Review Article

Mapping the Literature on Good Agricultural Practices: A Bibliometric Approach Using the Scopus Data

ABSTRACT

This study conducts a comprehensive bibliometric analysis of research on Good Agricultural Practices (GAP), using Scopus data to explore the chronological and thematic development of the topic from 1964 to 2025. GAP, established to guarantee food safety, environmental sustainability, and economic viability in agriculture, has achieved international acclaim. Nonetheless, investigations on the subject remain disjointed across fields such as agronomy, environmental science, and food safety. This analysis utilizes bibliometric tools like VOS viewer and Biblioshiny to synthesize and visualize significant contributions to GAP research. A total of 1,732 papers were examined to ascertain prominent authors, major nations, and significant topic trends. The findings indicate a growing emphasis on sustainable crop management, food safety regulations, and the incorporation of new technology like precision agriculture into Good Agricultural Practices (GAP). Nevertheless, a notable study deficiency remains in investigations centred on developing regions, where GAP might exert the most substantial influence. Moreover, socio-economic obstacles, especially those encountered by smallholder farmers in implementing GAP, remain little examined.The study underscores the necessity for more investigation into the long-term impacts of GAP, particularly concerning climate change and global food security. This analysis identifies research gaps and emerging trends, establishing a basis for future studies and policy measures to promote sustainable farming practices globally.

Keywords: Sustainable Agriculture, Economic Sustainability, Farmers, Bibliometric Analysis

1. INTRODUCTION

The concept of Good Agricultural Practices (GAP) has evolved into a comprehensive strategy addressing critical agricultural challenges, such as food safety, environmental sustainability, and rural development (Siebrecht, 2020a). Initially established by global organizations like the Food and Agriculture Organization (FAO), GAP standards have been widely adopted to standardize agricultural practices in both developed and developing regions (Amekawa et al., 2022). GAP aims to create a balanced agricultural system that can respond to external challenges, including climate change and market instability, by focusing on four key pillars: economic viability, environmental sustainability, social equity, and food safety.

The literature on GAP is comprehensive and diverse, encompassing fields such as agronomy, food safety, economics, and environmental sciences (Sparling et al., 2021). As a result,

researchers often face challenges in integrating data from many fields, leading to disjointed information and a limited understanding of how GAP influences different agricultural systems (Pervez et al., 2016). Bibliometric analysis may alleviate this fragmentation by offering a comprehensive evaluation of existing literature, tracking scholarly contributions, and outlining the evolution of GAP research over time (Zhao et al., 2023).

Scopus, a comprehensive abstract and citation database, serves as an ideal platform for bibliometric research due to its vast coverage of peer-reviewed journals, conference proceedings, and other academic resources. This study used Scopus data to systematically chart research output on GAP, identify leading authors, institutions, and countries in the field, and analyze citation trends to assess the impact of key articles. This study will discern emerging patterns and deficiencies in the literature by assessing significant phrases and thematic clusters, providing a framework for future research on the subject.

Given the worldwide agricultural challenges, particularly those related to climate change, resource limitations, and population growth, understanding the advancement of GAP research is crucial (Viana et al., 2022). This bibliometric analysis will yield essential insights into the research and use of GAP across many agricultural systems worldwide, aiding policymakers, practitioners, and scholars in promoting sustainable agricultural growth. This project will improve understanding of GAP's importance in advancing sustainable agriculture and addressing global food security challenges by clarifying the existing knowledge base.

2. LITERATURE REVIEW

The notion of Good Agricultural Practices (GAP) has received international recognition as a strategy to promote agricultural sustainability, environmental preservation, and food safety (Bertola et al., 2021). Numerous studies indicate that GAP frameworks offer systematic advice that assists farmers in implementing methods that reduce environmental degradation while improving productivity. Soil fertility management, water-use efficiency, and integrated pest management (IPM) are essential elements of Good Agricultural Practices (GAP) that promote sustainable agriculture.

Literature indicates that although GAP has been effectively implemented in affluent countries, its acceptance in underdeveloped ones is inconsistent (Eriksen et al., 2021). Factors including inadequate infrastructure, financial limitations, and restricted technical expertise hinder farmers from fully adopting GAP. Research indicates that surmounting these obstacles may result in substantial enhancements in agricultural productivity and livelihoods, especially in areas where subsistence farming is prevalent (Khatam et al., 2013). Furthermore, GAP has demonstrated its role in enhancing food safety standards, which is becoming increasingly vital in the realm of global commerce and export regulations.

