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Agricultural Insurance: Explore Trends and Advances Over the Last Two Decades

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Abstract
The agricultural sector faces major risks due to extreme climate change, market uncertainty and economic fluctuations, which can destabilize global food production. Agricultural insurance, despite its importance as a risk mitigation tool for farmers, still has limited article reviews compared to other insurance sectors such as health, life, and property. This study aims to conduct a bibliometric analysis of global research on agricultural insurance over the past two decades, focusing on publication trends, the most influential countries and journals, keyword analysis, and providing directions for future research. The study used data from Scopus with a total of 643 documents. Analysis was conducted using VOS viewer, RStudio, and Tableau to visualize collaboration patterns, dominant keywords, and global publication trends. The analysis shows a significant increase in the number of studies on agricultural insurance, which reinforces the urgency of insurance in supporting global food stability. The implications of this research point to the need to develop insurance models that are technology-based and more adaptive to climate change, especially to expand access for smallholder farmers in developing countries. Recommendations for future research are to strengthen cross-sector collaboration and technological innovation to support the sustainability and resilience of the agricultural sector in the future.
Keywords: agricultural insurance; sustainable agriculture; climate risk management

1. INTRODUCTION

The agriculture sector, which serves as the foundation of many countries' economies, is extremely exposed to a wide range of dynamic and complex threats. Extreme climate change, natural disasters, commodity price changes, and market uncertainty all enhance farmers' vulnerabilities (Mao et al., 2023). In this scenario, agriculture insurance develops as an important risk management tool. Agricultural insurance supports farmers' wellbeing while also contributing to food system stability by providing financial protection against losses caused by unexpected events.

Many academics and practitioners have expressed an interest in reviewing articles about insurance (Ellili et al., 2023; Jeris et al., 2023; Pattnaik et al., 2024; Schrijver et al., 2024). Extend literature has extensively explored different elements of insurance, spanning from

fundamental theory to practical applications in a variety of areas. However, in comparison to other sectors such as health insurance (Chi et al., 2024; Kumar et al., 2024; Zheng et al., 2024), life insurance (Jeris et al., 2023; Lim et al., 2023; Manteigas & António, 2024), and property insurance (du Plessis et al., 2024; Montero et al., 2024), there are currently comparatively few review papers on agriculture insurance. This implies a vacuum in the literature that should be filled. To the best of our knowledge, there is still a shortage of scientific literature covering advances and trends in agricultural insurance as compared to other insurance fields. This highlights the need for additional research to better understand the dynamics and problems involved in the development of agriculture insurance.

Bibliometrics allows us to identify study progress and trends. Previous research has focused on bibliometrics (Anshori et al., 2021; Dirpan, Ainani, et al., 2023; Dirpan, Hidayat, et al., 2023; Maspeke et al., 2024) mapping collaborative networks, quantifying the impact of publications, and identifying research gaps that might be filled with new research ideas. The data gathered from bibliometric analysis is extremely beneficial for decision-making in areas such as research subject selection, researcher performance evaluation, and resource allocation. In short, bibliometrics provides a more comprehensive perspective of the research landscape, allowing us to increase the quality and relevance of our research. Therefore, this review aims to provide an analysis of the research trends and advances in agricultural insurance over the last two decades. The specific time range (2005-2024) helps researchers to limit the object of research and avoid overly broad or irrelevant data. This study had five research questions as follows: (1) What are the latest trends in global agricultural insurance publications? (2) Which countries are most active in conducting research on agricultural insurance? (3) Which journals are most frequently cited on agricultural insurance? (4) What does the revealing of the research focus through keyword analysis? (5) What are the suggestions for future research in this field?

