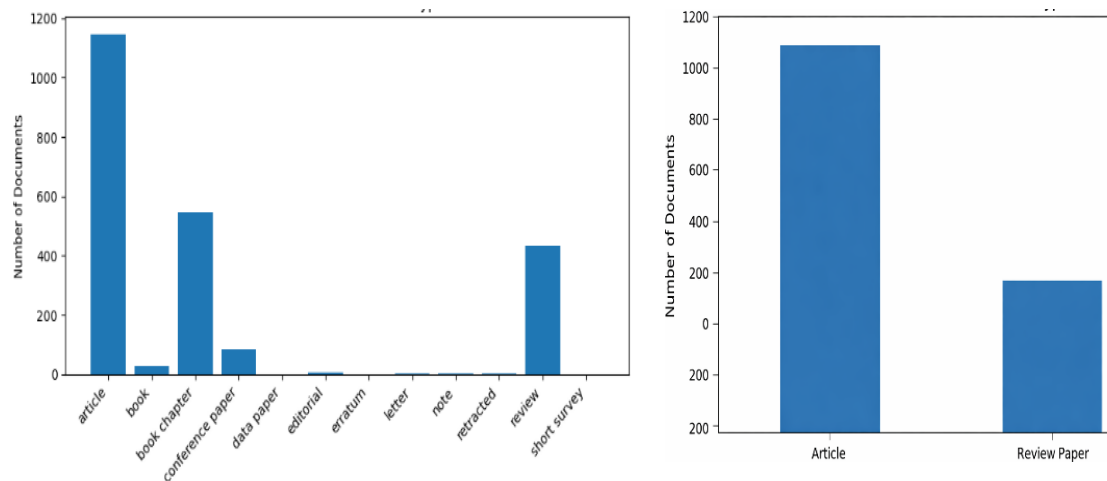


Figure 2. Distribution of document types and finally included document types related to climate change and agro-ecosystem stress

Table 2. Distribution of Final Included Document Types related to climate change and agro-ecosystem stress

Document Type	Frequency	Percentage (%)
Article	1,147	72.6
Review Paper	433	27.4
Total	1,580	100.0

In addition to the final document type distribution, Table 3 provides the main bibliometric information of the collected literature. The dataset covers the period from 1997 to 2026, indicating nearly three decades of scholarly development. The publications were distributed across 661 sources, showing that the topic has attracted attention from a wide range of journals and academic outlets. The annual growth rate of 14.96% demonstrates that research activity in this area has expanded rapidly, particularly as climate-related agricultural risks have become more urgent in South Asia.

As shown in Table 3, the average document age was 2.97 years, suggesting that much of the literature is recent and policy-relevant. The average citation rate of 13.67 citations per document indicates that the publications have gained moderate to strong scholarly influence. The table also shows that the field involves a large research community, with 8,655 authors contributing to the literature. The average of 5.79 co-authors per document and the international co-authorship rate of 45.99% demonstrate that this research area is highly collaborative and internationally connected. These indicators reflect the multidisciplinary and transboundary nature of climate change, agro-ecosystem stress, and agricultural adaptation research.

Table 3. Main information of the collected articles on climate change and agro ecosystem stress in South Asia

Indicator	Value	Interpretation
Timespan	1997–2026	The dataset covers nearly 30 years, indicating long-term scholarly development.
Sources	661	High number of journals/books.
Documents	2,259	Substantial corpus, mature and expanding research field.
Annual Growth Rate	14.96%	Field is rapidly expanding.
Average Document Age	2.97 years	Recent and dynamic research area.
Average Citations per Document	13.67	Average-high influence of publications.
Authors	8,655	Large and diverse scholarly community.
Single-authored Documents	106	Collaboration dominates this field.
Co-authors per Document	5.79	Substantial collaborative culture.
International Co-authorship	45.99%	Approximately half of publications are internationally collaborative.

The information in Table 3 confirms that the field has developed into a fast-growing and collaboration-intensive research domain. The high annual growth rate shows increasing academic attention to the effects of climate change on agricultural systems and

ecosystem stability. The relatively low average document age indicates that the literature is current, dynamic, and closely linked to contemporary policy concerns. The high number of authors and co-authored publications also suggests that the research problems addressed in this field are complex and require interdisciplinary cooperation. Overall, the document profile indicates that research on climate change impacts, agro-ecosystem stress, and adaptive agriculture in South Asia has matured into a systematic academic field supported by a strong base of peer-reviewed journal publications and review studies.

2.4. Bibliometric Data Processing and Visualization

The bibliometric analysis was conducted using the Bibliometrix package in R, which is widely applied for science mapping and quantitative literature analysis [22], [26]. Bibliometrix was used to process the Scopus metadata and generate descriptive indicators, including annual publication trends, source productivity, author productivity, citation performance, institutional contribution, country-level production, and collaboration patterns. The Scopus records were exported in CSV format and then imported into R for cleaning, conversion, and analysis [17], [23], [29]. In addition to Bibliometrix, VOSviewer was used to visualize bibliometric networks. VOSviewer is particularly useful for mapping relationships among keywords, authors, countries, and documents through co-occurrence, co-authorship, citation, co-citation, and bibliographic coupling analysis. In this study, VOSviewer helped identify thematic clusters and collaboration structures within the literature. The visualization results supported the interpretation of dominant and emerging research themes, especially those related to climate resilience, drought, food security, sustainable agriculture, and environmental stress management.

The data processing procedure involved several stages. First, the Scopus dataset was exported and checked for completeness. Second, bibliographic information such as titles, abstracts, keywords, author names, affiliations, publication years, sources, and citation counts was organized for analysis. Third, descriptive bibliometric indicators were generated using Bibliometrix. Fourth, network-based visualizations were created using VOSviewer. For network analysis, the fractional counting method was applied, and the number of authors per document was limited to 25 to reduce the influence of extremely large author groups and to ensure balanced network representation.

3. RESULTS AND DISCUSSION

3.1. Analysis of yearly Research Volume

Annual scientific output shows a distinct evolutionary trend, emphasizing the field's steady development. During the commencing period (1997–2008), publication output was insignificant and mostly fixed. That demonstrates insubstantial scholarly association and extension of knowledge base in this regard. Between 2009 and 2018, there was a switch to persistent development in yearly publications, which was a result of larger subject applicability, better data readiness. This advancement stage marks the combination of mainstream scholarly discussions. Following 2019, there was a measurable increase in publication numbers and maintaining the flow in 2024 as well. This rapid growth points to soaring funding and policy suitability, stronger interdisciplinary partnership, and escalating attention on a global scale. A research proliferation occurs when a topic gets top priority and collective recognition, as seen by the prompt extension trend during this time. It is urgent to be cautious when interpreting the apparent saturation in 2025 because it is more likely the result of low-quality database indexing than a true decline in research effort. All things considered, the pattern shows a shift from an emerging field of study to a quickly growing and internationally important scientific field.