The significance of certification methods related to GAP is a prevalent issue in the literature. GAP accreditation offers farmers competitive benefits, especially in gaining access to premium markets that need compliance with rigorous quality criteria (De Lima et al., 2023). Nevertheless, smallholder farmers frequently encounter obstacles in acquiring these certificates due to elevated expenses and bureaucratic impediments, underscoring the necessity for governmental initiatives that promote equal access to GAP advantages.

Recent research has examined the use of digital tools and precision agricultural technology with Good Agricultural Practices (GAP) to improve its efficacy (Onyango et al., 2021). Digital platforms provide real-time guidance, data acquisition, and monitoring systems, allowing farmers to execute Good Agricultural Practices (GAP) more effectively. The capacity of

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technology to improve GAP adoption and results is a burgeoning field of inquiry, especially regarding climate change and its effects on agriculture.

The current literature highlights the essential function of GAP in advancing sustainable agriculture and food security (Chouhan et al., 2021). It underscores the socio-economic hurdles and technological deficiencies that must be resolved to facilitate wider and more egalitarian adoption of GAP, especially in developing nations. Additional study is required to investigate the long-term effects of GAP on smallholder farmers, environmental sustainability, and global food chains (Beck-O'Brien & Bringezu, 2021).

3. METHODOLOGY

In several fields of study, researchers have used thorough scientific mapping approaches. There are other statistical and graphical methods available; one attractive open-source R package with user-friendly web apps is called Biblioshiny. Additionally, VOS Viewer, a powerful visualization tool for building and visualizing bibliometric networks, is employed (Khanam et al., 2023). The Scopus database was used for this research, which spanned the years 1964 through 2025. The Scopus is a well-recognized bibliographic information source among scientists (Kabir et al. 2024). In the first phase, we gathered 1732 papers by using the topic keywords "Good Agricultural Practices". After duplicates were removed, 1732 articles remained for the bibliometric examination of each paper's entire record and referred references. The search was conducted on September 21, 2024. Fig. 1 presents the five-step detailed research approach.

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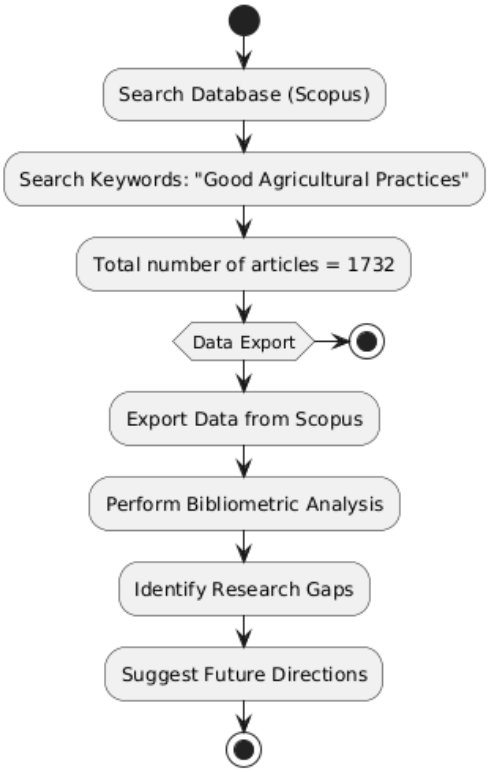

Figure 1. The research methodology for this article

4. RESULT AND DISCUSSION

4.1 Description of the Data

Table 1 presents the descriptive statistics of the dataset, spanning the years 1964 to 2025, incorporating contributions from 867 sources, including journals and books, resulting in a total of 1,732 documents. Despite this extensive dataset, the annual growth rate remains at 0%, and the average document age is 8.23 years. Each document averages 17.71 citations, amounting to a total of 71,684 references across all publications. The dataset contains 6,496 "Keywords Plus" (ID) and 4,605 "Author's Keywords" (DE). There are 6,079 contributing writers, with 206 having created single-authored works, amounting to a total of 221 publications. Each manuscript had an average of 4.36 co-authors, with 20.55% demonstrating international co-authorships, indicating strong collaboration. The document types include 1,159 articles, 195 book chapters, 196 conference papers, and 154 reviews, in addition to smaller categories such as editorials, data papers, and notes, reflecting a diverse range of contributions.