2. RESEARCH METHOD

Over the past two decades, there has been a growing global awareness of agricultural risks due to climate change, market fluctuations, and the integration of technologies such as satellite imagery and weather data into insurance schemes. This time span allows bibliometric analysis to capture shifts in research focus, scientific collaboration, and publication dynamics in a comprehensive and relevant manner. This study analyzed data from Scopus, an Elsevier-owned bibliographic database with several functionalities for high-quality bibliometric analysis. Scopus is a popular tool among academics for accessing high-quality analyses. This electronic database is far larger than Web of Science and PubMed, and more dependable than Google Scholar. Scopus was chosen as the data source for this project due to its reputation for providing extensive and accessible research. This study employed data from Scopus, Elsevier's bibliographic database that offers several

capabilities for doing high-quality bibliometric analysis. Scopus is a prominent tool in the academic field for individuals looking for high-quality analyses. This electronic database is far larger than Web.

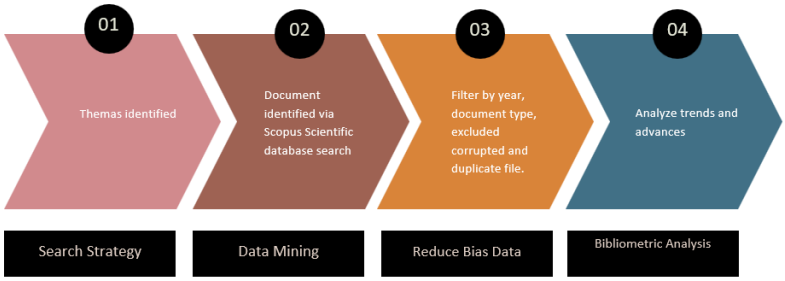


Figure 1. Research strategy for this bibliometric study

Figure 1 identifies the most important research strategy for this bibliometric study. Data was collected on one day, November 8, 2024, to reduce bias and preserve consistency in the face of database updates. To find all relevant publications, the search method employs search terms such as title, abstract, and keyword. These keywords include TITLE-ABS-KEY ("agricultural insurance").

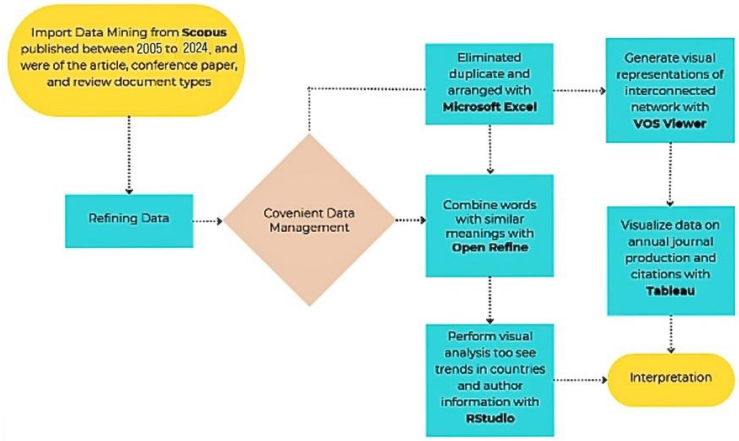


Figure 2. Bibliometric analysis flowchart

Figure 2 shows the flowchart of the bibliometric analysis that will be conducted in this article. The chosen papers satisfied the following requirements: they were in the final publication stage, written in English, published between 2005 to 2024, and were of the article, conference paper, and review document types. Documents that didn't fit these requirements weren't included. Duplicate data was eliminated, and the data was arranged in Microsoft Excel after being downloaded in CSV format for convenient data management.

Then, Open Refine (verse 3.8.5) receives the data. Words with similar meanings were combined using the Open Refine application accessed on November 9, 2024, such as

"agricultural insurance and agriculture insurance." Furthermore, the singular and plural variants of the same term were mixed. In the end, bibliometric analysis was performed on 643 documents.

The data obtained from Open Refine was then analyzed using VOS viewer (verse 1.6.20), RStudio (verse 4.4.2), and Tableau (verse 2024.3) for Windows. VOS viewer software was used to generate visual representations of interconnected networks involving countries, authors, keywords, and future perspectives in the field of agricultural insurance. Furthermore, RStudio was used to perform visual analysis to see trends in countries and author information. Tableau was used to visualize data on annual journal production and citations, as well as individual country contributions.

