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Mapping of Global Research on Climate Change and the Agricultural Sector: A Bibliometric Analysis 2000-2025

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ABSTRACT

This study presents a comprehensive bibliometric analysis of global research on climate change and the agricultural sector published between 2000 and 2025, using the Scopus database as the primary data source. A total of publications retrieved through a targeted keyword search were analyzed using VOSviewer to map co-authorship networks, keyword co-occurrence, citation patterns, and thematic clusters. The results reveal *agriculture* as the central conceptual hub, linking critical themes such as food security, agricultural productivity, climate change adaptation, biosafety, public policy, and gender empowerment. Thematic evolution indicates a shift from early biophysical impact assessments toward more integrated approaches that combine technological innovation, governance frameworks, and socio-economic equity considerations. Collaboration network analysis highlights France as a key bridging country connecting European, African, and Latin American research communities. Practical implications include the need to strengthen interdisciplinary integration, foster cross-regional partnerships, and address thematic gaps—particularly in linking social equity with climate adaptation strategies. This study contributes theoretically by clarifying the intellectual structure and research trends of the field, while its methodological approach offers a replicable framework for bibliometric mapping in sustainability-related domains. Limitations include database coverage, keyword constraints, and the inability to assess the qualitative rigor of individual studies. The findings provide an evidence base to inform policy priorities, funding allocation, and future research agendas in building climate-resilient and low-emission agrifood systems.

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1. INTRODUCTION

Over the last quarter-century, climate change has moved from a distant concern to a present and unevenly distributed stressor on global food systems. Rising temperatures, shifting precipitation patterns, and more frequent extremes are already altering where and how food can be produced. The scientific consensus synthesized in the IPCC Sixth Assessment Report (AR6) emphasizes that climate risks to food security are widespread, escalating, and interacting with non-climatic

drivers such as land degradation, conflict, and market volatility; in short, climate change is now a binding constraint on agricultural development in many regions [1], [2].

At the same time, agriculture is not only a victim of climate change but also a contributor. Recent FAO assessments estimate that agrifood systems—spanning on-farm production, land-use change, supply chains, and consumption—account for roughly one-third of anthropogenic greenhouse gas emissions, with nearly half arising within the farm gate (crop and livestock activities) and a substantial share linked to land-use dynamics [3]. These emissions have evolved since 2000, with declines from net forest loss but continued growth in farm-gate sources, underscoring the dual mitigation–adaptation imperative facing the sector [4], [5], [6].

The biophysical consequences for yields are no longer speculative [7]. Meta-analyses and multi-model assessments consistently find that, absent adaptation, aggregate yields for major cereals decline as warming intensifies, with particularly steep losses projected for maize and region-specific sensitivities for wheat and rice. While CO_2 fertilization can partially offset losses for some C3 crops, its benefits are frequently overwhelmed by heat stress, water scarcity, and pest and disease pressures amplified under a warmer climate. These findings have been reinforced across successive syntheses, making yield impacts one of the most empirically grounded facets of climate–agriculture research [8], [9], [10].

Beyond yields, climate change reshapes agricultural risk in ways that challenge farm households, markets, and policy. Increased variability in rainfall and temperature expands the tails of production outcomes; compounding events—such as concurrent heat and drought—propagate through storage, trade, and prices [11], [12]. These dynamics heighten vulnerability for smallholders and agri-food workers, with differential effects by gender and socioeconomic status. Recent analyses, for example, show that rural women in developing countries bear disproportionate income losses from heat and flood events, pointing to the importance of equity-sensitive adaptation and finance.

Over 2000–2025, scholarship at the intersection of climate change and agriculture has expanded dramatically, spanning impact detection, scenario modeling, adaptation options (from cultivar selection to agroecological practices), mitigation pathways (e.g., methane reduction, nitrogen management), and policy design. Yet the sheer volume and disciplinary breadth of this literature make it difficult to perceive the field's structure, identify core knowledge clusters, and trace how topics evolve over time. Early and recent bibliometric efforts signal maturing subfields and shifting emphases, but a comprehensive, updated mapping that covers the full 2000–2025 window is still needed to guide future research and policy conversations.