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Table 1. Descriptive statistics for the data

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1964:2025
Sources (Journals, Books, etc.)	867
Documents	1732
Annual Growth Rate %	0
Document Average Age	8.23
Average citations per doc	17.71
References	71684
DOCUMENT CONTENTS	
Keywords Plus (ID)	6496
Author's Keywords (DE)	4605
AUTHORS	
Authors	6079
Authors of single-authored docs	206
AUTHORS COLLABORATION	
Single-authored docs	221
Co-Authors per Doc	4.36
International co-authorships %	20.55
DOCUMENT TYPES	
article	1159
book	8
book chapter	195
conference paper	196
conference review	2
data paper	2
editorial	5
letter	3
note	5
review	154
short survey	3

4.2 Publication Progression

Figure 2 illustrates a line graph representing the annual publication count of publications from 1964 to 2025. The y-axis denotes the quantity of articles, whilst the x-axis illustrates the history across these years. The trend stays mostly stable, with few publications from 1964 until the mid-1990s, followed by a significant rise thereafter. Beginning in the year 2000, the quantity of articles had a consistent increase, with a pronounced acceleration noted from 2010

onwards. The quantity of articles reaches its zenith in 2021 before undergoing a significant decline by 2025. This graph illustrates a notable rise in scholarly publications throughout recent decades, accompanied by a steep decrease in the most recent year.

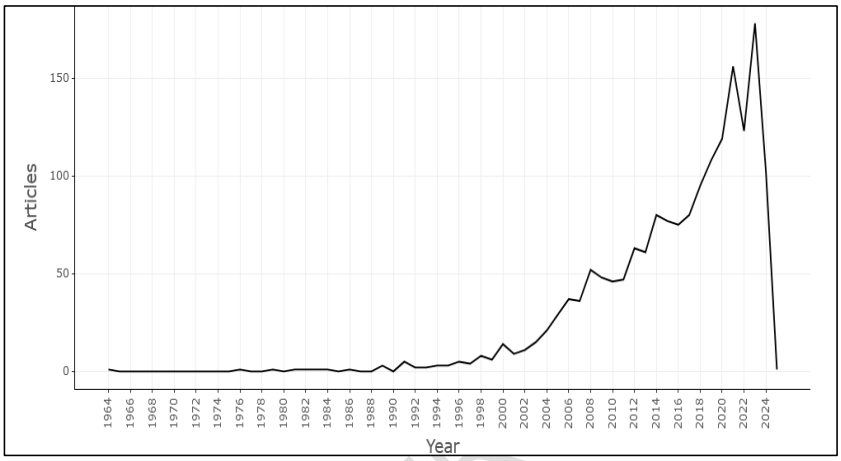

Figure 2. Annual progression of publications (1964-2024)

4.3 Influential Journals

Figure 3 depicts the cumulative frequency of publications from six distinct sources over the years 1964 to 2025. The magazine Acta Horticulturae (red) has the most substantial rise, with a marked increase starting about 2000 and approaching 100 total occurrences by 2025. The EFSA Journal (yellow) began to gather popularity in 2008, progressively increasing to roughly 50 occurrences. Food Control (green) started its contributions in 1996, with a consistent increase, especially post-2006, culminating in approximately 60 occurrences. The IOP Conference Series: Earth and Environmental Science (blue) commenced data collection in 2010 and exhibits a gradual increase, surpassing 40 occurrences by 2025. The Journal of Food Protection (cyan) started in 1996, exhibiting the same development trajectory, culminating in about 40 occurrences. Finally, Sustainability (Switzerland) (purple) begins later, approximately in 2016, exhibiting a more gradual rise by 2025, with fewer instances compared to the other sources. The graph illustrates the diverse publishing tendencies of the journals, with "Acta Horticulturae" exhibiting the most significant increase.