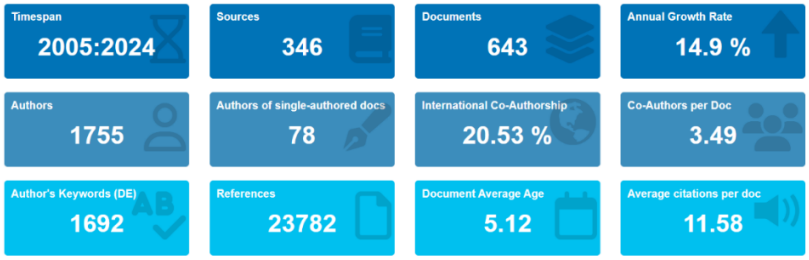


Figure 3. Main information of bibliometric data of agricultural insurance research over the last two decades

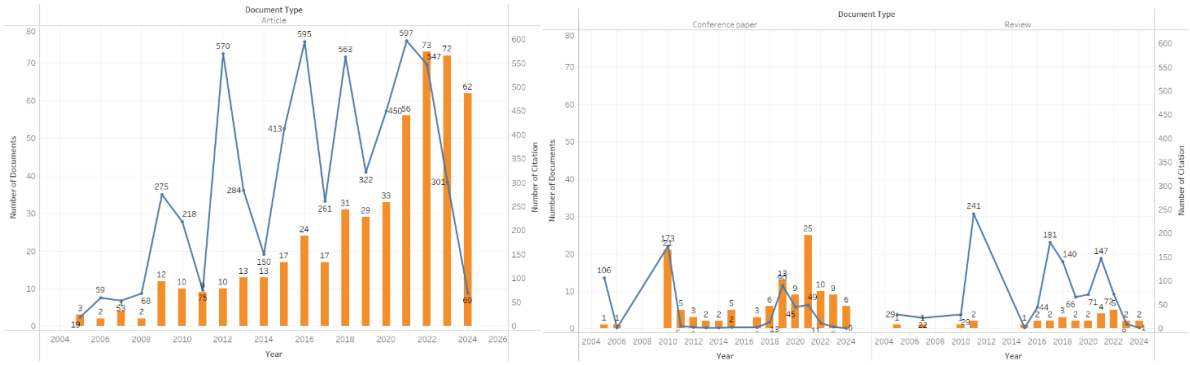
Over the previous 20 years, 643 journal papers on agriculture insurance have been published in English. Articles were published from 346 journals and proceedings sources, representing the contributions of 1755 authors. The average annual growth rate in productivity was 14.9%. A study of the given documents revealed that the average number of citations per document was 11.58. Figure 3 shows the important findings of the bibliometric analysis conducted on agricultural insurance.

3. RESULTS AND DISCUSSION

3.1 Trends publications about global agricultural insurance over the last two decades

There was a notable rise in agricultural research in 2021, influenced by several major factors such as the Covid-19 pandemic, intensifying climate change impacts, technological advancements in remote sensing, and a global surge in scientific publications. The pandemic exposed vulnerabilities in global food system through supply chain disruptions and mobility restrictions, underlining the critical role of agricultural insurance in mitigating risks (Alberca & Parte, 2020). Additionally, the growing frequency and severity of droughts, floods, and storms increased interest in adaptive insurance models such as weather index insurance, known for its speed and efficiency in protecting farmers (Bucheli et al., 2021). Remote sensing innovations also enabled the development of data driven insurance products and improved risk assessment accuracy, supporting fairer premiums

and better climate risk management (Hoffmann et al., 2020). The increase in publications was also shaped by the pandemic's broader effects on academic output, including heightened global research focus (Lee & Haupt, 2021), shifts in disciplinary agendas (Shapira, 2022), and faster publication processes (Bagdasarian et al., 2020).



(a) (b) (c)

Figure 4. Trends of publication a) article, b) conference, c) review from 2005 to 2024

The trend is illustrated in Figure 4.a and 4.b, which show publication peak in 2021. Meanwhile, Figure 4.c highlights that although review article are fewer, their citation in 2011 and 2017 rose by over 100% compared to articles and conference papers, as they often synthesize findings across disciplines and attract wider scholarly attention (Aksnes, 2003). Journals also prefer review articles for their impact on visibility and citation metrics (Ketcham & Crawford, 2007).

