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Review

A Visual Knowledge Map Analysis of Cross-Border Agri-Food Supply Chain Research Based on CiteSpace

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Abstract: How to reshape the cross-border agricultural supply chain is a common concern in the global agricultural field. Using the bibliometrics method, 761 studies in the literature were selected from the core database of WOS (Web of Science) to explore research hotspots and development trends in this field, clarify the historical context, and explore future trends. Using the knowledge map visualization software CiteSpace, an in-depth review and visualization analysis of hot topics in this field were conducted. The results showed that since 2017, research in this field has shown a strong development trend. The United States and the University of Wageningen are the field's most influential country and research institution, respectively. *Sustainability* is the journal with the highest number of publications in the field. Research hotspots included cross-border agricultural product safety, cross-border agricultural supply chain systematization, and technology integration, and gradually evolved towards the high-quality development of digital intelligence with informatization, digitization, and big data as the main focus. The sustainability of cross-border agricultural supply chains and the resilience of the global food supply system have become the main lines of research in this field.

Keywords: cross-border agri-food; supply chain; bibliometric analysis; CiteSpace

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1. Introduction

With the wave of economic globalization, the development of a cross-border agricultural supply chain in the world has also ushered in a period of prosperity [1]. Facing the situation of rigid growth of food consumption demand, resource, and environmental carrying capacity constraints [2], cross-border agricultural product supply chains continue to optimize the structure. The supply chains provide strong support for countries around the world to achieve the goal of buying and selling global agricultural products [3,4]. Due to the influence of geography, economic productivity, and other factors, the competitiveness of cross-border agricultural supply chains in various countries is very different. In this context, some countries and regions should make better use of the benefits and opportunities brought about by globalization and interconnection and strengthen their ties with the global market [5]. However, since 2020, due to the spread of COVID-19 [6], the aggravation of climate extremes [7], local wars, and conflicts [8], the international food market still faces great uncertainty [9,10]. The problem of food security is becoming more and more serious [11,12], threatening the lives, safety, and livelihood security of people all over the world, especially vulnerable groups [13,14]. How to jointly rebuild and innovate cross-border agricultural supply chains is a topic of common concern in the current global agricultural field [15].

Therefore, it is necessary to comprehensively, and systematically analyze and present the research hotspots and development context of the cross-border agricultural supply chain, provide new ideas and directions for relevant research in the field, enrich the relevant theories of cross-border agricultural supply chain, and guide the development and cooperation of cross-border supply chain among countries in the world [16]. This will provide a reference and inspiration for solving the world's food shortages [17,18].

The number of related research results of the cross-border agri-food supply chain has begun to take shape. The primary research is as follows: (1) the agri-food supply chain: at present, some scholars have summarized the agri-food supply chain under the background of the digital economy [19]. Some related scholars reviewed the literature on the agri-food supply chain from three perspectives: challenge, network design, and performance measurement [20]. Some scholars have systematically summarized the supply chain of agri-food from the perspectives of total trade platforms [21], blockchain technology [22], and Industry 4.0 [23]. (2) The global supply chain of agri-food during the COVID-19 epidemic: some scholars systematically reviewed the impact of COVID-19 on the global agricultural supply chain [24–27] and conducted a literature review on the interweaving relationship between the COVID-19 epidemic and the challenges faced by global supply chain, logistics, and transportation [28–30]. In addition, some scholars summarized the application trend of cloud computing and the blockchain in the global supply chain [31,32]. (3) Cross-border e-commerce supply chain of agri-food: some scholars systematically reviewed the supply chain management supported by blockchain in cross-border electronic commerce [33–35]. Some scholars examined performance evaluation methods and index systems of the cross-border e-commerce supply chain of agri-food [36,37]. Some scholars classified the existing research on cross-border e-commerce supply chain optimization [38].

These literature reviews contributed to the study of cross-border agricultural supply chains, but there are limitations. First, the research content requires a comprehensive cross-border agricultural food supply chain summary. Therefore, the contribution of this paper is to conduct a comprehensive and systematic review and analysis of the entire research field of the cross-border agricultural food supply chain. The second defect is that most existing research is based on subjective analysis and interpretation, and the proportion of objective analysis using scientific measurement tools is tiny. Therefore, with the help of CiteSpace, this paper uses the method of scientific bibliometrics to analyze the visual map of various factors in this field. The contribution is to enrich the objectivity and scientificity of literature review research in this field. Finally, the contribution is specifically subdivided into answering the following questions:

1. What is the annual number of articles published in the cross-border agri-food supply chain field, the current situation of hot countries and institutions, core authors and author cooperation networks, and high-frequency journals?
2. What main analysis methods are used to research cross-border agri-food supply chains?
3. What are the cross-border agri-food supply chain's research hotspots and evolution paths?
4. What are the essential knowledge documents in cross-border agri-food supply chain research?
5. What are the implications of the existing research on cross-border agri-food supply chains for future research?

The remainder of this paper is structured as follows. Section 2 introduces the research methods and data sources. Section 3 analyzes the visual knowledge map of cross-border agri-food supply chain-related literature. Section 4 analyzes the hot spots and development trends of the cross-border agri-food supply chain. Section 5 provides statistics and analyses of the knowledge. Section 6 discusses the significance of this study and the future research direction in this field. Section 7 summarizes the conclusions, limitations, and prospects of this study.

2. Research Methods and Data Sources

2.1. Research Methodology

The traditional literature review research method is to review the theme, author, scientific research institution, and research field of the literature, and then describe and summarize it. Because of the large number of original sample documents used in this article, the traditional literature review research method does not apply to this study. Bibliometric analysis of scientific literature is a literature review method using mathematical and statistical tools [39]. Through the presentation of a bibliometric map of literature knowledge, researchers can understand the characteristics of the field more intuitively and deeply and can use scientific methods to track the evolution of field research [40]. As an excellent bibliometrics software program, CiteSpace is applied to multivariate, time-sharing, and dynamic citation visualization analysis. The software can detect research hotspots, research frontiers, and trends in related fields [41,42]. It has the function of navigating theoretical knowledge in the literature and belongs to the category of scientific bibliometrics [43,44]. Based on the above reasons, this article used CiteSpace6.1.R6 econometric analysis software to explore the research hotspots and trends of cross-border agricultural product supply chains.