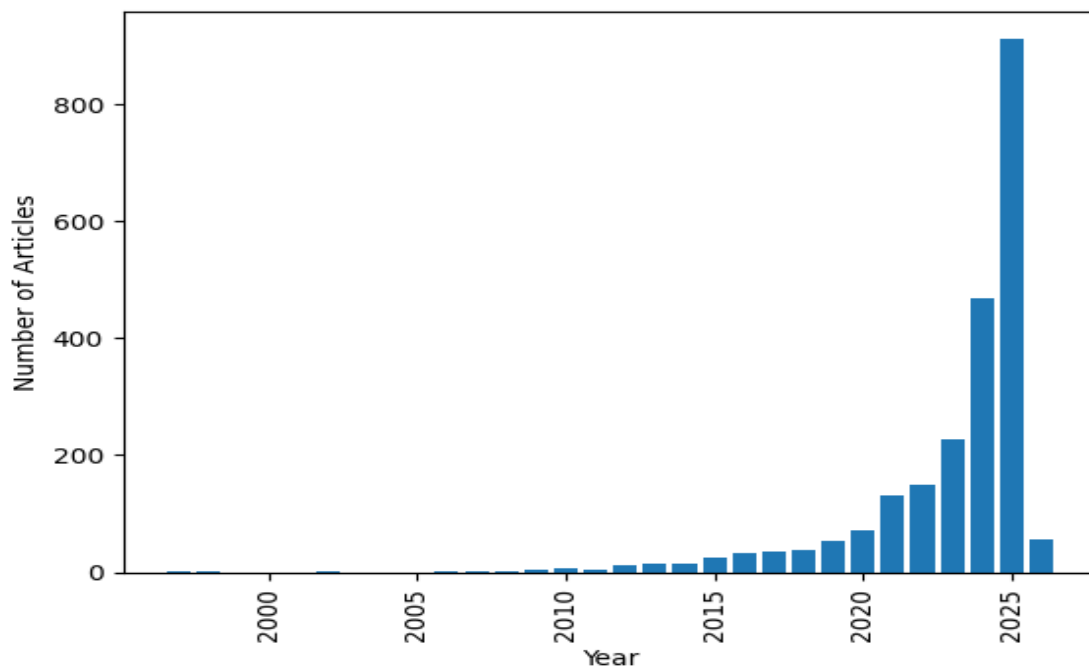


Figure 3. Annual scientific production of articles in climate change and agriculture stress

3.2. Authors who are highly and influential in research of climate change and agriculture stress

A small handful of powerful researchers control a highly centralized organization, as seen by the author cooperation network. With the biggest node size and the greatest number of collaborative links, Kumar S is the most popular and central author with high citation. This advocates a noteworthy degree of productivity in research together with play a crucial role in the platform coordination. A widely acceptable documented research team with persistent collective output is advanced by the fact that Kumar S is embedded in a dense collaboration cluster with authors like Singh H, Das A, and Sharma S.

Kumar P and Singh S authorize a secondary but strongly connected hub, focusing their function in interdisciplinary knowledge exchange. They demonstrate high internal creativity, networking and maintain cross-links with the Kumar S cluster. By connecting considerable clusters and promoting extensive network integration, Singh A come to light as a crucial interconnecting author. Small scale yet coordinated sub-networks are constituted by other contributors, such as Iqbal R, Khan S, Ali S, and Ahmad M. Their partnership represent the emergence of cooperative groupings. Overall, the network displays a core-periphery trend in which a small number of immensely influential authors fix the direction of studies and the volume of collaboration within the field.

Table 4. Top productive authors of climate change climate change and agriculture stress

Rank (Citations)	Author	Total Publications	Total Citations	Avg Citations/Year	Rank (Publications)	Rank (Impact)
1	SINGH S	36	770	17.73	4	1
2	KUMAR A	50	725	13.80	2	3
3	KUMAR P	40	512	10.41	3	6
3	SINGH A	33	512	12.92	5	5
4	KUMAR M	27	476	13.45	8	4

Rank (Citations)	Author	Total Publications	Total Citations	Avg Citations/Year	Rank (Publications)	Rank (Impact)
5	KUMAR S	57	439	9.13	1	8
6	SHARMA A	32	435	8.00	6	10
7	DAS A	23	311	8.06	10	9
8	KUMAR R	30	211	9.17	7	7
9	IQBAL R	25	141	14.11	9	2

Source: Result of Bibliometrix (R).

The ranking shows a considerable difference between the top authors' citation impact and research productivity. Singh S emerges as the most influential scholar, holding the top place in total citations (770) and impact rank (1), despite being fourth in publication volume, suggesting consistently high-quality and highly recognized work. Kumar S, on the other hand, is the most prolific author with 57 publications but ranks lower in impact (8th), indicating that greater productivity does not always equate to greater citation effect. Kumar A strikes a balance between good citation performance (ranked third in impact) and productivity (ranked second in publications), establishing this author as both prominent and active in the field. Notably, Iqbal R has one of the greatest average citations per year (14.11) and ranks second in impact despite being ninth in production, indicating developing or highly concentrated influence. Authors like Sharma A and Das A, on the other hand, have moderate output but a relatively less impact on citations. Overall, the findings highlight the significance of research visibility and relevance above raw output number, showing that academic influence in this subject is driven more by citation quality and annual impact rate than by publication quantity alone.

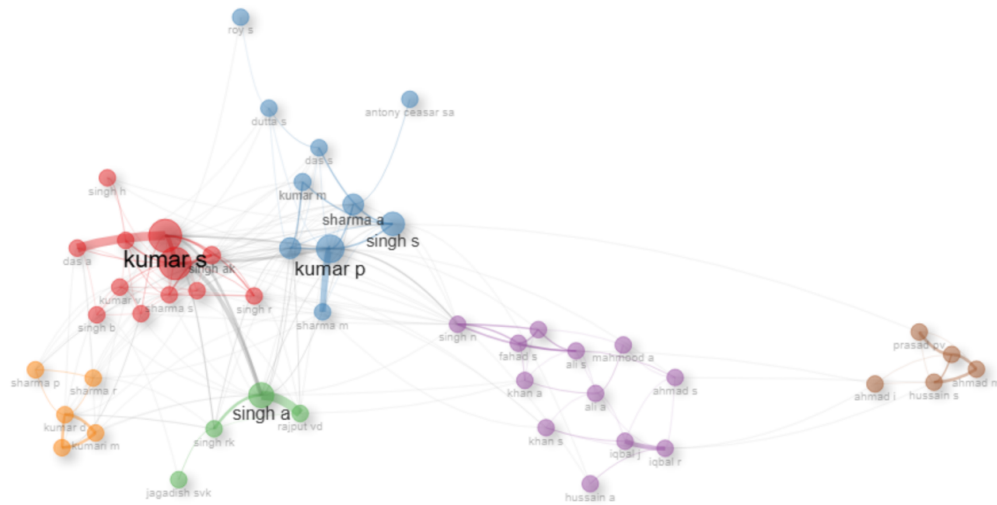


Figure 4. Cluster of author's collaboration in climate change and agriculture stress

3.3. Country production analysis of the articles

Country-level production analysis was conducted to identify the major geographical contributors to research on climate change impacts, agro-ecosystem stress, and adaptive agricultural strategies. As presented in Table 5, India recorded the highest research production, with 13,792 articles, followed by Pakistan with 2,955 articles, Bangladesh with 2,051 articles, China with 2,023 articles, and the United States with 1,931 articles. This distribution indicates that South Asian countries, particularly India, Pakistan, and Bangladesh, play a central role in generating scientific knowledge in this field.