Despite rapid growth in publications, the climate–agriculture literature remains fragmented across disciplines, geographies, and methodological traditions. Policymakers and practitioners seeking actionable insights confront dispersed evidence on impacts, adaptation, and mitigation, while researchers face duplication risks and blind spots—such as uneven attention to the Global South, value chains beyond production, and social dimensions like gender and equity. Without a systematic bibliometric map of global research from 2000 to 2025, it is hard to (i) reveal the intellectual structure and leading themes, (ii) track temporal shifts (e.g., from impacts to solutions), (iii) surface collaboration networks and influential institutions, and (iv) spotlight emerging fronts (e.g., climate services, digital agriculture, methane abatement) that merit investment.

This study conducts a comprehensive bibliometric analysis of global research on climate change and the agricultural sector over 2000–2025 to (1) map the knowledge structure—including core keyword co-occurrences, thematic clusters, and citation networks; (2) characterize temporal evolution

in topics, methods, and geographies; (3) identify influential authors, institutions, countries, and journals; and (4) detect emerging research fronts and gaps linked to impacts, adaptation, mitigation, and equity.

2. METHODS

This study employs a **bibliometric analysis** to systematically map and evaluate the body of literature on climate change and the agricultural sector published between 2000 and 2025. The bibliometric approach is widely recognized for its ability to reveal research trends, intellectual structures, and thematic evolution within a field by using quantitative techniques on bibliographic data [13]. The primary data source is the **Scopus** database, selected for its extensive coverage of peer-reviewed journals, conference proceedings, and book chapters across multiple disciplines relevant to climate and agriculture. The search strategy combined controlled vocabulary and Boolean operators, using keywords such as *"climate change"*, *"global warming"*, *"agriculture"*, *"farming"*, *"crop production"*, and *"food systems"*. Titles, abstracts, and keywords were searched, and results were filtered to include only English-language publications within the defined time frame.

After retrieval, the dataset was cleaned to remove duplicates, irrelevant records, and incomplete entries. The bibliographic information extracted included authors, titles, publication years, journals, author affiliations, abstracts, keywords, and citation counts. These data were exported in CSV and RIS formats for analysis. The cleaning process ensured that synonymous terms (e.g., "greenhouse effect" vs. "climate change") were unified, and variant author names or institutional affiliations were standardized. Descriptive bibliometric indicators such as annual publication trends, most prolific authors, institutions, countries, and citation performance were calculated to provide an overview of research productivity and influence.

For science mapping and network visualization, the study utilized VOSviewer (van Eck & Waltman, 2010) to construct and analyze co-authorship, co-occurrence, and bibliographic coupling networks. Keyword co-occurrence mapping identified the main research themes and their interconnections, while overlay visualization revealed the temporal evolution of topics. Thematic clusters were interpreted qualitatively to classify research into impact assessment, adaptation strategies, mitigation measures, and cross-cutting socio-economic dimensions.

3. RESULTS AND DISCUSSION

Co-Authorship Analysis

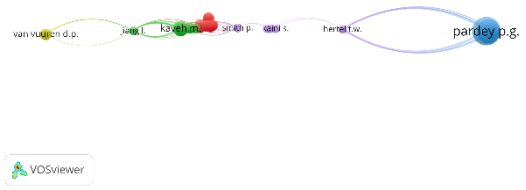

Figure 1. Author Visualization
Source: Data Analysis

Figure 1 illustrates a **co-authorship map** highlighting collaboration patterns among influential authors in the field of climate change and agriculture. The most prominent node, *Pardey P.G.*, appears as the largest and most centrally connected, indicating high publication output and citation influence, as well as serving as a key connector between different author clusters. The network shows distinct colored clusters representing collaborative groups: the blue cluster (centered on Pardey P.G.) is linked to agricultural economics and policy analysis; the green and red clusters (including authors like *Kaiser H.M.* and *Smith P.*) appear to focus on climate impact modeling and environmental sustainability; and the yellow cluster (with *van Vuuren D.P.*) is associated with integrated assessment modeling and global scenario analysis. The relatively linear connection pattern suggests limited cross-cluster integration, with collaborations occurring mainly within thematic groups rather than across the broader network.