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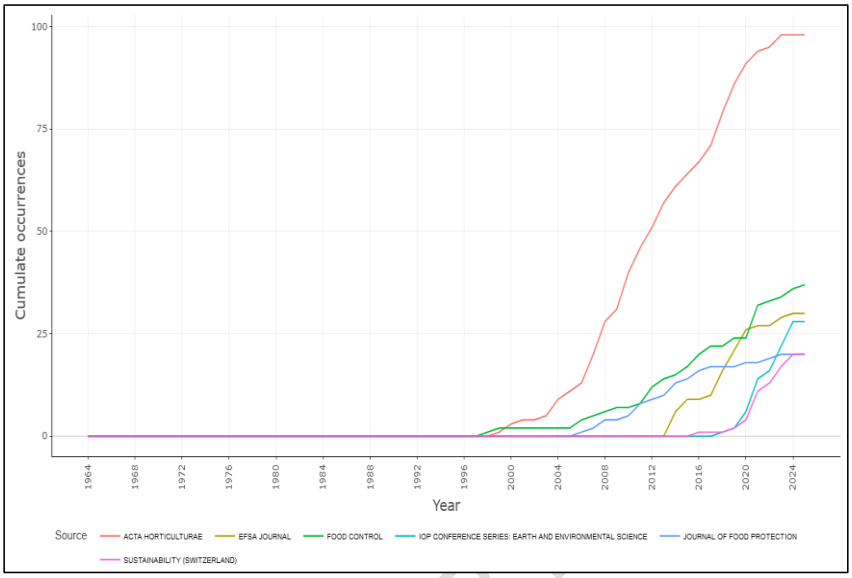

Figure 3. Influential journals

4.4 Author's Outputs

Figure 4 displays a horizontal bar graph illustrating the leading writers according to the number of submitted papers. The y-axis enumerates the writers, whilst the x-axis delineates the quantity of documents. Hu J has authored 19 papers, while Santos M has authored 17. Authors Greco L, Jarrah S, Leuschner R, Miron I, Pedersen R, Reich H, and Theobald A have each produced 16 documents. Ultimately, Brancato A has produced 15 papers. The diameter of the circles at the terminus of each bar visually signifies the number of papers, with larger circles denoting a greater number of contributions. This graph illustrates the primary contributors to the dataset, with Hu J ranked first.

Commented [HA7]: Suggestion: Figure 4 presents a horizontal bar chart ranking authors according to the number of published papers. The y-axis lists the authors, while the x-axis shows the number of papers. Hu J ranks first with 19 papers, while Santos M is second with 17 papers. Greco L, Jarrah S, Leuschner R, Miron I, Pedersen R, Reich H, and Theobald A share third place, each with 16 papers. Finally, Brancato A ranks fifth with 15 papers. On the chart, the diameter of the circles at the end of each bar visually indicates the number of papers, with larger circles representing authors who have contributed more papers. This graph shows the authors who have made the most significant contributions to the dataset, with Hu J in first place.

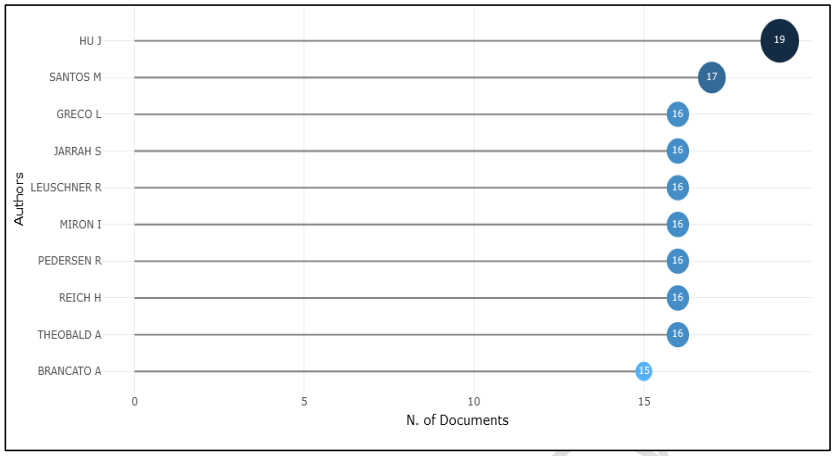

Figure 4. Most Relevant Authors in Good Agricultural Practice

4.5. Author Efficiency using Lotka's Law

Figure 5 illustrates a curve depicting the distribution of writers according to the quantity of documents they have authored. The x-axis denotes the quantity of documents authored, whilst the y-axis indicates the proportion of writers. The solid and dashed lines exhibit a dramatic drop initially, signifying that most writers have produced just a limited number of papers. Approximately 80% of the writers have submitted between 1 and 3 documents. Subsequently, the curve exhibits a pronounced flattening, indicating that a minimal number of writers have produced more than five documents. The distribution indicates that a few of writers account for the majority of the documents, but the majority of authors contribute minimally.