Table 5. Country production analysis of the articles on climate change and agriculture stress

Rank	Country	Total Articles
1	India	13,792
2	Pakistan	2,955
3	Bangladesh	2,051
4	China	2,023
5	USA	1,931

The dominance of India, as shown in Table 5 and illustrated in Figure 5, reflects the country's strong research capacity and high exposure to climate-related agricultural challenges. India's large agricultural sector, diverse agro-climatic zones, and frequent experiences with droughts, floods, heat stress, and food security concerns may explain its leading position. Pakistan and Bangladesh also show substantial research contributions, which is highly relevant because both countries are strongly affected by climate variability, water stress, flooding, and livelihood vulnerability. Their strong presence in the dataset suggests that climate-resilient agriculture and agro-ecosystem adaptation have become important research priorities across South Asia.

Figure 5 further confirms the geographical concentration of scientific production. The figure shows that research output is highly concentrated in a small number of countries, with India contributing far more than other countries. At the same time, the presence of China and the USA among the top five contributors indicates that research on climate change and agricultural stress in South Asia is not limited to the region itself. Instead, it has attracted wider international attention from countries with strong scientific infrastructure and active climate research communities.

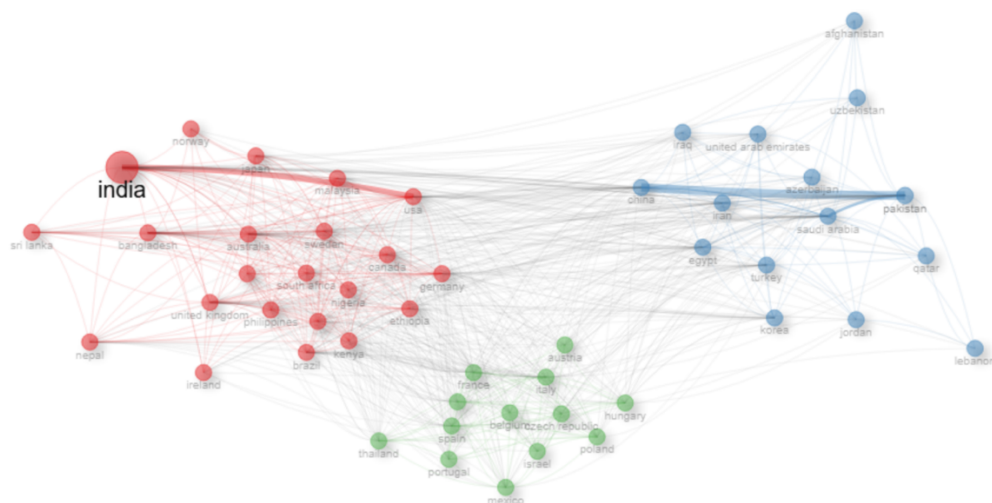


Figure 5. Country scientific production of publication related to climate change and agriculture stress

The collaboration pattern presented in Figure 6 provides additional insight into the international structure of this research field. The country collaboration network shows that South Asian countries are connected with several major global research partners. India appears as a key collaboration hub, linking regional and international researchers. Pakistan and Bangladesh also demonstrate visible collaborative connections, indicating growing participation in international research networks. These patterns suggest that climate change impacts and agricultural stress are increasingly being studied through cross-border and multidisciplinary collaboration.

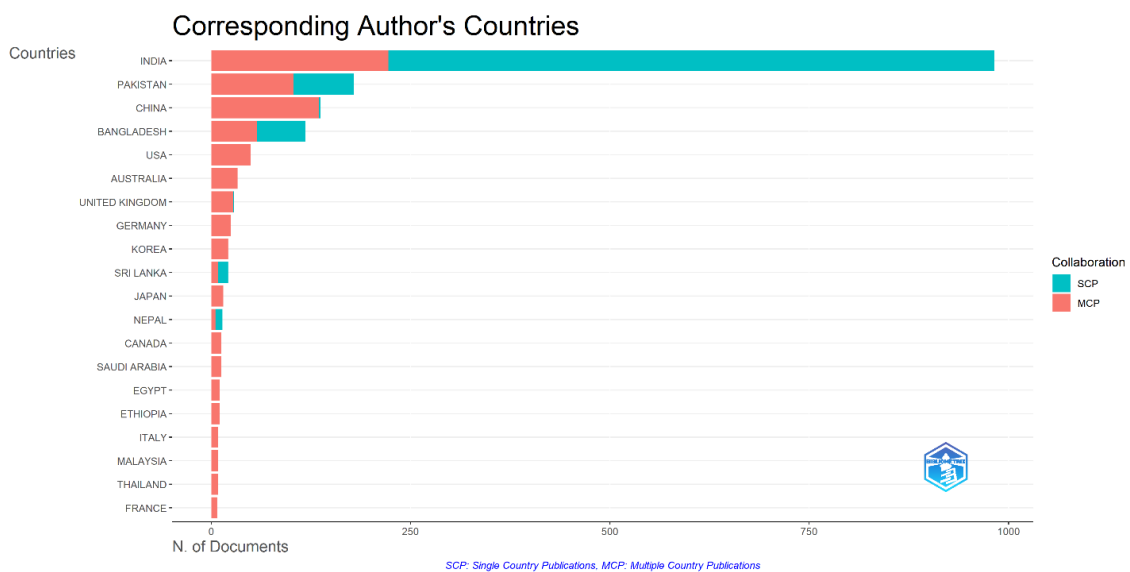


Figure 6. Cluster of collaborative countries of the articles of climate change impacts, agro-ecosystem stress, and adaptive agricultural strategies

the findings in Table 5, Figure 5, and Figure 6 demonstrate that research production is strongly concentrated in South Asia, with India serving as the leading contributor. Pakistan and Bangladesh also show important growth as climate-vulnerable countries with increasing scientific engagement. Meanwhile, China and the USA contribute significantly as external research partners, supporting the global relevance of the topic. The collaboration network indicates that the field is not only regionally important but also internationally connected, reflecting the shared concern over climate change, food security, ecosystem stress, and agricultural adaptation.

3.4. Productive affiliation analysis

The productive affiliation analysis was conducted to identify the institutions that contributed most actively to research on climate change impacts, agro-ecosystem stress, and adaptive agricultural strategies. As shown in Figure 7, research output is strongly concentrated among agricultural universities and research-oriented institutions, particularly those located in South Asia. This pattern indicates that the field is mainly driven by institutions with strong expertise in agriculture, rural development, environmental science, and climate adaptation.