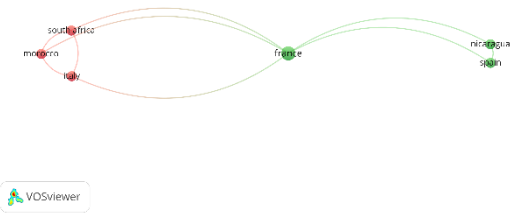

Figure 2. Density Visualization
Source: Data Analysis

Figure 2 depicts a **country collaboration network** within climate change and agriculture research, where node size represents publication volume and link thickness indicates collaboration strength. *France* emerges as the central connector, bridging two distinct regional clusters. On the left, the red cluster—comprising *South Africa*, *Morocco*, and *Italy*—suggests strong South–North collaboration, possibly around Mediterranean and African climate-agriculture issues. On the right, the green cluster—featuring *Spain* and *Nicaragua*—reflects partnerships likely tied to agricultural adaptation in Latin and Southern Europe contexts. The central positioning of France, with equally visible links to both clusters, indicates its pivotal role as a research intermediary and collaboration hub, facilitating knowledge exchange between European, African, and Latin American research communities.

Keyword Co-Occurrence Analysis

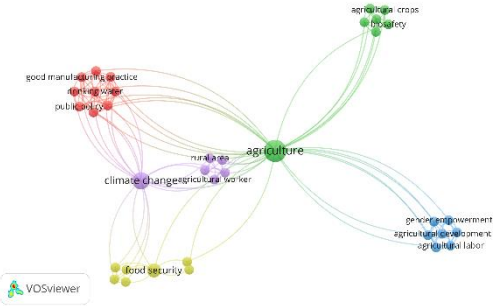

Figure 3. Network Visualization
Source: Data Analysis

Figure 3 represents a **keyword co-occurrence map** in the field of climate change and agriculture, with *agriculture* serving as the central node that connects multiple thematic clusters. The size of each node indicates the frequency of keyword occurrence, while the colors denote different thematic groupings. The central positioning of *agriculture* underscores its role as the primary conceptual anchor, linking diverse research subfields from agronomic practices to socio-economic dimensions. This visualization highlights the multidisciplinary nature of climate-agriculture research, integrating production science, policy, social equity, and food security concerns.

The green cluster, radiating to the upper right, focuses on *agronomic aspects* of agriculture, with terms like *agronomic crops* and *productivity*. This grouping likely represents studies on crop yield optimization, climate-resilient crop varieties, and field management techniques. These keywords suggest a strong research emphasis on improving productivity under changing climatic conditions, potentially through plant breeding, soil management, and precision agriculture technologies. Such studies often form the technical backbone of adaptation strategies, especially for regions highly dependent on staple crops.

The **red cluster**, extending to the upper left, centers on *good management practice* and *public policy*. This cluster points to research on best practices in agricultural production, sustainability standards, and policy frameworks aimed at supporting farmers in climate adaptation and mitigation. It reflects the interface between governance, extension services, and farm-level implementation. The linkage between policy-oriented keywords and agriculture suggests that policy support and institutional frameworks are considered crucial for scaling up sustainable agricultural practices in the face of climate change.

The **yellow cluster**, located at the bottom left, revolves around *food security*. Keywords here are tied to the societal and economic outcomes of agricultural productivity in the context of climate change. This thematic focus reflects the research stream that connects agricultural production and distribution systems to nutrition security, poverty alleviation, and resilience in rural

communities. The direct link between *food security* and *climate change* indicates recognition that climate variability and extreme events directly threaten food system stability, especially in vulnerable regions.

The **blue cluster**, positioned to the lower right, addresses *social equity and labor issues* in agriculture. Keywords such as *gender empowerment*, *agricultural development*, and *agricultural labor* suggest a research focus on the human dimension of agricultural adaptation. This cluster reflects studies exploring gendered impacts of climate change, empowerment strategies for marginalized groups, and the role of labor in building climate-resilient farming systems. The inclusion of *gender empowerment* indicates growing attention to social justice in agricultural climate adaptation discourse, signaling an important shift from purely technical solutions to inclusive and equitable approaches.