2.2. Data Sources

This scoping review was conducted according to PRISMA guidelines [45]. In this study, the literature database was obtained from the core collection database of the Web of Science (WOS) because the WOS database is an essential database for obtaining global academic information, and contains high-quality journal literature with significant influence in the world, including citation index databases of SCI-EXPANDED, SSCI et al [46]. Even though there are several bibliographic databases, such as Scopus, Google Scholar, Dimensions, Microsoft Academic, etc., WOS was more suitable for large-scale, highly reliable bibliometric analysis [47,48]. This ensures the high quality and cutting-edge literature sources used in this paper and makes the analysis and research results more convincing, according to the theme of this study, and the analysis and reference of the literature in the CiteSpace field [49,50]. Using Boolean logic operators to integrate the retrieval formula of the WOS database is TI = (”cross border*” OR “export” OR “import” OR “import and export” OR “foreign*” OR “global*” OR ”international*”) AND (agriculture* OR foodstuff* OR “agricultural product*” OR “agri-food” OR ”fresh food” OR “grain and oil” OR “grain*”) AND (”logistics*” OR “supply chain*” OR “supply network*” OR “value chain*” OR “demand chain*” OR “e-commerce*” OR “e-business*” OR “e-market*”). The retrieval rule was set as “topic” retrieval, and the retrieval period was from 1th January 2007 to 16th November 2022. The total number of documents obtained was 1234. In the first round of screening, literature types such as “summary papers”, “conference proceedings papers”, “editorial materials”, and “letters”, which were not needed for this research topic, were deleted. Then, according to the statistics of literature discipline categories, the papers not related to this study’s subject disciplines, such as Optics, and Law, were deleted. Thereafter, the number of papers was 975. In the second round, 762 articles were selected after reading the title, abstract, and keywords of the remaining 975 articles. The 762 documents were then entered into CiteSpace software for “de-duplication” analysis, and one duplicate document was removed. Finally, 761 documents were obtained for the research and analysis theme of this article. The summary of the PRISMA review is shown in Figure 1.

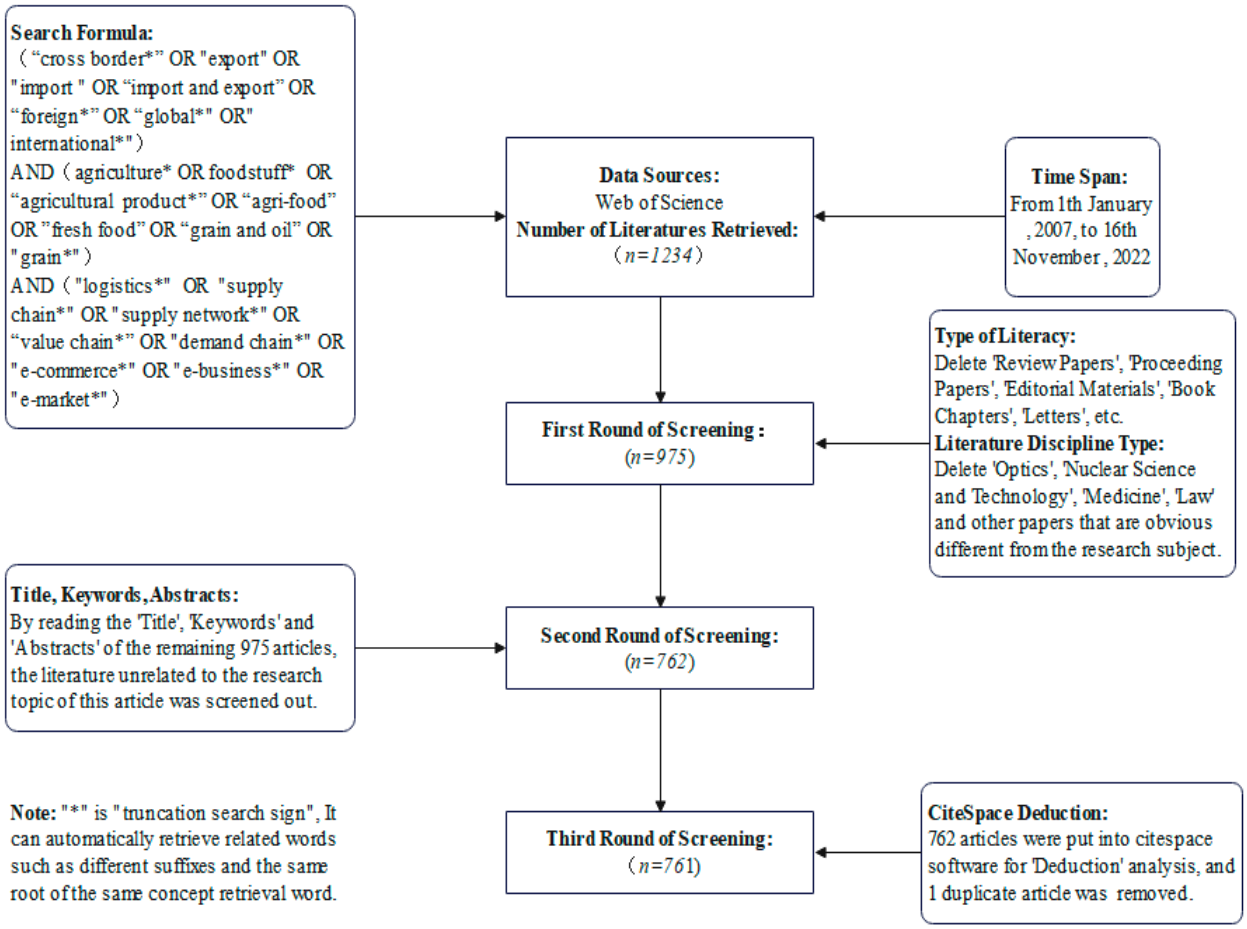

Figure 1. Summary of the PRISMA Review.