3.2 Bibliometric analysis of country performance

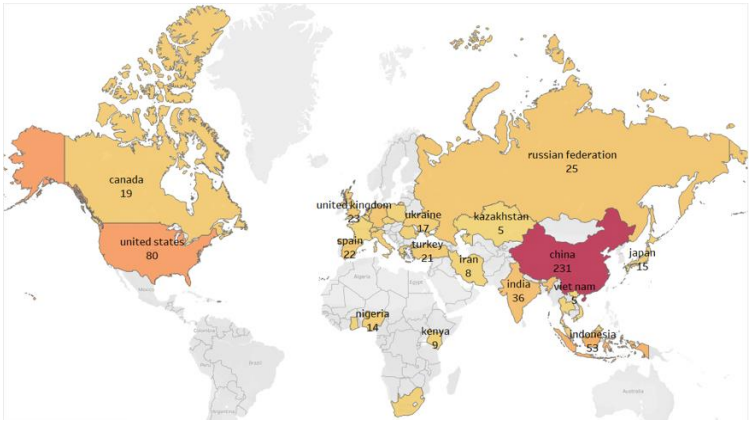


Figure 5. Number of documents with collaborative article authorship by country

Sixty-six countries actively participated in disseminating research related to agricultural insurance. The countries with the most significant author productivity are China with 231, United States with 80, Indonesia with 53, and India with 36. The level of publishing production among the next five countries is in the range of 20-30, namely Germany, Russia, United Kingdom, Spain, Turkey shown in Figure 5.

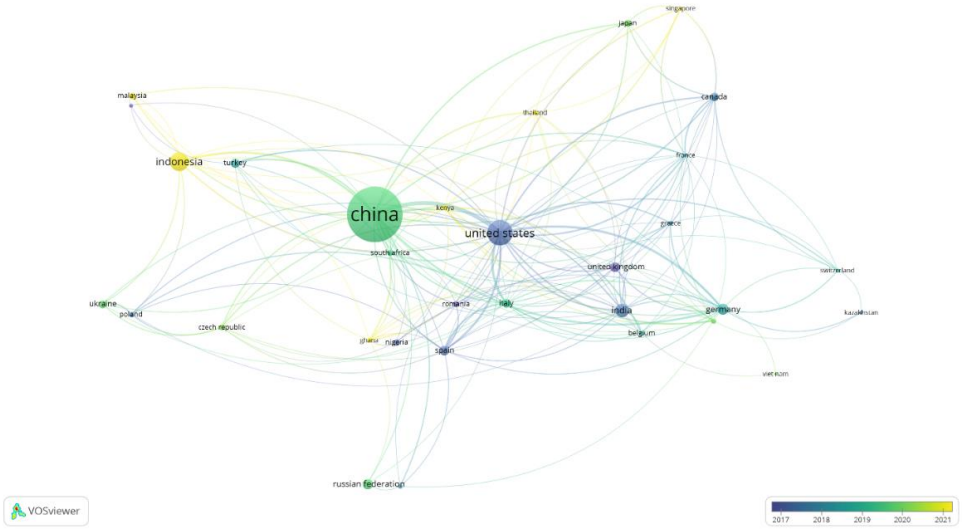


Figure 6. Co-authorship analysis by country

Figure 6 explains that the bibliometric study conducted using VOS viewer revealed that collaborative authorship was observed in 32 of the 66 countries involved. The presence of the largest and more vividly colored circle notation representing China signifies a higher level and longer duration of collaboration compared to those in other countries; the intensity of the network color corresponds to the duration of collaboration, with darker colors signifying a longer period of collaboration, while lighter yellowish colors signify that collaborative writing began within the past year. Indonesia is the country that started the collaborative authorship network most recently, in 2021.