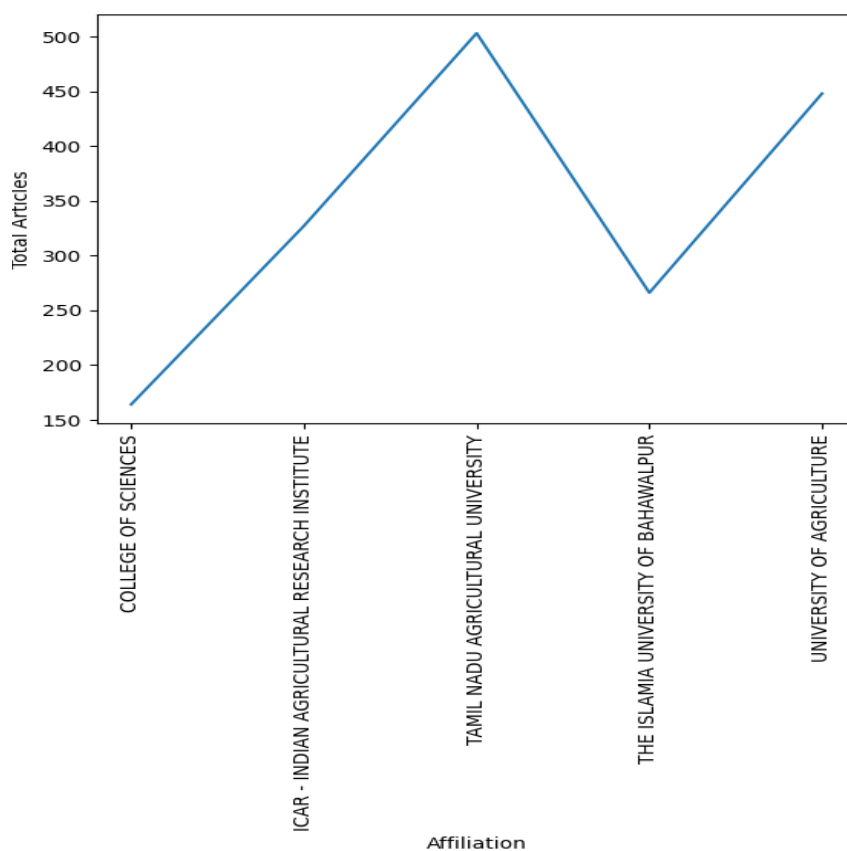


Figure 7. Productive affiliation related to climate change and agriculture stress

Figure 7 shows that Tamil Nadu Agricultural University is the most productive affiliation, with 196 articles, making it the clear institutional leader in this research area. As presented in Table 6, the University of Agriculture ranks second with 115 articles, followed by ICAR–Indian Agricultural Research Institute and The Islamia University of Bahawalpur, each contributing 96 articles. These results suggest that Indian and Pakistani agricultural

institutions play a major role in producing scientific knowledge on climate-related agricultural stress and adaptation.

Table 6 also shows the presence of institutions from Bangladesh, such as Gazipur Agricultural University, which contributed 53 articles. This indicates the growing role of Bangladesh-based institutions in climate and agricultural research, which is highly relevant given the country's vulnerability to flooding, salinity intrusion, and climate-induced livelihood risks. In addition, the inclusion of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) reflects the contribution of international agricultural research organizations, although regional universities remain the dominant producers.

Table 6. Top ten highest productive affiliations of article in climate change and agriculture stress

Rank	Affiliation	Articles	Interpretation
1	Tamil Nadu Agricultural University	196	Clear institutional leader
2	University of Agriculture	115	Strong agricultural research base
3	ICAR – Indian Agricultural Research Institute	96	National research powerhouse
4	The Islamia University of Bahawalpur	96	Major Pakistan-based contributor
5	College of Sciences	57	Mid-level academic contributor
6	Gazipur Agricultural University	53	Important Bangladesh presence
7	International Crops Research Institute (ICRISAT)	48	Global agricultural research body
8	Lovely Professional University	44	Growing private university output
9	Banaras Hindu University	37	Established Indian academic center
10	Aligarh Muslim University	32	Traditional university with steady output

the results in Table 6 confirm that research production is largely led by specialized agricultural and rural-focused institutions rather than broad-based general universities. This finding highlights the applied nature of the research field, where institutional expertise in crop science, farming systems, climate resilience, and food security is essential. The strong representation of Indian institutions also reflects India's large agricultural research infrastructure and its high exposure to climate-related agricultural risks. The institutional collaboration network presented in Figure 8 provides further insight into how these affiliations are connected. The network shows that collaboration is mostly concentrated within national or regional clusters, particularly in India and Pakistan. Institutions such as ICAR–Indian Agricultural Research Institute, University of Agriculture Faisalabad, and The Islamia University of Bahawalpur appear as important knowledge hubs, indicating their central role in climate and agriculture-related research collaboration.

Figure 8 also suggests that collaboration among institutions is stronger within countries than across borders. For example, Indian agricultural institutions tend to collaborate closely with other Indian institutions, while Pakistani institutions form their own collaborative clusters. Although some international and interdisciplinary links are visible, cross-border collaboration within South Asia appears relatively limited. This indicates an opportunity to strengthen regional research partnerships, especially because climate change impacts, food security challenges, and agro-ecosystem stress often extend beyond national boundaries.

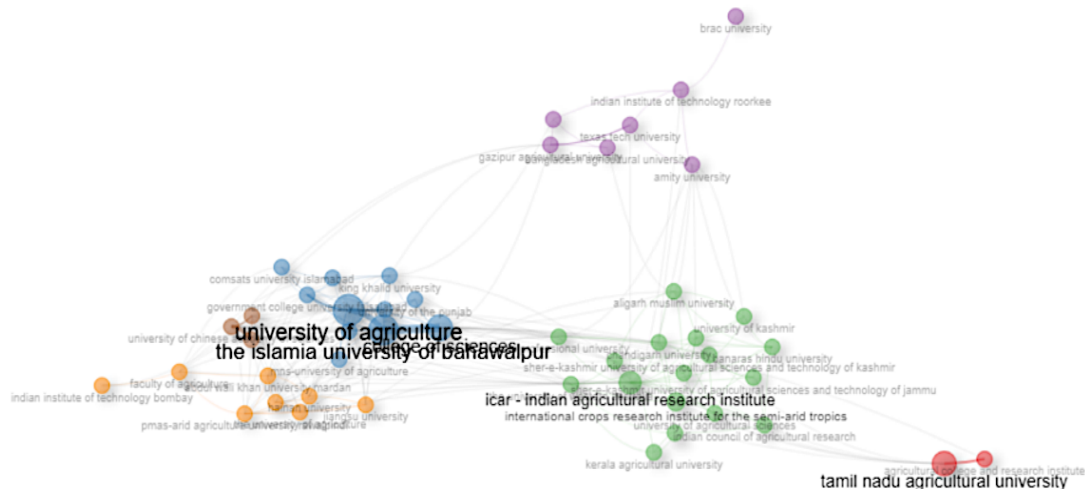


Figure 8. Institutional collaboration of the articles of climate change and agriculture stress

3.6. Citation analysis of the articles

The most widely referenced papers in the collection are highlighted in this graphic, which reveals both the historical underpinnings and new directions of climate-plant stress research. With 764 citations, Hu Y. (2019, *Nature Genetics*) is by far the most influential paper. Its publication in a prestigious genetics journal indicates that high-impact research on stress tolerance is currently being driven by molecular and genomic techniques. More than ten years later, the subject is still being shaped by earlier foundational evaluations on climate impacts and agricultural adaptation, as evidenced by the next most referenced works, Wassmann R. (2009, *Advances in Agronomy*), with 531 and 464 citations.