3. Visual Knowledge Map Analysis of Cross-Border Agri-Food Supply Chain Research

3.1. Trend Analysis of Published Documents

The annual number of articles is an important indicator when measuring the development trend of a particular field in a specific period, and is of great significance for analyzing the development trend of a particular field and predicting its future development trend [51]. In this paper, the website of the Strategic Consulting Intelligent System was used to create statistics from the number of 761 sample documents published between 1 January 2007 to 16 November 2022. The analysis results are shown in Figure 2. From 1 January 2007 to 16 November 2022, research on the cross-border agri-food supply chain was active, showed an upward trend and rapid development. Before 2010, focus the cross-border agri-food supply chain was still relatively low, and the research was in its infancy. With the acceleration of economic globalization and the rise and development of cross-border e-commerce after 2010 [52], six ASEAN countries revoked tariffs on cross-border commodity transactions [53]. More scholars became interested in researching the cross-border agri-food supply chain. During 2010–2019, research on cross-border agri-food supply chains gradually increased and was in its initial stage of development. From 2019 to 2021, research on the cross-border agri-food supply chain reached a peak of development, and the related literature reached its peak at this stage in 2021 (157 articles), which was 22.4 times that of 2007. The decrease seen in the number of annual publications in 2022 compared to 2021 is because the search time for this study does not cover the whole year of 2022, and the relevant literature in late November and December 2022 is not included in our literature samples. Under this influence, the number of publications in 2022 still reached 127, with a small gap from 2021 and more than in 2020, indicating that research in this field is still on the rise. Blockchain, big data, and other technologies promoted the development of the cross-border agri-food

supply chain from 2019 to 2022 [54], and the outbreak of the epidemic in 2019 made the problem of poor circulation in global agri-food more apparent. As a result, more scholars turned their attention to the cross-border agri-food supply chain. Generally speaking, research on the cross-border agri-food supply chain in academic circles will show an upward trend in the future, and the cross-border agri-food supply chain will become a hot field of academic research and practice.

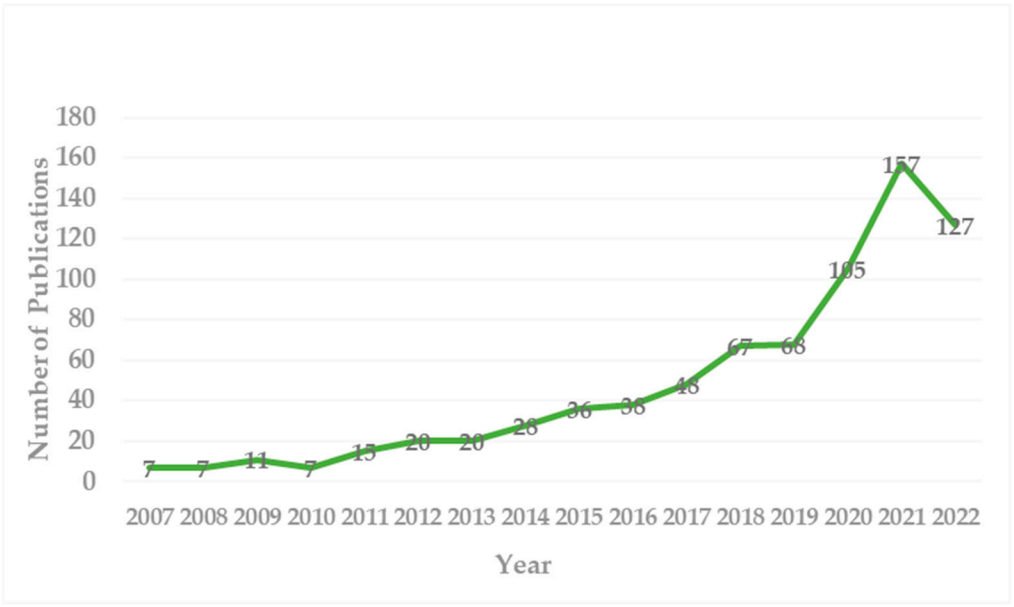

Figure 2. Statistics on the number of publications in the field of cross-border agri-food supply chain research from 2007 to 2022.

3.2. Analysis of Hot Institutions and Hot Countries

The number of articles can reflect research institutions' scientific research strength and influence [55]. In this paper, "Time Slicing" from the CiteSpace software was set to "2007JAN-2022DEC", and "Institution" in Node Types was selected, and other options are kept by default [56], thus obtaining the cooperation network map of research institutions (Figure 3).

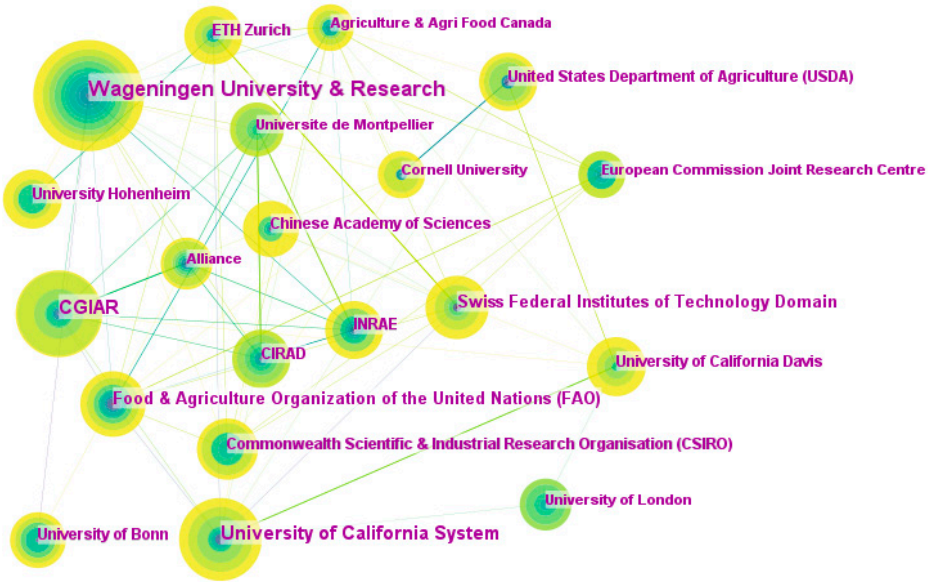

Figure 3. Research institutions map of the cross-border agri-food supply chain from 2007 to 2022.