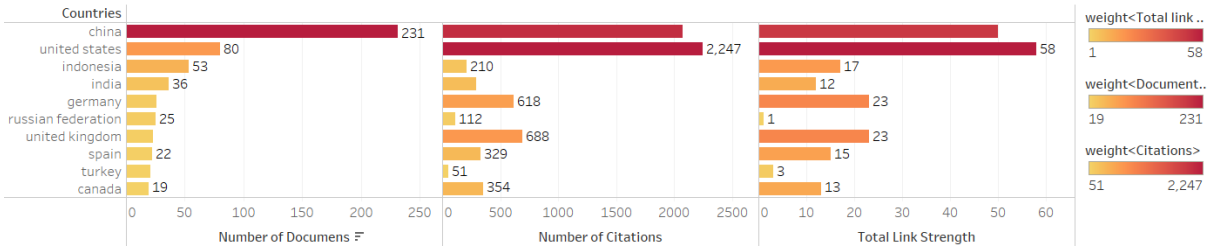


Figure 7. Number of documents, citation, and corresponding countries

Figure 7 displays the number of citations of the 10 countries with the highest publications. Total link strength in Figure 5c, indicates a country's collaboration with other countries. The United States, which has a total publication of only 34.6% of China, has the highest level of collaboration with other countries. China dominates due to several factors. The first factor is the rapid mobilization of research, including interdisciplinary and international collaborations, which resulted in a high number of publications related to COVID-19 topics as well as research on the health, economic and environmental sectors affected by the pandemic (Grammes et al., 2020). Furthermore, strong research infrastructure support, (Zyoud & Zyoud, 2021) explains that with advanced research infrastructure and support from institutions such as the Chinese Academy of Sciences,

China is able to produce high research output. Next is the focus on economic and social impacts, (Ba & Bai, 2020) explains that as the first country to feel the impact of the pandemic, research in China also focuses a lot on economic recovery, digital technology, and financial innovation, which accelerates the recovery process and produces many publications related to crisis management and economic recovery. The last one is the role in global collaboration, (Grammes et al., 2020) explaining China became one of the main contributors in global research and often collaborates with other countries, especially the United States and European countries, in joint research, which increases the productivity of international publications.

3.3 Most productive and frequently cited journal

The most productive and most cited journals related to agricultural insurance are indicators to determine the standard of research or trends in the field. The frequency of how often the article is cited can evaluate the success of the research, and citations are usually seen as an indicator of the impact, credibility, or prominence of a scientific article. In addition to the number of documents and number of citations, h-index and quartile score values can also be used as benchmarks to determine the impact of a journal on the scientific community and the development of a topic.

Table 1. Top ten productive source publishing in the field agricultural insurance

Rank	Sources	Total Publication	Publisher	H-Index	Quartile Score	Total Citation
1st	Sustainability (Switzerland)	25	Multidisciplinary Digital Publishing Institute	169	Q1	172
2nd	IOP Conference Series: Earth and Environmental Science	21	IOP Publishing Ltd.	48	Not available	259
3rd	Agricultural Finance Review	20	Emerald Group Publishing Ltd.	35	Q1	48
4th	Agriculture (Switzerland)	18	Multidisciplinary Digital Publishing Institute	66	Q1	229
5th	Agriculture and Agricultural Science Procedia	16	Not available	16	Not available	67
6th	Remote Sensing	12	Multidisciplinary Digital Publishing Institute	193	Q1	4
7th	E3S Web of Conferences	9	EDP Sciences	39	Not available	146
8th	North American Actuarial Journal	8	Taylor and Francis Ltd.	51	Q2	173
9th	Computers and Electronics in Agriculture	8	Elsevier B.V.	168	Q1	115
10th	Journal of Integrative Agriculture	7	Scientia Agricultura Sinica	81		278

The most productive journals on agricultural insurance are presented in Table 1 along with their h-index and quartile scores. Of the 643 documents published in the period 2005-2024, approximately 346 different publishing sources were involved in the publications. Based on the data obtained in Table 1, Sustainability (Switzerland) is the most dominant journal for the number of publications (25 documents).