Mazdiasni O. (2017, *Science Advances*), Kaushal M. (2016, *Annual Review of Microbiology*), and Wahab A. (2023, *Plants*) comprise a second group with quite high citations (about 330–350 citations). A trend toward plant-microbe interactions, physiological stress mechanisms, and interdisciplinary climate resilience research is suggested by this combination of recent and mid-period studies. Despite having significantly less citations (between 280 and 310), papers like Shahzad A. (2021), Kole C. (2015), Vimal S.R. (2017), and Hassan M.U. (2021) still have a significant impact, especially in the areas of plant physiology, soil systems, and environmental stress management.

In general, the pattern demonstrates a progression in knowledge: foundational agronomy and climate adaptation research (2009 period) laid the framework. Research on soil, microbiology, and stress physiology grew in the middle of the 2010s. The citation landscape is currently dominated by recent high-impact genomics research (post-2019), indicating a shift toward molecular-level remedies for abiotic stress and drought brought on by climate change. This suggests that the field is shifting from agronomic adaptation and effect assessment to genetic, microbiological, and physiological innovation for climate change resilience.

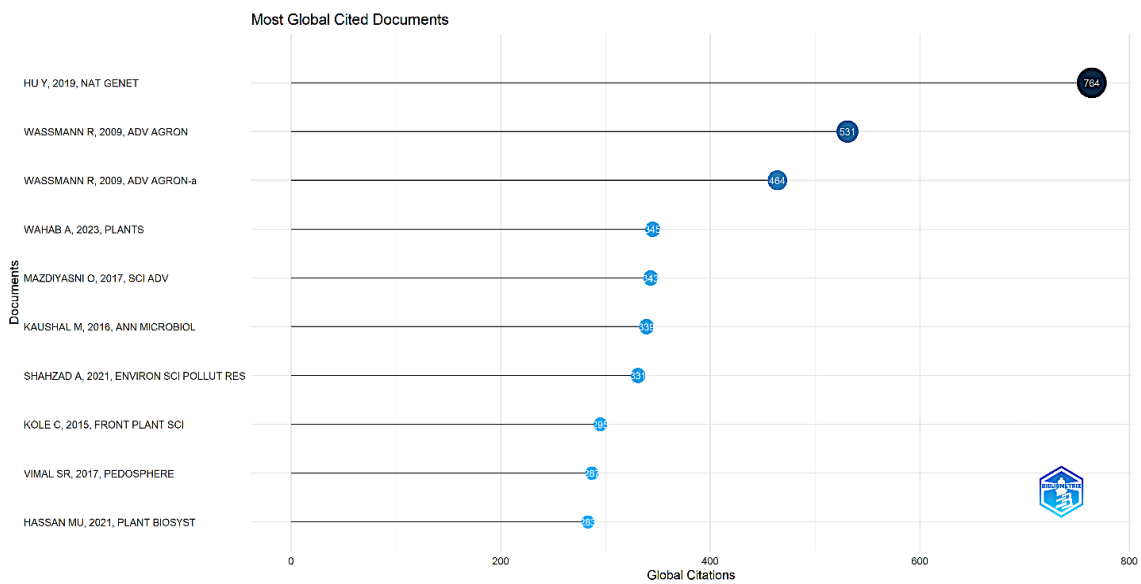


Figure 10. Top ten global cited documents related to climate change and agriculture stress

3.7. Top ten influential paper

The citation analysis of the top ten publications reveals definite patterns of academic influence across time. The most recognized article overall is Hu et al. (2019, Nature Genetics), which ranks first with 764 total citations and the top citation rate (95.5 citations per year), designating both strong academic impact and retained contemporary importance. In contrast, the two studies by Wassmann (2009) occupy the second and third place in total citations (531 and 464, respectively). Similarly, they exhibit comparatively low annual citation rates and normalized impact scores, whose improvement in influence has plateaued over time. Notably, Wahab et al. (2023, Plants) demonstrates a different path: although listed as fourth in total citations (345), it represents an exceedingly high annual citation rate (86.25) and the highest normalized citation score (19.92), categorized it as a sharp emerging study. Similarly, Shahzad et al. (2021) and Hassan et al. (2021) show yearly citation performance relative to their total numbers highlighting growing contemporary attraction. Middle-ranged articles such as Mazdiyasn et al. (2017) and Kaushal et al. (2016) illustrate stable moderate citation growth, indicating sustained influence. Overall, the results highlight a transition from toward a new wave of rapidly rising recent studies shaping current research directions. Table 7 shows Top ten influential papers related to climate change and agriculture stress.

Table 7. Top ten influential papers related to climate change and agriculture stress

Rank	Paper	Total Citations	Citations per Year	Normalized TC
1	HU Y, 2019, <i>Nature Genetics</i>	764	95.50	16.52
2	WASSMANN R, 2009, <i>Advances in Agronomy</i>	531	29.50	2.09
3	WASSMANN R, 2009, <i>Advances in Agronomy</i>	464	25.78	1.82
4	WAHAB A, 2023, <i>Plants</i>	345	86.25	19.92
5	MAZDIYASNI O, 2017, <i>Science Advances</i>	343	34.30	7.34
6	KAUSHAL M, 2016, <i>Annals of Microbiology</i>	339	30.82	6.81
7	SHAHZAD A, 2021, <i>Environmental Science & Pollution Research</i>	331	55.17	9.33
8	KOLE C, 2015, <i>Frontiers in Plant Science</i>	295	24.58	7.51
9	VIMAL SR, 2017, <i>Pedosphere</i>	287	28.70	6.14
10	HASSAN MU, 2021, <i>Plant Biosystems</i>	283	47.17	7.98

3.8. keywords trends of the articles in climate change and agriculture stress

Figure 11 presents the intellectual structure where *Climate Change* is the central theme, with four major thematic clusters. This structure shows how the literature progresses from environmental stressors to human vulnerability to adaptive responses. The bibliometric keyword analysis manifests that *climate change* is the significant organizing theme within the dataset, followed by high-frequency terms such as *drought* (240 occurrences), *abiotic stress* (207), and *resilience* (171). The thematic structure shows four main intellectual clusters. Firstly, a climate hazard cluster emphasizes environmental stressors, particularly drought and abiotic pressures that affects ecosystems and agricultural systems. Secondly, a resilience cluster spotlighted a rising research shift toward climate resilience and sustainable agricultural practices. Thirdly, a food and livelihood security cluster links climate stress with human susceptibility, emphasizing risks to food systems and rural livelihoods. Finally, the attendance of Bangladesh and other vulnerable regions indicates a robust regional accumulation of research in climate-sensitive areas of the Global South. Overall, the thematic distribution reveals a transition in the literature from hazard identification toward dealing with resilience and integration

capacity, reflecting a proceeding research schedule centered on sustainability and vulnerability.