According to the analysis of the institutional cooperation net map, there are 387 issuing institutions in the sample, with 475 connections between institutions, and the density of the institutional cooperation network is only 0.0064. As shown in Figure 4, the research institution with the most significant number of articles is Wageningen University and Research (43 articles) [57–59], and another institution with the most significant number of articles is CGIAR (26 articles) [60,61], the University of California System (23 articles) [62], Food and Agriculture Organization of the United Nations (FAO) (15 articles) [63], etc. The three institutions that contribute the most to the cross-border agri-food supply chain are Wageningen University and Research, CGIAR, and the University of California System. From the perspective of research institutions, the research institutions of the cross-border agri-food supply chain are mainly concentrated in universities and research organizations, among which Wageningen University and Research, the top university in the world, is far ahead in the number of articles published in this field. The centrality of a node indicates the degree of connection between the node and other nodes. When the node's centrality is $\geq$0.1, it indicates good centrality and is closely related to other nodes [64]. According to Figure 4, the centrality of Wageningen University and Research is 0.09, followed by the University of California System and Swiss Federal Institutions of Technology Domain, both of which is 0.08, and the centrality of cross-border agri-food supply chain research institutions is less than 0.1. Therefore, the cooperation of hot research institutions in the cross-border agri-food supply chain is relatively loose, and the degree of contact between institutions is low. In addition, through analysis, it can be seen that research institutions with solid centrality are not necessarily high-yield institutions, such as the Swiss Federal Institutes of Technology Domain. Therefore, institutions with solid centrality should further intensify research efforts and increase the number of papers to give full play to the radiation-driving effect in the field.

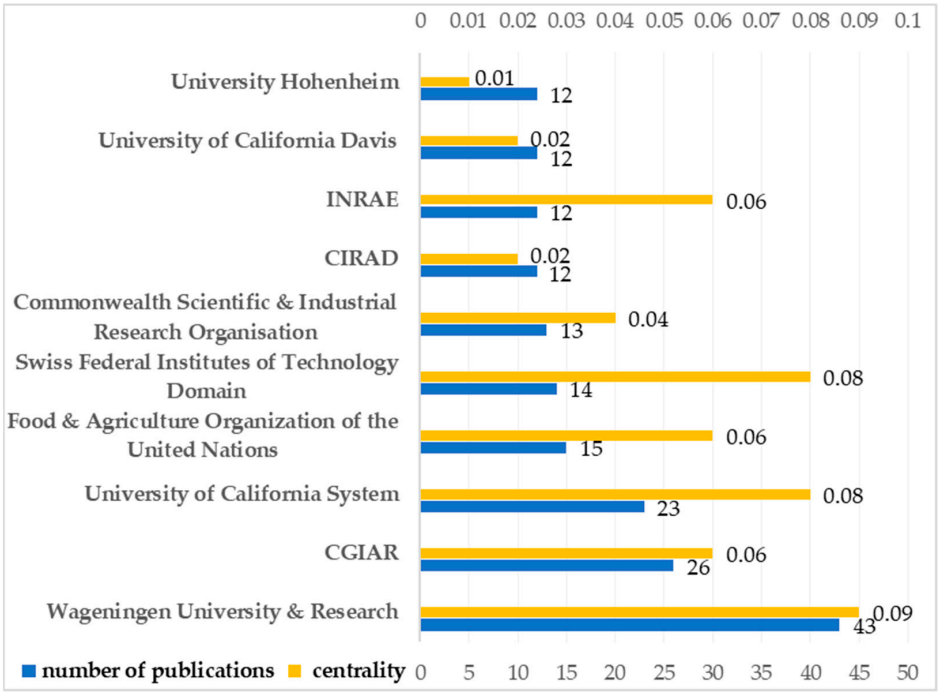

Figure 4. Number of publications and central statistics for the top 10 institutions.

The emergence and development of hot research are closely related to the country's overall social environment and economic development [65]. As shown in Figure 5, 761 samples in the literature were distributed over 102 countries and regions, among which 12 countries published more than 30 articles. The United States ranked first with 155 articles, accounting for 20.3% of the total achievements. China ranked second with 96 articles, accounting for 12.6%. Italy ranked third with 87 articles. In addition, Britain

(82 articles), Germany (79 articles), Australia (68 articles), the Netherlands (66 articles), and other countries are also high-yield countries for cross-border agri-food supply chain research. As the world's largest food exporter, the cultivated land and planting area of the United States is at the forefront of the world, and the national agricultural technology level is at the forefront of the world. Artificial intelligence, big data, and other technologies have been widely used in agriculture. In the last 15 years, the research on cross-border agri-food supply chains has been active and achieved outstanding results, occupying an essential position in the research field. There are 663 connections between countries, and the density of the national cooperation network is 0.1287. The centrality of the top ten hot countries is mostly greater than 0.1 (as shown in Figure 6), and the network density is high. The research cooperation between hot countries in the cross-border agri-food supply chain field is close, providing a solid foundation for developing international cooperation in this field.