Table 2. Top ten article cited in "agricultural insurance"

Rank	Authors	Title	Year	Journal	Cited by	TC per year	H-Index	Quartile Score	Ref
1st	Hansen J.W. et al	Review of Seasonal Climate Forecasting for Agriculture in Sub-Saharan Africa	2011	Experimental Agriculture	239	17.07	54	Q2	(Hansen et al., 2011)
2nd	Binswanger-Mkhize H.P.	Is There Too Much Hype about Index based Agricultural Insurance?	2012	Journal of Development Studies	174	13.38	106	Q1	(Binswanger-Mkhize, 2012)
3rd	Ullah R. et al	Factors Effecting Farmers' risk attitude and risk Perceptions: The case of Khyber Pakhtunkhwa Pakistan	2015	International Journal of Disaster Risk Reduction	131	13.10	86	Q1	(Ullah et al., 2015)
4th	Zougmoré R. B. et al	Facing climate variability in sub-Saharan Africa: analysis of climate-smart agriculture opportunities to manage climate-related risks	2018	Cahiers Agricultures	128	18.29	25	Q2	(Zougmoré et al., 2018)
5th	Benami E. et al	Uniting remote sensing, crop modelling and economics for agricultural risk management	2021	Nature Reviews Earth and Environment	126	31.50	67	Q1	(Benami et al., 2021)
6th	Smith V.H. et al	Agricultural Insurance in Developed Countries: Where Have We Been and Where Are We Going?	2012	Applied Economic Perspectives and Policy	123	9.46	62	Q1	(Smith & Glauber, 2012)
7th	Carter M. et al	Index Insurance for Developing Country Agriculture: A Reassessment	2017	Annual Review of Resource Economics	114	14.25	55	Q1	(Carter et al., 2017)
8th	Collier B. et al	Weather Index Insurance and Climate Change: Opportunities and Challenges in Lower Income Countries	2009	Geneva Papers on Risk and Insurance: Issues and Practice	113	7.06	42	Q2	(Collier et al., 2009)
9th	Tyc G. et al	The RapidEye mission design	2005	Acta Astronautica	106	5.30	105	Q1	(Tyc et al., 2005)
10th	Bokusheva R. et al.	Satellite-based vegetation health indices as a criteria for insuring against drought-related yield losses	2016	Agricultural and Forest Meteorology	105	11.67	196	Q1	(Bokusheva et al., 2016)

Table 2 shows that 10 articles with the highest number of citations published between 2005 and 2024 related to agricultural insurance over the last two decades. The overall number of citations of the 10 articles ranged from 105 to 239, each published in different journals. The article titled Review of Seasonal Climate Forecasting for Agriculture in Sub-Saharan Africa oleh Hansen et al has accumulated the highest number of citations (239 in total) with an average of 17.07 citations per year. Among these 10 articles, four were identified as review articles entitled Review of Seasonal Climate Forecasting for Agriculture in Sub-Saharan Africa oleh Hansen, Is There Too Much Hype about Index based Agricultural Insurance? oleh Binswanger-Mkhize H.P., Agricultural Insurance in Developed Countries: Where Have We Been and Where Are We Going? oleh Smith, dan Index Insurance for Developing Country Agriculture: A Reassessment oleh Carter.

3.4 Research focus through keyword analysis

Keywords are the embodiment of the essence of an article. Keyword analysis can show the direction and main points of research in agricultural insurance. Keyword occurrence analysis is used to identify gaps and track the development of scientific research in a field (Wang et al., 2021). VOS viewer is used to understand research trends and identify emerging research areas by visualizing the relationship between keywords based on their frequency of occurrence in literature. The color of the circle indicates the relationship between keywords and being in the same cluster (Lam et al., 2022).