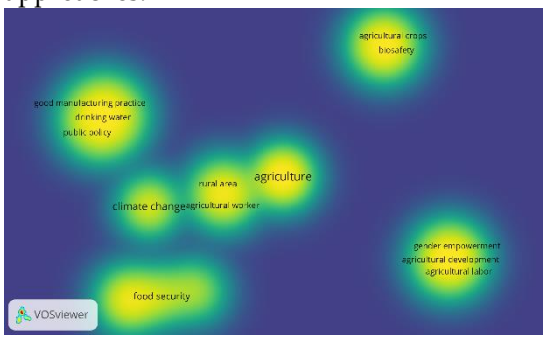

Figure 4. Density Visualization
Source: Data Analysis

Figure 4 VOSviewer highlights the most frequently occurring keywords in climate change and agriculture research, with brighter yellow areas indicating higher co-occurrence intensity. *Agriculture* is the most dominant term, serving as the central thematic hub connecting various specialized areas. Surrounding it are key topics like *climate change*, *rural area*, and *agricultural worker*, reflecting the strong linkage between environmental change, rural livelihoods, and labor dynamics. The dense yellow clusters around these terms suggest that they are foundational concepts within the literature, appearing consistently across numerous publications.

Other bright clusters represent distinct thematic concentrations. The top-right cluster (*agricultural crops*, *biosafety*) reflects agronomic and technological research, while the bottom clusters—*food security* and the grouping of *gender empowerment*, *agricultural development*, and *agricultural labor*—indicate strong social, economic, and equity-focused research streams. Meanwhile, the upper-left cluster (*good manufacturing practice*, *public policy*, *drinking water*) points to governance, policy, and resource management dimensions.

Practical Implication

The findings of this bibliometric analysis provide actionable insights for policymakers, development agencies, and agricultural practitioners. By identifying the dominant research themes, such as agricultural productivity, food security, climate adaptation strategies, and socio-economic equity—this study offers an evidence-based foundation for prioritizing policy interventions and funding allocations. For example, the prominence of keywords like *climate change*, *food security*, and *agricultural worker* indicates the urgent need for integrated programs that combine technical innovations with social protection measures. The collaboration networks revealed through author and country mapping can guide international partnerships, enabling knowledge transfer between high-output research hubs (e.g., France, Spain) and climate-vulnerable regions. Furthermore, understanding the thematic gaps, such as limited cross-linkages between gender empowerment and climate adaptation research, can inform the design of inclusive agricultural policies that address both productivity and equity.

Theoretical Contribution

This study contributes to the theoretical advancement of climate change and agricultural research by systematically mapping the intellectual structure, thematic evolution, and collaboration patterns over a 25-year period. Through co-occurrence and network analyses, it refines the conceptual linkages between biophysical impacts,

technological adaptation, governance frameworks, and social equity dimensions in agricultural climate research. By integrating bibliometric evidence with thematic clustering, the study enriches the understanding of how the field has transitioned from early impact-assessment models toward more holistic approaches that combine mitigation, adaptation, and resilience-building. Additionally, it offers a methodological contribution by applying science mapping tools like VOSviewer to generate a multi-dimensional view of the literature, which can serve as a replicable framework for bibliometric analyses in other domains of sustainability science.

Limitations

While comprehensive in scope, this study has several limitations. First, the analysis relies solely on the **Scopus** database, which, despite its broad coverage, may omit relevant publications indexed in other databases such as Web of Science or regional repositories. Second, the keyword-based search strategy, although carefully designed, may exclude studies that address climate–agriculture issues without explicitly using the selected terms, leading to potential underrepresentation of interdisciplinary or context-specific research. Third, bibliometric methods focus on quantitative patterns in publication and citation data; they do not evaluate the substantive quality, methodological rigor, or field applicability of individual studies. Finally, the inclusion of literature up to 2025 may not fully capture the most recent trends in real time due to indexing delays, suggesting that the findings should be periodically updated to maintain relevance.

4. CONCLUSION

This bibliometric analysis provides a comprehensive mapping of global research on climate change and the agricultural sector from 2000 to 2025, revealing the field's multidisciplinary nature and its evolution from early biophysical impact studies toward integrated approaches encompassing adaptation, mitigation, governance, and socio-economic equity. The findings highlight *agriculture* as the central thematic hub, closely linked to key domains such as food security, agricultural productivity, climate resilience, and social empowerment, while also exposing gaps in cross-thematic integration—particularly between technical innovations and social inclusion strategies. Collaboration patterns show that certain countries, notably France, act as pivotal connectors bridging diverse geographic research clusters, underscoring the value of strengthening South–North and cross-regional partnerships. By identifying dominant themes, influential actors, and emerging research fronts, this study not only informs academic discourse but also provides practical guidance for policymakers, funding agencies, and practitioners seeking to design targeted, evidence-based interventions for building climate-resilient and low-emission agrifood systems.

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