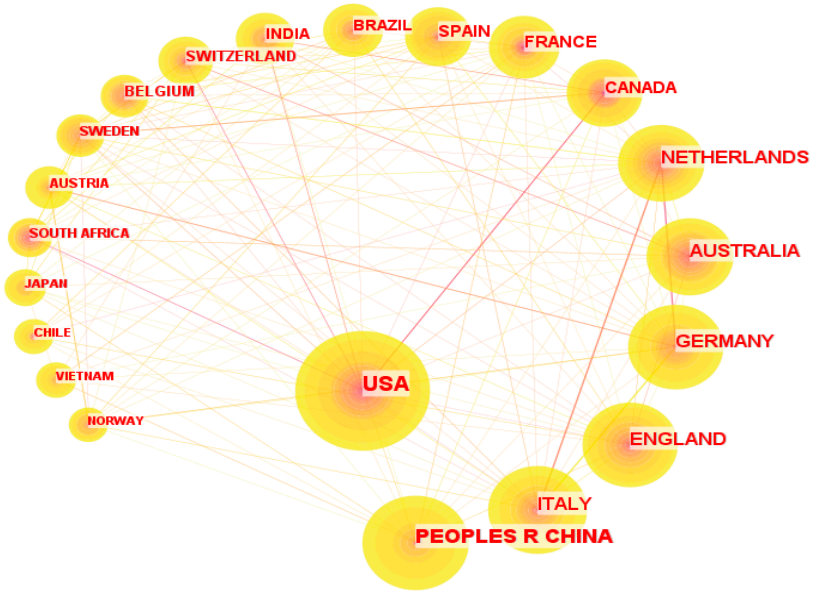

Figure 5. National map of hot spots in cross-border agri-food supply chain from 2007 to 2022.

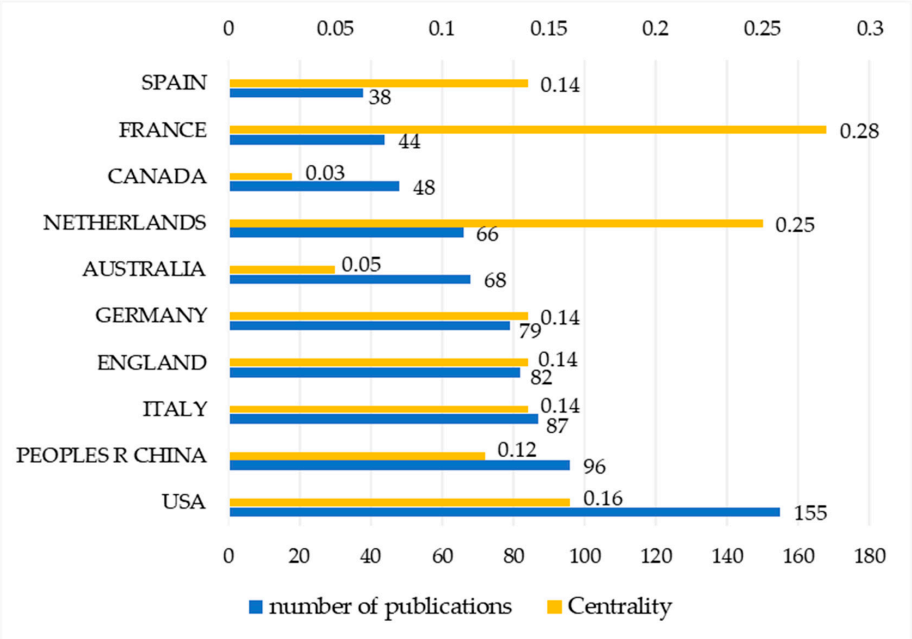

Figure 6. Number of Publications and Central Statistics for the Top 10 Countries.

3.3. Analysis of Core Authors and Author Cooperation Network

In the cooperative network map of authors in a particular field, authors with a high volume of papers show a particular influence. At the same time, the author cooperation network map can also reveal the connection relationship between different authors in this field [66,67]. This paper used the analysis function of "Author" of CiteSpace, kept other parameters unchanged by default, and obtained the author cooperation network map of the "Cross-border Agri-food Supply Chain" (As shown in Figure 7).

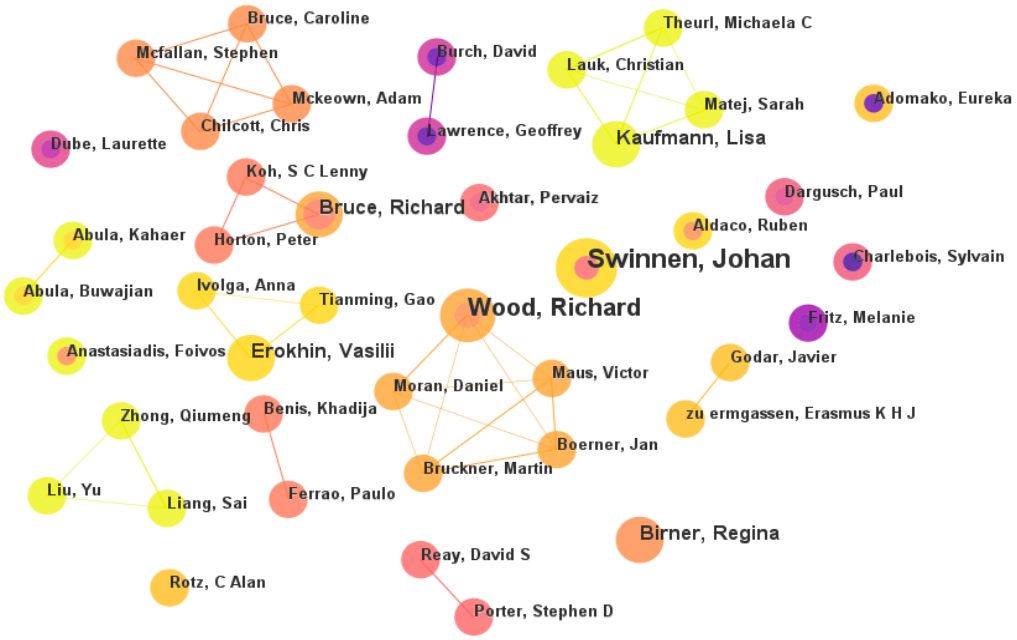

Figure 7. Author Cooperation Network Map of Cross-border Agri-food Supply Chain Research from 2007 to 2022.