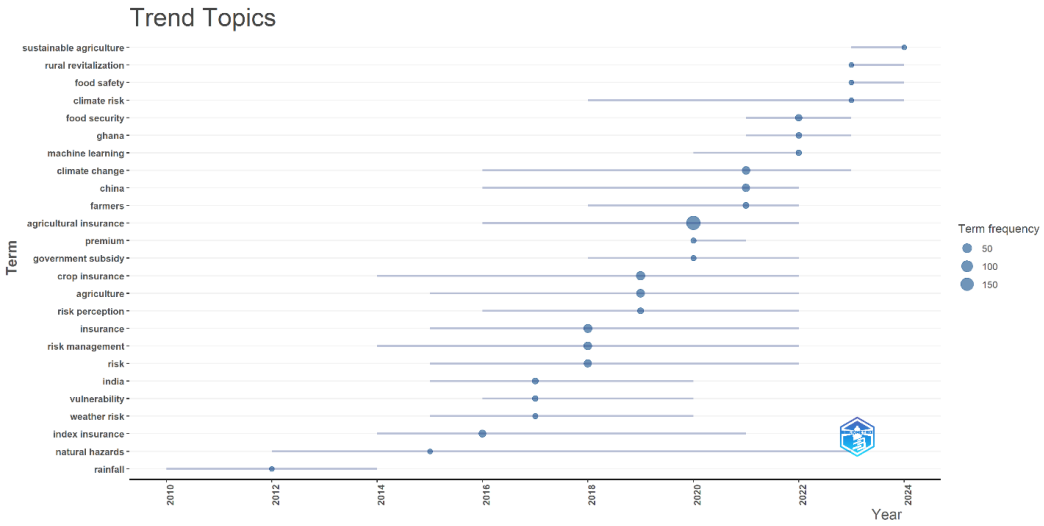


Figure 8. Trend topics of agricultural insurance

Figure 8 shows some of the key themes and emerging research directions. Figure 8 explains how specific topics in agricultural insurance research have evolved. By analyzing the frequency and distribution of these terms, we can understand research trends, key focus areas, and the evolution of interest in this field. The x-axis depicts the research period, and the dots show the frequency of occurrence in each particular year. The size of the dot indicates the frequency where the larger the dot, the higher the frequency of occurrence of the keyword. The keyword "agricultural insurance" consistently stands out, indicating a great interest in this topic in the literature. In addition, the themes of "risk management" and "climate change" are an important focus of many studies, especially with the increasing global climate uncertainty affecting the agricultural sector. The research trend also shows a shift in certain years. The first keyword that appeared in this study was "rainfall", which started in 2010. The keyword agricultural insurance began to be intensely used in 2016 and was most widely used in 2020. Some terms were hotly discussed in certain periods, such as "insurance", "risk", and "risk management" in 2018, "crop insurance", "agriculture", "risk perception" in 2019, "agricultural insurance", "government subsidy" in 2020, "climate change" and "farmers" in 2021. This shift reflects the increasingly complex risk mitigation efforts in the agricultural sector, involving the role of government and more climate-responsive insurance models (Bucheli et al., 2021).

In addition, technologies such as “machine learning and food security” began to emerge in 2022, “rural revitalization, food safety, and climate risk” in 2023, reflecting increasing attention to food security amid challenging climate change (Hoffmann et al., 2020). By 2024, “sustainable agriculture” had shown a significant increase in frequency, indicating attention to sustainability in the development of insurance models for the agricultural sector. This analysis provides insights into the direction of agricultural insurance research and points to areas that require further attention, especially in developing relevant, sustainable and responsive to increasingly complex global climate challenges.

3.5 Future perspective, challenges, and limitation

Over the last two decades, agricultural insurance has increasingly focused on the issues of sustainable agriculture, rural revitalization, food safety, and climate risk. Sustainable agriculture receives special attention, with insurance potentially providing incentives for farmers who adopt environmentally friendly practices, such as regenerative or organic farming, which help maintain productivity while reducing environmental impact. In addition, rural revitalization is encouraged through the support of critical infrastructure such as irrigation and crop storage, allowing rural communities to be more resilient in the face of economic uncertainty and climate change (Du et al., 2022). Thus, agricultural insurance is not only financial protection, but also a strategic instrument for rural economic development.