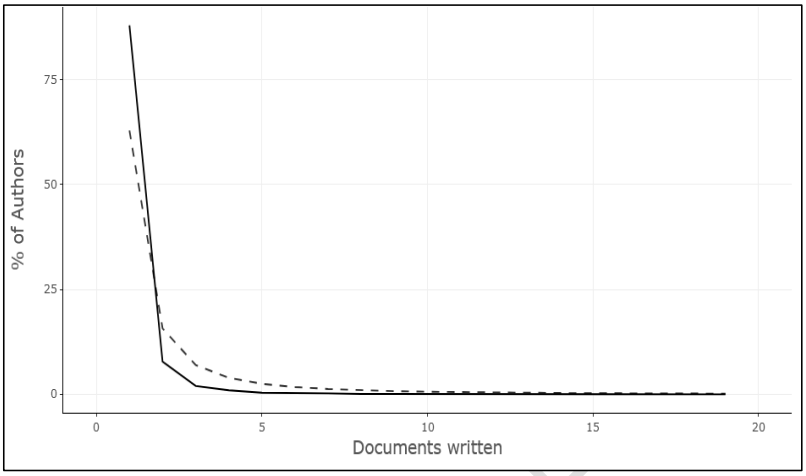

Figure 5. Productivity of authors using Lotka's rule

4.6 Countries of Corresponding Authors

Figure 6 depicts the distribution of published documents by country, classified according to collaboration type: MCP (Multiple Country Publications) and SCP (Single Country Publications). China is first in the number of publications, followed by the United States and India. In each instance, the blue bars signify SCPs, whereas the red bars indicate MCPs. In most nations, SCPs prevail, signifying that a considerable volume of research articles is generated locally without international collaboration. The United States, India, and China own a significant proportion of MCPs, indicating robust international collaboration in research. Countries such as Brazil, Thailand, and Indonesia have substantial contributions, but with a greater fraction of SCPs. The graphic illustrates the worldwide distribution of scientific contributions, with China and the USA emerging as the most prolific in both single and multi-country publications.

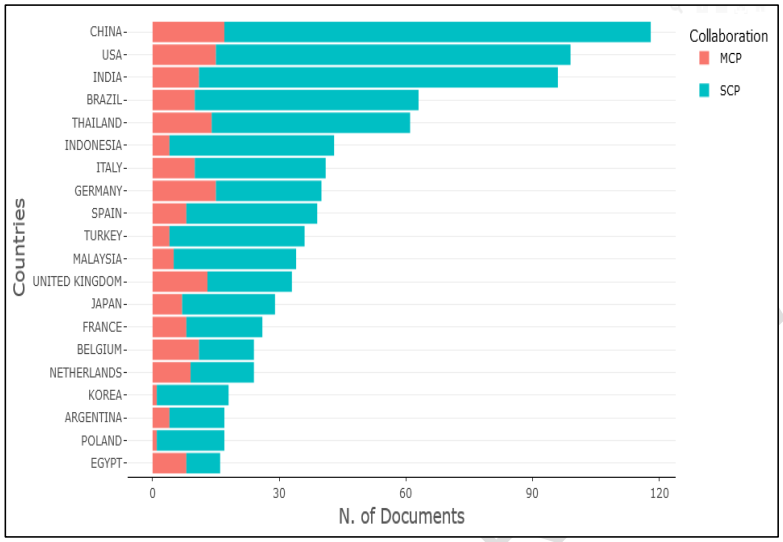

Figure 6. Corresponding 'authors' countries

4.7 Scientific Production by Countries

The map depicts the global distribution of scientific output. The nations are colour-coded to signify their proportional contribution to the overall scientific output. Darker blue hues signify elevated levels of scientific output, whilst lighter hues denote diminished levels. The chart indicates that the United States and China are the foremost nations in scientific production, succeeded by India, Japan, Germany, the United Kingdom, France, South Korea, Canada, and Italy. Countries such as Brazil, Russia, Australia, Spain, and Mexico have substantial scientific production. Nevertheless, several locations, especially in Africa and certain areas of Asia, demonstrate very low levels of scientific output.