There are 430 nodes and 306 connections in the network, the overall network density is 0.0033, and there are few connections between the authors. Therefore, the cooperation degree among researchers in the "cross-border agri-food supply chain" field is still shallow, and a relatively stable cooperative group has not yet been formed. The number of articles published by the author can also reflect the scientific research strength and influence of the scholar in a specific field. The scholar with the most significant number of articles is Swinnen, Johan and the number of articles is 5 (As shown in Table 1). The literature published by Swinnen, Johan is focused on 2020–2022, and the research mainly involves the agri-food value chain [68], agricultural food policy [69], etc., which provides enlightenment for agricultural and food policy and provides a reference for future research in this field.

Table 1. Statistics on the Top 10 Institutions of Core Authors.

Rank	Number of Publications (Article)	Year	Author
1	5	2016	Swinnen, Johan
2	4	2018	Wood, Richard
3	3	2022	Kaufmann, Lisa
4	3	2017	Bruce, Richard
5	3	2018	Birner, Regina
6	3	2021	Erokhin, Vasilii
7	2	2016	Reay, David S.
8	2	2017	Benis, Khadija
9	2	2019	Maus, Victor
10	2	2017	Ferrao, Paulo

As the leading force in promoting academic progress and scientific development in a particular field, core authors have high paper outputs and academic influence and lead the development of a specific discipline [70]. Price's Law reveals the search for so-called "core" authors from the perspective of the number of published papers. Focusing on the "quantity" of scientific research achievements in a certain field reflects scientists' scientific research output and activity in this field. According to Price's Law, the core authors in this field were determined [71], as shown in Formula (1). The total number of papers published by scientists who have published more than $0.749\sqrt{N_{max}}$ papers is equal to half of the total number of papers; in other words, the number of papers published by the lowest-yield scientist among the outstanding scientists is 0.749 times the square root of the number of papers published by the highest-yield scientists; where "M" is the minimum number of papers published by core authors, and "N_{max}" is the number of papers published by authors with the most significant number of papers in this field [72].

$$M = 0.749\sqrt{N_{max}} \quad (1)$$

According to statistics, the author with the most published documents is Swinnen, who has published five documents in total, so N_{max} is 5. Substituting Formula (1), M is 1.674 according to the rounding principle. The authors with two or more published documents form the core of cross-border agri-food supply chain research. Therefore, Swinnen (5 articles), Wood, Richard (4 articles), Kaufmann, Lisa (3 articles), Bruce, Richard (3 articles), Birner, Regina (3 articles), Erokhin, Vasilii (3 articles) are the core research authors in this field and have made significant contributions in this field. According to Price's Law, when the number of articles published by core authors in a particular field reaches more than 50%, the core author group in this field is formed [73]. According to statistics, the total number of articles published by core authors in the research sample is 125, accounting for 16.4%, far less than 50%, which indicates that core authors and research teams in cross-border agri-food research still need to be formed. Therefore, scholars in this field should be encouraged to strengthen cooperation and exchanges across universities, research institutions, and government research departments to contribute scientific research strength to the author cluster in this field and jointly promote the development and progress of this field.

3.4. Statistics and Analysis of High-Frequency Periodicals

The statistics of high-frequency journals in the cross-border agri-food supply chain field can reflect the hot journals publishing in this field. According to the types and characteristics of hot journals, we can analyze and study the research priorities and hot spots of those scholars in this field who have been paid attention to. In this paper, 761 published journals were imported into Excel, and the frequency of repeated journals was calculated using the "COUNTIF" function. According to the statistical results, the top ten journals in published volume and frequency were sorted. Table 2 shows that the top ten journals have published 195 articles, accounting for 25.6% of the total articles. Among them, *Sustainability* ranked first, with 52 articles accounting for 6.8% of the total articles. It has made outstanding contributions to academic exchanges, progress, and sustainable development in the cross-border agri-food supply chain. In addition, through observation and analysis, we can obtain the following conclusions:

(1) 90% of the JCR divisions of the top ten hot journals in this field are in Q1 and Q2 (that is, they are in the top 50% of the impact factors of journals in subject fields), which shows that the quality and grade of hot journals in this field are at a high level, and high-level journals also favor the research results in this field;
(2) The hot journals published in this field mainly focus on food, environment, food, and sustainability. This also shows that the research direction in this field is mainly the coordinated and sustainable development of a cross-border supply chain of agri-food such as grain and environment;

(3) The countries and regions where hot journals in this field are published are mainly concentrated in Switzerland, Britain, the Netherlands, the United States, and other European and American countries. It shows these countries have a solid academic atmosphere in the cross-border agri-food supply chain field and encourages academic exchanges, innovation, and high-quality development. On the other hand, the top ten publishing countries still need countries such as Asia, South America, and Africa. This also indicates that the development of the cross-border agri-food supply chain in the world reflects the characteristics of regional imbalances. Countries and scholars in Asia, South America, and other continents should intensify efforts to promote the development level and quality of their cross-border agri-food supply chain. Countries in all continents should strengthen exchanges, cooperation, and academic discussion and share in this field to achieve balanced and coordinated development of the global agricultural supply chain and enhance the resilience level of the global agricultural supply chain and the academic level of field research.

Table 2. High-frequency Journal Frequency Statistics of Sample Literature.

Rank	The Title of Journal	Frequency of Occurrence	Journal Impact Factor/JCR Partition	Publishing Country
1	Sustainability	52	3.889/Q2	Switzerland
2	Journal of Cleaner Production	50	11.072/Q1	USA
3	British Food Journal	20	3.224/Q2	United Kingdom
4	Food Policy	15	6.08/Q1	United Kingdom
5	Science of the Total Environment	12	10.753/Q1	Netherlands
6	International Food and Agribusiness Management Review	11	1.515/Q4	USA
7	Agricultural Economics	10	3.887/Q1	Netherlands
8	Environmental Research Letters	9	6.947/Q1	United Kingdom
9	Sustainable Production and Consumption	8	8.921/Q1	Netherlands
10	Global Environmental Change-human and Policy Dimensions	8	11.16/Q1	United Kingdom

3.5. The Statistics of Domain Literature Analysis Methods

The title, abstracts, keywords, and prefaces of 761 articles in this field were carefully read, and the research methods used were statistically summarized. Analysis methods used five times or more are listed in Table 3.