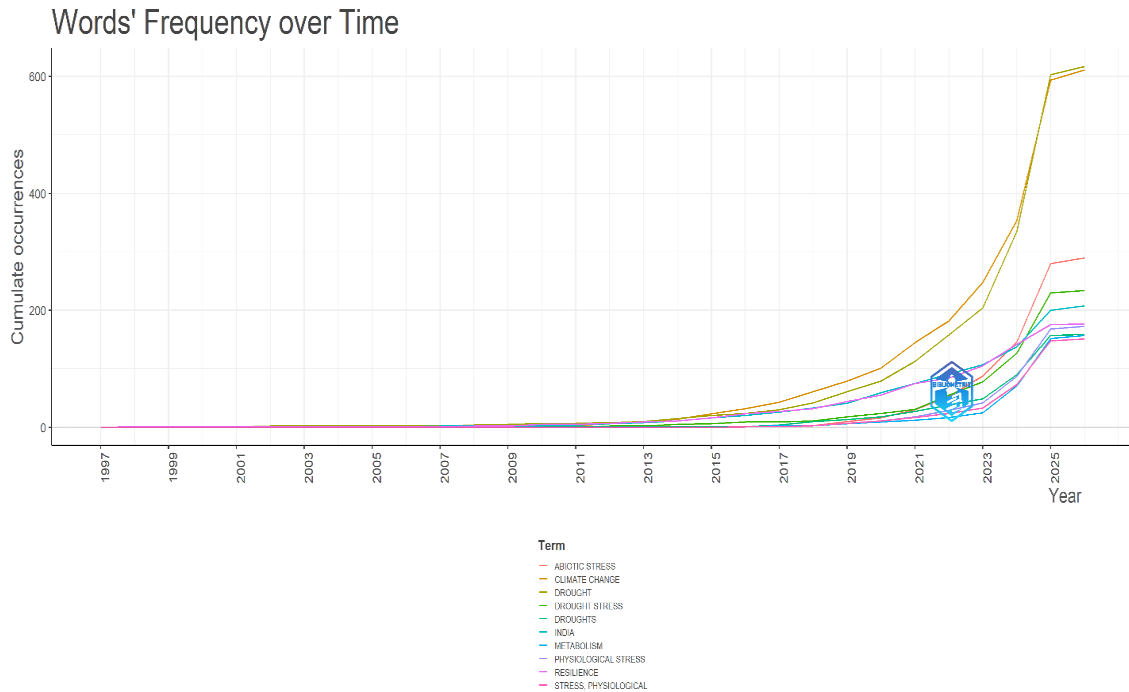


Figure 11. Top Ten keywords related to climate change and agriculture stress

Table 8. Top ten keywords of climate change and agro-agriculture stress

Rank	Keyword	Occurrences
1	climate change	336
2	drought	240
3	abiotic stress	207
4	resilience	171
5	drought stress	117
6	climate resilience	78
7	sustainable agriculture	72
8	vulnerability	72
9	food security	69
10	Bangladesh	63

Results suggest that a strong thematic concentration around climate–environment stress and adaptive capacity. “Climate change” popped up as the most prominent term (336

occurrences) far outstripped most all other keywords and confirming its first position in the research depiction. After this, "drought" (240) and "abiotic stress" (207), were followed by indicating that a large amount of the literature focuses on environmental strainer influence ecological and agricultural systems. The prominence of "resilience" (171) and "drought stress" (117) further highlights an analytical shift from impact assessment toward coping and adaptive responses. Mid-ranking terms such as "climate resilience" (78), "sustainable agriculture" (72), and "vulnerability" (72) suggest an integrated perspective linking environmental change with livelihood sustainability and risk exposure. Furthermore, the emergence of "food security" (69) highlight the distress over the socio-economic consequences of climatic flexibility. Mentionable, "Bangladesh" (63) ranks within the top ten keywords, focusing the regional significance of this climate-sensitive area in the literature. Overall, the ranking exhibits that recent research is progressively detailed around the crisscrossing of climate stress, agricultural sustainability, and resilience-oriented adjustment, with effective depiction from South Asian case analysis.

3.9. Discussion

The bibliometric review of climate change impacts, agro-ecosystem stress, and adaptive agriculture in South Asia from 1997 to 2026 divulges this research field is experiencing sharp intellectual extension and thematic transition. This turning point likely conforms to the integration of global climate policy agendas and wide appreciation of agriculture as both a vulnerable sector and a mitigation pathway[3]. The body of documents is strongly driven by peer-reviewed journal articles, which mostly comprised the final dataset. It indicates knowledge sharing in this field depends mainly on rigorous empirical and theoretical inputs. At the same time, the significant presence of review papers recommends growing academic endeavors to synthesize scattered related findings and build useful policy and conceptual strategies. In general, this trend marks an evolving discipline that values both original evidence generation and integrative knowledge development.

The time- based organization of the literature convey a noticeable rise after 2015, with strong growth after 2019. This pattern display more than soaring publication numbers; it suggests a strategic transformation in global and regional research focus toward climate-resilient agriculture, food security, and sustainable resource management[1], [4]. In the South Asia, where agriculture is highly susceptible to drought, flooding, salinity

intrusion, and heat stress, the proliferation of research output hints increasing validation of the region's socio-ecological relevance[1], [2]. Stronger financing support, interdisciplinary cooperation, and greater alignment between scientific output and policy urgency are also suggested by the quick growth trend.

Authorship and collaboration are centered around a comparatively limited number of productive researchers and institutions, according to the field's author collaboration map. The authors Singh S, Kumar A, Kumar P, and Kumar S have prominent positions in terms of output and citation influence in the area. Similarly, Tamil Nadu Agricultural University, ICAR—Indian Agricultural Research Institute, along with other specialized South Asian organizations are remarkable examples of agricultural universities and research institutes where institutional leadership is consolidated. This agglomeration shows strong regional expertise, but it also raises the possibility of path dependency with other scholars in broader contexts.

Country-level research production further demonstrate that South Asia has become the knowledge hub of the field. India overwhelmingly leads scientific production, followed by Pakistan and Bangladesh. After that China and the United States remain significant contributors to the domain. Although, Western countries dominated many scientific domains traditionally, in South Asia, research leadership is increasingly located in climate-vulnerable regions because local exposure to environmental stress has stimulated endogenous scientific capacity of these developing countries. Again, collaboration networks remain more nationally clustered than internationally integrated, denoting that the potential for cross-border knowledge transfer both within and outside of South Asia is still unevaluated.

From an Information Systems and Informatics (IS/I) standpoint, the gravity of the findings lies in how bibliometric methods reconfigure fragmented scholarly outputs into comprehensive intellectual frameworks[29]. Rather than presenting as detail recorded list, these tools function analytically by revealing implicit configuration such as thematic emergence, collaboration centrality and knowledge diffusion—that are otherwise challenging to identify. In addition, the high number of recent publications suggests a short knowledge cycle, where prolific research may excel synthesis. In this circumstances,

informatics-driven system becomes fundamental for combining scattered evidence and supporting incremental knowledge generation, especially in multidisciplinary areas[19].