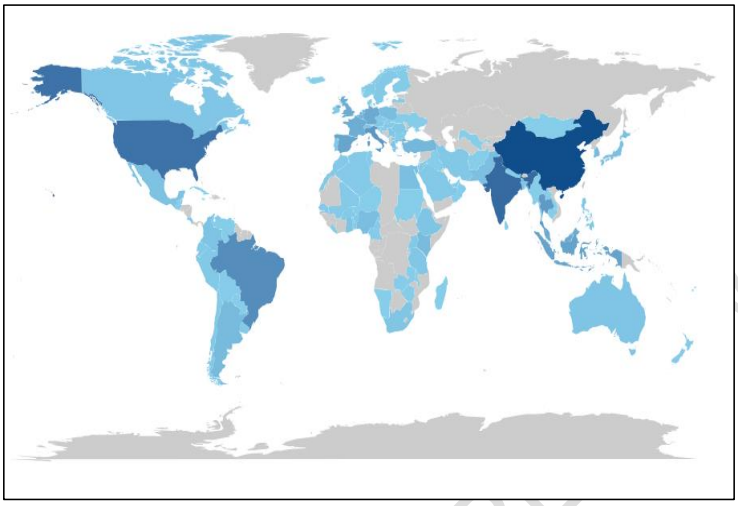

Figure 7. The countries and their production

4.8 Country Collaboration

Figure 8 illustrates a worldwide network of research relationships. The map has lines linking nations, indicating the prevalence of joint research activity among them. The width of each line signifies the strength of this cooperation. The United States, China, and several European nations appear as crucial centers in this network, with extensive linkages to other countries. The visualization underscores the increasing interconnection of scientific research worldwide, with cooperation extending across continents and regions.

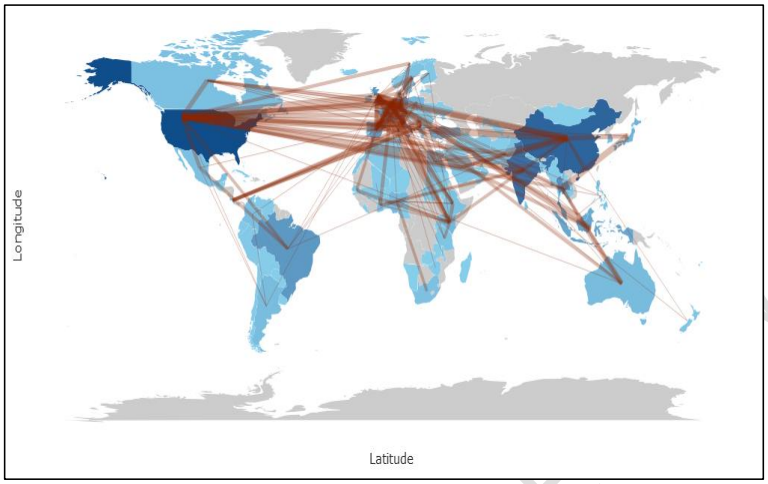

Figure 8. Collaboration among the countries

4.9 Active Institutions

Figure 9 displays a bar chart listing the ten leading universities according to the volume of published research publications. The horizontal axis denotes the number of articles, whilst the vertical axis enumerates the names of the organizations. Ghent University leads with 67 published publications, succeeded by the University of Science and Technology Beijing with 54 articles. Additional institutions inside the top 10 are Chiang Mai University, Not Reported, China Agricultural University, Anand Agricultural University, Kasetsart University, Agricultural Research Centre, Wageningen University, and the University of Nairobi. The figure illustrates the comparative contributions of different institutions to the research output in the designated subject of study.