Table 3. Frequency Statistics of Analysis Method of Domain Literature.

Rank	Analysis Method	Frequency of Occurrence
1	Method of life circle assessment (LCA)	63
2	Multi-region input-output model (MRIO)	25
3	AHP (AHP)	9
4	SWOT analysis	8
5	Genetic algorithm (NSGA)	7
6	System Dynamics (SD)	7
7	Multi-criteria decision-making model (MCDM)	7
8	Multiple regression analysis	6
9	Aco algorithm (ACO)	5
10	Random effect model (REM)	5
11	Particle Swarm Optimization Algorithm (PSOCP)	5
12	Machine learning algorithm (ML)	5
13	Structural Equation Model of Partial Least Squares Method (PLS-SEM)	5
14	Data Development Analysis (DEA)	5

(1) Life cycle assessments (LCA) and multi-region input-output models (MRIO) were widely used in this field, at 63 times and 25 times, respectively. The total frequency of the two methods in the total number of samples in literature (761) is as high as 11.69%. From the statistical results of many scholars using life cycle assessment to study cross-border agri-food supply chains, we can draw the following conclusions: (1) Decisionmakers increasingly use life cycle assessment (LCA) to measure the environmental sustainability of products [74–78]; and (2) Maintaining collaborative and sustainable development with the related ecological environment in developing a cross-border agri-food supply chain is a crucial research topic for scholars [79]. According to the MRIO model, the technology and scientific and technological means used in the cross-border agri-food supply chain are balanced with the raw materials and service requirements of each link so that each link can be integrated into the supply chain in the most appropriate state for the whole [80–84]. Deureret et al. [85] used the LCA method to study the contribution of major life cycle stages of kiwifruit cross-border supply chain shipping, to reduce the carbon footprint of the kiwifruit cross-border supply chain;

(2) Genetic algorithms (NSGA) [86–88], ant colony algorithms (ACO) [89,90], particle swarm optimization (PSO) [91–94], and other heuristic algorithms have attracted more and more attention in the research of cross-border agri-food supply chain. Because of the complexity and dynamics of each link of the cross-border agri-food supply chain, many scholars have begun to apply heuristic algorithm thinking to research in this field. Chai et al., (2019) used the NSGA-II algorithm to optimize the traditional logistics ecosystem and constructed a new intelligent short-term cross-border agri-food supply chain and logistics system using Internet technology [95];

(3) Analytic hierarchy rocess (AHP) [96–99] and system dynamics (SD) [100–102], which combine quantitative and qualitative methods, have also been favored by many scholars in the research of cross-border agricultural supply chains. Using this quantitative and qualitative research method, we can deeply analyze the essence, influencing factors, and their internal relations to the cross-border agri-food supply chain. Ni et al. [103] combined the analytic hierarchy process and fuzzy theory and comprehensively evaluated cross-border green logistics of agri-food based on the evaluation index.

4. Analysis of Hot Spots and Development Trends of Cross-Border Agri-Food Supply Chain

4.1. Co-Occurrence Analysis of High-Frequency Keywords

Keywords are the core point of a paper. Analyzing keywords in the related literature in a particular field helps to ascertain research hotspots in this field [104,105]. The higher the frequency of keywords, the stronger the research enthusiasm of scholars in the related fields of this keyword [106]. Therefore, it is helpful for researchers to study the research hotspots and evolution trends in this field by condensing and summarizing the keywords in the literature [107]. In this paper, 761 samples from the literature were processed and analyzed with the help of CiteSpace. A keyword atlas, as shown in Figure 8, was obtained, and the number of nodes generated in the atlas is 971, and the number of connected lines is 4794. The larger the ring area of nodes in the graph, the higher the frequency of the keywords. Moreover, the network density in the Figure 8 is high, which shows that the research cooperation on the cross-border agri-food supply chain worldwide is close.

The Donohue formula is an essential basis for dividing high and low keywords [108], as shown in Formula (2). T represents the lowest number of high-frequency keywords, and I is the number. In this article, the I value is 971, and the T value is calculated by 43. That is, keywords that occur 43 or more times are high-frequency keywords, as shown in Table 4.