Food safety issues are also becoming an increasingly important focus, especially with consumers' increasing awareness of the quality of food products (Atoloye et al., 2024). Agricultural insurance can provide protection against the risk of product damage or contamination, maintain product reputation in the market, and increase consumer confidence. In addition, climate risk is a major challenge that is being addressed through the development of weather index insurance, which allows claims to be paid based on climate parameters such as rainfall. This approach speeds up the claims process and provides quick relief for farmers affected by disasters. Overall, the focus of agricultural insurance on sustainability, food security, and climate risk mitigation is expected to strengthen the resilience of the agricultural sector in the face of increasingly complex environmental and social challenges.

While this research covers a wide range of important topics, there are some limitations. The analysis is limited to English-language literature and publications in Scopus, which may reduce the scope of representation of certain regions or more specific local contexts. In addition, there are areas that are under-explored and require further attention. First, specialized insurance models for small-scale farmers need to be developed to make them more accessible to farmers with limited resources in developing countries. Second, the integration of green technologies, such as renewable energy-based sensors for climate risk monitoring, is still limited. Given that most farmers in developing countries are smallholders, further research is needed to create insurance models that can be accessed and adapted by smallholders with limited capital and access to information (Beza et al.,

2017). Finally, while technologies such as remote sensing and machine learning continue to evolve, not all regions have access to adequate infrastructure to utilize these technologies, which limits the applicability of research results in the field. As such, this keyword analysis provides a snapshot of where agricultural insurance research is heading and points to areas that still require further exploration, such as the application of accessible technologies to different regions, financial education for farmers, and more adaptive insurance models for changing climate risks.

4. CONCLUSION

The bibliometric analysis of agricultural insurance research over the past two decades shows significant growth in this topic.

The latest trends in global agriculture insurance publications

There has been a notable upward trend in the number of publications on agricultural insurance over the past two decades, especially after 2020. This growth reflects increasing academic attention to agricultural insurance as a critical risk management tool, especially in the context of climate change and food security. Researchers increasingly prefer journal publication over conference proceedings, suggesting a pursuit of higher academic visibility and impact.

The most active countries

China is the country with the most significant contributions, showing high levels of productivity and author collaboration with other countries. The United States, which ranked second in productivity, became the country with the highest publication citations and the highest collaboration with other countries.

The most frequently cited journals

The journal Sustainability (Switzerland) was noted as the most productive and frequently cited publication source on this topic, signaling its importance in disseminating research on agricultural insurance. Hansen J.W. et all's article Review of Seasonal Climate Forecasting for Agriculture in Sub-Saharan Africa was the highest cited article with 239 citations. Its consistent publication of high impact article highlights its pivotal role in shaping discourse on agricultural risk and sustainability.

The research focuses through keyword analysis

The keyword analysis reveals that "agricultural insurance" remains the most dominant topic with increasing attention to "risk management" and "climate change" over time. Early research focused on weather related risks like "rainfall" while recent years have seen a shift toward interdisciplinary technological and socioeconomic themes such as "machine learning", "food security", and "sustainable agriculture." This trend underlines the necessity for future research to explore integrative, adaptive, and technological enhanced insurance models that respond to the escalating complexity of agricultural risks.

The suggestions for future research

Future studies are encouraged to explore the socioeconomic impacts of agricultural insurance schemes, technological integration such as artificial intelligence and remote sensing, the development of inclusive models for smallholder farmers, and more interdisciplinary and cross-country collaborations to ensure comprehensive and globally relevant solutions.

5. RECOMMENDATION

From a future perspective, research is expected to increasingly lead to the development of technologies that support agricultural insurance, improved adaptation to climate change, and greater involvement of developing countries in global research networks.

Diversity research topics

Future studies should broaden their focus to include socioeconomic aspects, implementation of digital insurance for smallholder farmers, and the integration of artificial intelligence and big data in risk assessment models.

Enhance international collaboration

Developing countries in Southeast Asia, Africa, and Latin America are encouraged to increase cross-country research collaborations to strengthen local capacity and enrich global perspectives.

Target strategic journals

Researchers are advised to publish in high impact and frequently cited journals such as Sustainability to improve the visibility and influence of their work.

Promote interdisciplinary approaches

Strengthening the integration of climate science, agricultural economics, and information technology is essential to develop more adaptive and relevant solutions to current agricultural challenges.

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