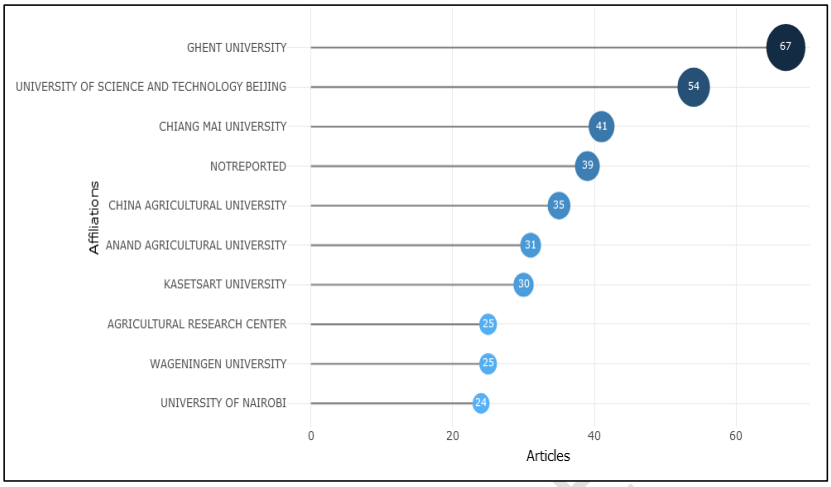

Figure 9. Most relevant affiliations

4.10 Network Analysis and Trend Word Analysis

4.10.1 Co-occurrence network of the keywords

Figure 10 illustrates a network visualization of scholarly papers about Sustainable Development Goal (SDG) 2: Zero Hunger. The nodes in the network signify keywords derived from the publications, whilst the edges linking them denote the co-occurrence of these keywords inside the same texts. The dimensions of each node reflect the frequency of the corresponding keyword, while the hue indicates its semantic category. The center node, "agriculture," underscores the primary focus of the research, with interrelated terms such as "pesticide residue," "risk assessment," "chemistry," and "human" constituting significant clusters. The network elucidates the several subjects encompassed by SDG 2, such as "food contamination," "nonhuman," "microbiology," and "food handling." The visualization offers a comprehensive picture of the knowledge ecosystem of SDG 2, highlighting critical research topics and potential links among various study subjects.

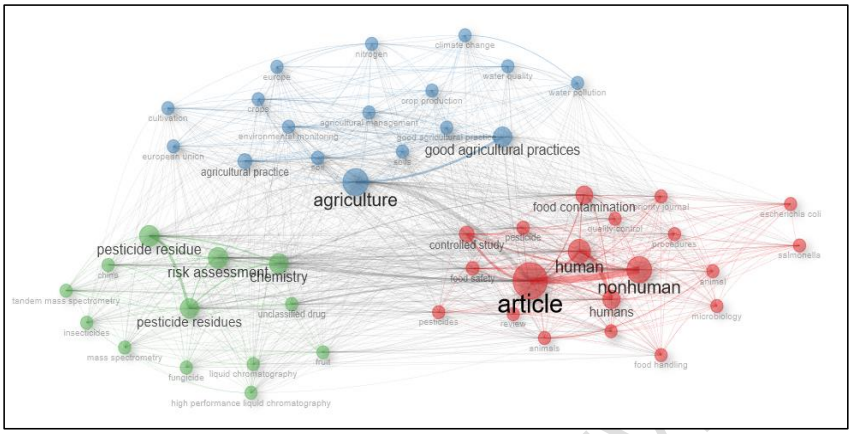

Figure 10. Co-Occurance network of the keyword

4.10.2 Trend topics

Figure 11 displays a word cloud representation of the most prevalent phrases associated with the subject of "Trend Topics." The words are organized to show their relative significance, with larger terms signifying greater frequency. The word cloud is segmented into separate portions, each denoting a specific subtopic within the overarching theme. Notable terms encompass "Germany," "Greece," "United Kingdom," "*Triticum Aestivum*," "Herbaceous Agent," "Oos Taurus," "World Health Organization," "Drug Contamination," "Drug Products," "Drug Quality," "Europe," "Herbicides," "Standard," "Safety," "Netherlands," "Eastern Hemisphere," "Western Europe," and "Manure." The visualization offers a graphical overview of the principal themes and subjects addressed in "Trend Topics."