The collaboration pattern marked by regional concentration and restricted global integration convey analytical implications. The leadership of countries such as India, Pakistan, and Bangladesh show not only susceptibility to climate risks but also uneven research capacity within the region. This consolidation can lead to path dependency, where a small set of institutions and authors predominately shape research directions. At the same time, limited number of cross-regional collaboration recommends low level of knowledge sharing constraining the exchange of technological innovations and policy learning. Therefore, writing partnership patterns they actively shape whose knowledge is produced, circulated, and legitimized [26], [37].

Thematic development from disaster-focused research to resilience and adaptation-directed approaches represents a substantive alteration in the paradigm of the field. Early emphasis on climate stressors (e.g., drought, abiotic stress) demonstrate a phase centered on problem identification. Then, the subsequent shift toward resilience, sustainability, and food security considers movement into a solution-oriented phase, where research engages more directly with action plans and systemic transfiguration. Analytically, this restructuration suggests gradual maturity of the discipline, but it also raises questions about the degree of integration between ecological, technological, and socio-economic aspects [30][6], [14], [19], [23], [28].

Citation structures identify a parallel methodological reorganization. Highly influential research incrementally produced from genetics, plant science, environmental systems and interdisciplinary sustainability journals. The distinction of highly cited publication on genomics, microbial systems, stress physiology, and climate adaptation implies that scientific engagement is shifting beyond traditional agronomy toward innovation-driven solutions. The rising citation of studies on machine learning, precision agriculture, and genetic innovation signifies the application of digital and computational model into agricultural research. This transformation is analytically noteworthy because it hints the increasing usages of the data-intensive methods and predictive techniques. From an IS/I approaches, this convergence emphasizes the use of information systems not just as

tools, but as underlying motivation that shape how agricultural problems are defined, modeled, and addressed [24].

This is consistent with the prominent role of information systems and data analytics can play in handling complicated environmental threats, as highlighted in the literature [25], [31], [32]. In spite of these advancements, several knowledge gaps remain under solved. First, yet there is limited use of informatics-driven approaches in synthesizing large-scale climate and agricultural data. Second, context-specific, policy-focused research left underdeveloped. Third, socio-economic dimensions, such as farmer-level adjustment and organizational barriers, are less examined compared to biogenic and technological direction [8], [16]. These limitations stress on the need for increased interdisciplinary research frameworks.

On a whole, these findings clarify that research on climate change and agro-ecosystem stress in South Asia is progressing toward a larger “Resilience and Intelligence” pattern. Scientific progress is no more confined to identifying hazards, but steadily focuses on adaptive capacity, sustainability and data-based agricultural management. Upcoming studies should bolster regional teamwork and develop decision-support systems that incorporate real-time climate data, farmer needs, and institutional requirements. Such dedication will be necessary for building scientifically robust and practically implementable pathways toward climate-resilient agriculture in South Asia.

4. CONCLUSION

This study presents a comprehensive overview of the development and direction of research on climate change impacts, agro-ecosystem stress, and adaptive agricultural strategies in South Asia through a rigorous bibliometric approach. Some notable conclusions can be made based on the methodical examination of publication trends, collaborative networks, contributing authors, and theme clusters from 1997 to 2026. The research domain has encountered substantial growth, particularly after 2015, with increasing scholarly attention. This expansion is largely motivated by escalating concern over climate vulnerability, food security challenges, and the immediate need for sustainable agricultural transformation across the region. Within the literature, peer-reviewed journal articles are the dominant mode of knowledge production, while the

powerful presence of review papers confirm evidence synthesis and policy framing. Snapshots of results disclose that India appears as the leading research hub, followed by Pakistan and Bangladesh, establishing that climate-vulnerable regions are becoming central contributor of knowledge rather than passive recipients of external scholarship. Although, several inequalities exist, as international collaboration and institutional capacity are disproportionate distributed across the region. Keyword mapping exhibits an impactful diversification of research priorities. While climate change, drought, and abiotic stress remain fundamental themes, newer frontiers emphasize on resilience, vulnerability, food security, and sustainability. Although, several limitations should be noted. The reliance on the Scopus database may exclude relevant local and non-English publications, while bibliometric methods initially capture quantitative patterns and may overlook the qualitative depth and contextual nuance of individual studies[33]. Moreover, database indexing and keyword-based recapture may influence thematic presentation and may miss relevant works using different terminology. Future research should target interdisciplinary integration, importantly by combining environmental science with Information Systems and social science perspectives. As well as, more research on local adaptation practices, farmer-level experiences, and policy implementation processes is required. Enlarging data sources and integrating bibliometric analysis with qualitative approaches would further support understanding of climate resilience and sustainable agriculture in South Asia. Overall, this study contributes an organized, data-driven method on the evolution of the field and offers a scope for more targeted and context-sensitive research and policy development.

ACKNOWLEDGEMENT

I am grateful to my mentors and colleagues Md Fysal-E-Alam, Afsana Mimi and Mohammad Rakibul Islam Bhuiyan respectively.

REFERENCES

- [1] K. Vinke *et al*, "Climatic risks and impacts in South Asia: extremes of water scarcity and excess," *Reg. Environ. Change*, vol. 17, no. 6, pp. 1569–1583, Aug. 2017, doi: 10.1007/s10113-015-0924-9.

- [2] J. Sentian, C. M. Payus, F. Herman, and V. W. Y. Kong, "Climate change scenarios over Southeast Asia," *APN Sci. Bull.*, vol. 12, no. 1, pp. 102–122, Oct. 2022, doi: 10.30852/sb.2022.1927.
- [3] Y. Wu, S. Meng, C. Liu, W. Gao, and X.-Z. Liang, "A bibliometric analysis of research for climate impact on agriculture," *Front. Sustain. Food Syst.*, vol. 7, p. 1191305, Jul. 2023, doi: 10.3389/fsuufs.2023.1191305.
- [4] C. Li *et al.*, "A Bibliometric Analysis of Global Research on Climate Change and Agriculture from 1985 to 2023," *Agronomy*, vol. 14, no. 11, p. 2729, Nov. 2024, doi: 10.3390/agronomy14112729.
- [5] V. V. Kumari *et al.*, "Adapting sorghum and other millets to climate challenges: An integrated bibliometric and meta-analysis of global literature," *J. Agric. Food Res.*, vol. 21, p. 101987, Jun. 2025, doi: 10.1016/j.jafr.2025.101987.
- [6] D. B. Lobell, W. Schlenker, and J. Costa-Roberts, "Climate Trends and Global Crop Production Since 1980," *Science*, vol. 333, no. 6042, pp. 616–620, Jul. 2011, doi: 10.1126/science.1204531.
- [7] L. Lipper *et al.*, "Climate-smart agriculture for food security," *Nat. Clim. Change*, vol. 4, no. 12, pp. 1068–1072, Dec. 2014, doi: 10.1038/nclimate2437.
- [8] T. Wheeler and J. Von Braun, "Climate Change Impacts on Global Food Security," *Science*, vol. 341, no. 6145, pp. 508–513, Aug. 2013, doi: 10.1126/science.1239402.
- [9] A. Loboguerrero, B. Campbell, P. Cooper, J. Hansen, T. Rosenstock, and E. Wollenberg, "Food and Earth Systems: Priorities for Climate Change Adaptation and Mitigation for Agriculture and Food Systems," *Sustainability*, vol. 11, no. 5, p. 1372, Mar. 2019, doi: 10.3390/su11051372.
- [10] B. M. Campbell, P. Thornton, R. Zougmore, P. Van Asten, and L. Lipper, "Sustainable intensification: What is its role in climate smart agriculture?," *Curr. Opin. Environ. Sustain.*, vol. 8, pp. 39–43, Oct. 2014, doi: 10.1016/j.cosust.2014.07.002.
- [11] R. Sahar, M. Munawaroh, and J. Iqbal, "Climate change adaptation in agriculture food supply chains: a bibliometric and content analysis," *Discov. Sustain.*, vol. 6, no. 1, p. 1396, Nov. 2025, doi: 10.1007/s43621-025-02105-9.
- [12] S. Gil-Clavel, T. Wagenblast, and T. Filatova, "Incremental and transformational climate change adaptation factors in agriculture worldwide: A comparative analysis using natural language processing," *PLOS ONE*, vol. 20, no. 3, p. e0318784, Mar. 2025, doi: 10.1371/journal.pone.0318784.