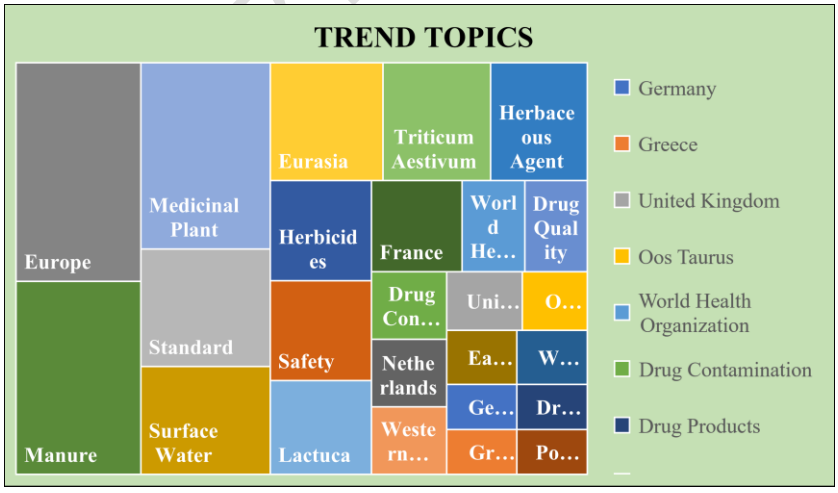

Figure 11. Trend topic in Good Agricultural Practices

5. Research Gaps and Future Directions

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Notwithstanding the significant study on Good Agricultural Practices (GAP), some deficiencies in the literature remain that require attention for a thorough comprehension and more efficient use of GAP (Siebrecht, 2020b). A significant disparity exists in the regional distribution of research on GAP. Although wealthy countries and regions with robust agricultural infrastructure possess an abundance of studies, research from emerging nations, especially in Africa, South Asia, and Latin America, remains scarce, despite the significance of agricultural practices for food security and livelihoods in these areas. The absence of localized research obstructs the formulation of region-specific GAP solutions that address the distinct environmental, social, and economic problems encountered by farmers in these areas (Mojid & Mainuddin, 2021).

Moreover, current research frequently emphasizes the technical and environmental advantages of GAP, while it pays little attention to the socio-economic obstacles to its implementation, especially for smallholder farmers. Challenges include market access, budgetary limitations, insufficient knowledge or training, and the substantial expense of GAP certification. Investigating the socio-economic determinants affecting the adoption of GAP is crucial for comprehending how to enhance the accessibility and sustainability of these practices for small-scale farmers.

A further domain for future investigation is the enduring effect of GAP on productivity, environmental sustainability, and rural livelihoods. Although most studies emphasize the immediate advantages of implementing GAP, there is a paucity of research about its long-term implications, especially regarding climate change resistance and economic sustainability for farmers. Furthermore, the impact of technology and innovation on improving the efficiency and effectiveness of GAP practices is yet inadequately examined. Digital instruments like precision agriculture, data analytics, and mobile applications can enhance the implementation and oversight of Good Agricultural Practices (GAP); nevertheless, their amalgamation with conventional agricultural methods remains nascent.

Subsequent studies should concentrate on policy frameworks and governance structures that facilitate the execution of GAP (Kanger et al., 2020). There is a necessity for research that evaluates the efficacy of governmental policies, subsidy initiatives, and international frameworks in facilitating GAP adoption. Furthermore, analyzing the function of public-private partnerships in promoting GAP adoption, especially in resource-limited environments, may yield insights into scalable solutions for sustainable agriculture.

In summary, tackling these research gaps necessitates a multidisciplinary strategy that integrates socio-economic, technical, and policy perspectives. Subsequent research should emphasize under-represented areas, investigate long-term effects, assess the influence of future technologies, and analyze the policy landscape to guarantee the effective worldwide implementation of GAP (Forster et al., 2020). By addressing these deficiencies, researchers and policymakers may promote more sustainable agriculture methods that improve global food security and environmental health.

6. Conclusion

The bibliometric study of Good Agricultural Practices (GAP) literature utilizing Scopus data offers a thorough picture of research trends, primary focal points, and current deficiencies in the field. The study indicates a growing scholarly focus on GAP, especially in areas where sustainable agriculture is prioritized due to environmental and economic concerns. The majority of research has focused on the environmental advantages of GAP, including soil health, water management, and agricultural yield, while also emphasizing the obstacles to its implementation, particularly in poor nations.

Nevertheless, the analysis also revealed significant deficiencies in the literature. Research on the socioeconomic impediments to the adoption of Good Agricultural Practices (GAP), especially among smallholder farmers, is still insufficient. Furthermore, there is a necessity for additional research examining the long-term effects of GAP on agricultural production, climate change resilience, and the livelihoods of rural populations (Pervez et al., 2024). The disproportionate geographic distribution of research reveals that several developing nations, where GAP adoption is critically required, are inadequately represented in existing academic literature.

Future research must prioritize these neglected domains and concentrate on incorporating technical advancements, tackling socio-economic issues, and formulating governmental frameworks that facilitate the broader use of GAP. By addressing these deficiencies, researchers can aid in the formulation of more efficacious and region-specific GAP solutions that boost agricultural output while promoting environmental sustainability and socio-economic welfare.

In conclusion, bibliometric analyses are crucial for understanding the field of GAP study and can guide future research toward the most significant topics for global sustainable agricultural progress.

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