- [13] P. Jaisridhar, R. Nirosha, S. Jasimudeen, M. Senthilkumar, I. Ponsneka, and P. Raja, "Institutional dynamics in climate change adaptation – a bibliometric analysis," *Front. Environ. Sci.*, vol. 13, p. 1598908, Jun. 2025, doi: 10.3389/fenvs.2025.1598908.
- [14] J. Pretty *et al.*, "Global assessment of agricultural system redesign for sustainable intensification," *Nat. Sustain.*, vol. 1, no. 8, pp. 441–446, Aug. 2018, doi: 10.1038/s41893-018-0114-0.
- [15] Q. Hernandez-Escobedo *et al.*, "Renewable Energies in the Agricultural Sector: A Perspective Analysis of the Last Three Years," *Energies*, vol. 16, no. 1, p. 345, Dec. 2022, doi: 10.3390/en16010345.
- [16] S. J. Vermeulen, B. M. Campbell, and J. S. I. Ingram, "Climate Change and Food Systems," *Annu. Rev. Environ. Resour.*, vol. 37, no. 1, pp. 195–222, Nov. 2012, doi: 10.1146/annurev-environ-020411-130608.
- [17] N. Donthu, S. Kumar, D. Mukherjee, N. Pandey, and W. M. Lim, "How to conduct a bibliometric analysis: An overview and guidelines," *J. Bus. Res.*, vol. 133, pp. 285–296, Sep. 2021, doi: 10.1016/j.jbusres.2021.04.070.
- [18] M. Chen, T. Yao, and K. Wang, "The economic impact of climate change: a bibliometric analysis of research hotspots and trends," *Environ. Sci. Pollut. Res.*, Feb. 2023, doi: 10.1007/s11356-023-25721-2.
- [19] I. Zupic and T. Čater, "Bibliometric Methods in Management and Organization," *Organ. Res. Methods*, vol. 18, no. 3, pp. 429–472, Jul. 2015, doi: 10.1177/1094428114562629.
- [20] J. P. Aryal, D. B. Rahut, T. B. Sapkota, R. Khurana, and A. Khatri-Chhetri, "Climate change mitigation options among farmers in South Asia," *Environ. Dev. Sustain.*, vol. 22, no. 4, pp. 3267–3289, Apr. 2020, doi: 10.1007/s10668-019-00345-0.
- [21] A. Sharma, P. L. Patel, and P. J. Sharma, "Climate change impact on crop stress and food security in a semi-arid river basin," *AQUA – Water Infrastruct. Ecosyst. Soc.*, vol. 72, no. 12, pp. 2313–2330, Dec. 2023, doi: 10.2166/aqua.2023.168.
- [22] H. Derviş, "Bibliometric Analysis using Bibliometrix an R Package," *J. Scientometr. Res.*, vol. 8, no. 3, pp. 156–160, Jan. 2020, doi: 10.5530/jscires.8.3.32.
- [23] P. Ahmad, J. A. Asif, M. K. Alam, and J. Slots, "A bibliometric analysis of *Periodontology 2000*," *Periodontol. 2000*, vol. 82, no. 1, pp. 286–297, Feb. 2020, doi: 10.1111/prd.12328.
- [24] K. Liakos, P. Busato, D. Moshou, S. Pearson, and D. Bochtis, "Machine Learning in Agriculture: A Review," *Sensors*, vol. 18, no. 8, p. 2674, Aug. 2018, doi: 10.3390/s18082674.

- [25] J. Hellin, E. Fisher, M. Taylor, S. Bhasme, and A. M. Loboguerrero, "Transformative adaptation: from climate-smart to climate-resilient agriculture," *CABI Agric. Biosci*, vol. 4, no. 1, p. 30, Aug. 2023, doi: 10.1186/s43170-023-00172-4.
- [26] I. Passas, "Bibliometric Analysis: The Main Steps," *Encyclopedia*, vol. 4, no. 2, pp. 1014–1025, Jun. 2024, doi: 10.3390/encyclopedia4020065.
- [27] N. J. Van Eck and L. Waltman, "Software survey: VOSviewer, a computer program for bibliometric mapping," *Scientometrics*, vol. 84, no. 2, pp. 523–538, Aug. 2010, doi: 10.1007/s11192-009-0146-3.
- [28] J. A. Moral-Muñoz, E. Herrera-Viedma, A. Santisteban-Espejo, and M. J. Cobo, "Software tools for conducting bibliometric analysis in science: An up-to-date review," *El Prof. Inf.*, vol. 29, no. 1, Jan. 2020, doi: 10.3145/epi.2020.ene.03.
- [29] S. Büyükkidik, "A Bibliometric Analysis: A Tutorial for the Bibliometrix Package in R Using IRT Literature," *Eğitimde Ve Psikolojide Ölçme Ve Değerlendirme Derg.*, vol. 13, no. 3, pp. 164–193, Sep. 2022, doi: 10.21031/epod.1069307.
- [30] W. Waridin, C. Musliha, M. I. Prastyadewi, and A. Nur Furoida, "Bibliometric Analysis on Farmers' Vulnerability to Climate Change Impacts," *Soc. Sci. Humanit. J.*, vol. 9, no. 05, pp. 7984–7996, May 2025, doi: 10.18535/sshj.v9i05.1822.
- [31] J. Li, E. Xia, L. Wang, K. Yan, L. Zhu, and J. Huang, "Knowledge domain and emerging trends of climate-smart agriculture: a bibliometric study," *Environ. Sci. Pollut. Res.*, vol. 29, no. 46, pp. 70360–70379, Oct. 2022, doi: 10.1007/s11356-022-20796-9.
- [32] B. J. Balabaygloo *et al.*, "Smart Connected Farms and Networked Farmers to Tackle Climate Challenges Impacting Agricultural Production," Dec. 19, 2023, *arXiv*: arXiv:2312.12338. doi: 10.48550/arXiv.2312.12338.
- [33] S. Wolfert, L. Ge, C. Verdouw, and M.-J. Bogaardt, "Big Data in Smart Farming – A review," *Agric. Syst.*, vol. 153, pp. 69–80, May 2017, doi: 10.1016/j.agry.2017.01.023.