$$T = \left[-1 + \sqrt{(1 + 8I)}\right]/2 \quad (2)$$

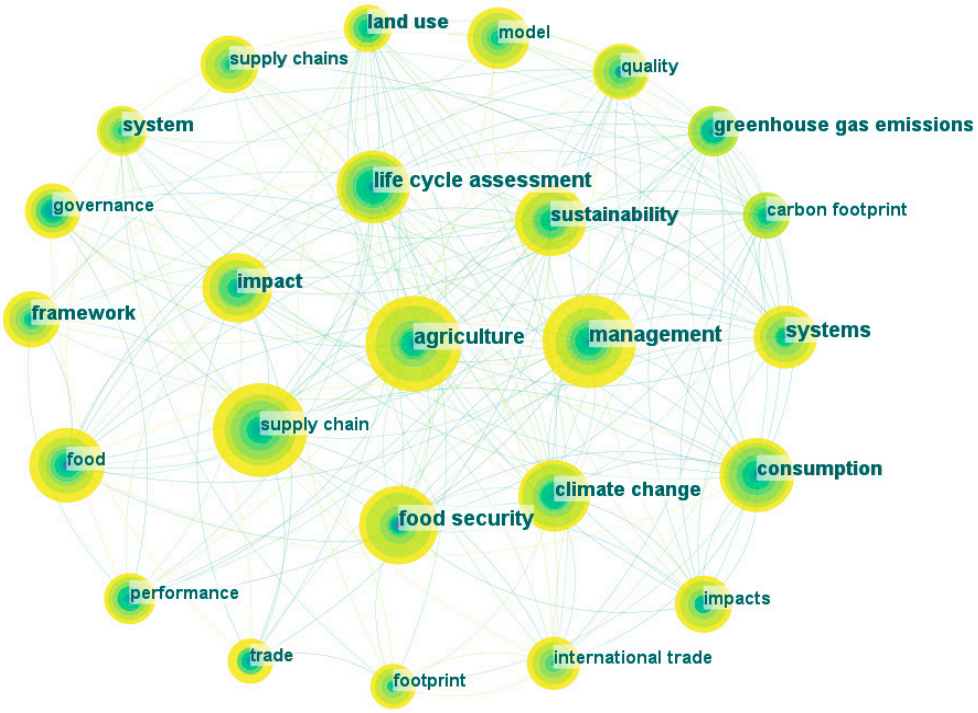

Figure 8. Keywords co-occurrence map of cross-border agri-food supply chain research.

Table 4. Keywords Frequency Statistics of Cross-border Agri-food Supply Chain Research.

Rank	Keyword	Frequency of Occurrence	Centrality
1	Agriculture	90	0.09
2	Management	84	0.10
3	Supply Chain	83	0.06
4	Food Security	59	0.05
5	Food	55	0.05
6	Consumption	55	0.11
7	Life Cycle Assessment	55	0.03
8	Climate Change	51	0.05
9	Impact	49	0.08
10	Sustainability	49	0.04
11	System	43	0.08

This paper classified and integrated these 11 high-frequency keywords, concluding that the international attention and research hotspots in the cross-border agri-food supply chain in the past 15 years are as follows:

(1) The object subject of the cross-border agri-food supply chain: its representative hot words are "agriculture", "supply chain", "food" and "food security". The cross-border agri-food supply chain's main objects are agriculture and agri-food [109]. With the improvement of people's living standards and international standards of agri-food, more and more international scholars paid attention to improving the safety of agri-food in all links of the cross-border supply chain of agri-food [110,111]. For example, Dilla et al. [112] analyzed and studied six kinds of agri-food in two-way transit in the agri-food chain and guided local producers on how to obtain the profits generated by such cross-border economic activities in a limited way;

(2) Sustainability of cross-border agricultural supply chain: the representative hot words are "sustainability", "consumption", "climate change", "impact" and "life cycle assessment". With the continuous development and improvement of science and technology levels in the agricultural field, the amount and frequency of chemical fertilizers used

in the agricultural planting field are increasing, which has caused massive pollution to water quality around farmland [113,114]. On the other hand, extensive management is widespread in all aspects of the cross-border supply chain of agri-food, and the level of logistics specialization could be higher. Especially in some developing countries, the loss rate of agri-food such as fruits and vegetables has reached 25–30% [115,116]. The agricultural life cycle method (LCA) has gradually become a hot field for international scholars to explore and study. Zelaya-Molina et al. [117] put forward eight methods to reduce the waste of fruits and vegetables in all links of the supply chain;

(3) Innovation of system mode and management method of the cross-border agri-food supply chain: "system" and "management" are internal interactive factors to improve the quality and efficiency of the cross-border agri-food supply chain. Systematization, informatization, standardization, and efficient management of the supply chain have become new research and attention hotspots in the cross-border agri-food supply chain. Examples include the application of system dynamics (SD) and the analytic hierarchy process (AHP) in the evaluation system of influencing factors of cross-border agri-food supply chain [118], the rise and innovative development of cross-border e-commerce model, the application of management software such as ERP and SCM and big data, etc. [119]. Teng et al. [120] concluded that the route planning method of cross-border e-commerce logistics of agri-food based on the cyclic neural network could effectively resist the influence of external factors, thus obtaining the optimal route for cross-border e-commerce logistics in agri-food.

4.2. Keyword Cluster Analysis

The analysis of keyword co-occurrence and prominence in the cross-border agri-food supply chain field was used to further analyze and confirm the research hotspots in this field. The results are shown in Figure 9. The cluster module value Q of the cluster map is 0.7607, more significant than 0.3, which means that the cluster structure is significant. The average contour value S is 0.9016, greater than 0.7, indicating that the clustering is convincing [121]. The map contains ten clustering categories, which are #0 industry (68), #1 smes (35), #2 community flow (29), #3 global value chain (25), #4 live (25), #5 food system (21), #6 food policy (19), #7 willow (19), #8 human health (15) and #17 capital good (5). The size of each category area in the map represents the cluster scale, which is the characterization value of the number of keywords in the cluster. The larger the cluster scale, the more related keywords in the cluster, which also shows that the cluster topic has received greater attention in this research field [122].

Three research topics in this field (as shown in Table 5) were analyzed and summarized by manual induction. These include commercialization and capitalization of the cross-border agri-food supply chain; food safety of the cross-border agri-food supply chain; and diversification of cross-border agri-food supply chain subjects.

Table 5. Clustering Topic Analysis of Cross-border Agri-food Supply Chain Research Keywords.

Research Theme	Cluster Label	Cluster Size	Related Keywords
Commerce and capitalization of cross-border agricultural supply chain	#1 smes	35	global supply chains; corporate social responsibility; cross border cooperation; small-scale farmers; floriculture exports; life cycle inventory data; ecoinvent database; environmental relationship; infrastructure;
	#2 commodity flow	29	
	#3 global value chain	25	
	#17 capital goods	5	
Food safety in cross-border agricultural supply chain	#5 food system	21	agri-food supply chains; vertical integration; agricultural policy; obesity; westernization; olive oil; protected geographical indication; organic product; plant; soil; co2; yield;
	#6 food policy	19	
	#8 human health	15	
Diversification of cross-border agricultural supply chain entities	#0 agriculture	68	food security; supply chain management; global value chains; model; optimization; agriculture; water stress; sub-Saharan agriculture; advanced biofuel technology; lignocellulosic ethanol;
	#4 livestock	25	
	#7 willow	19	

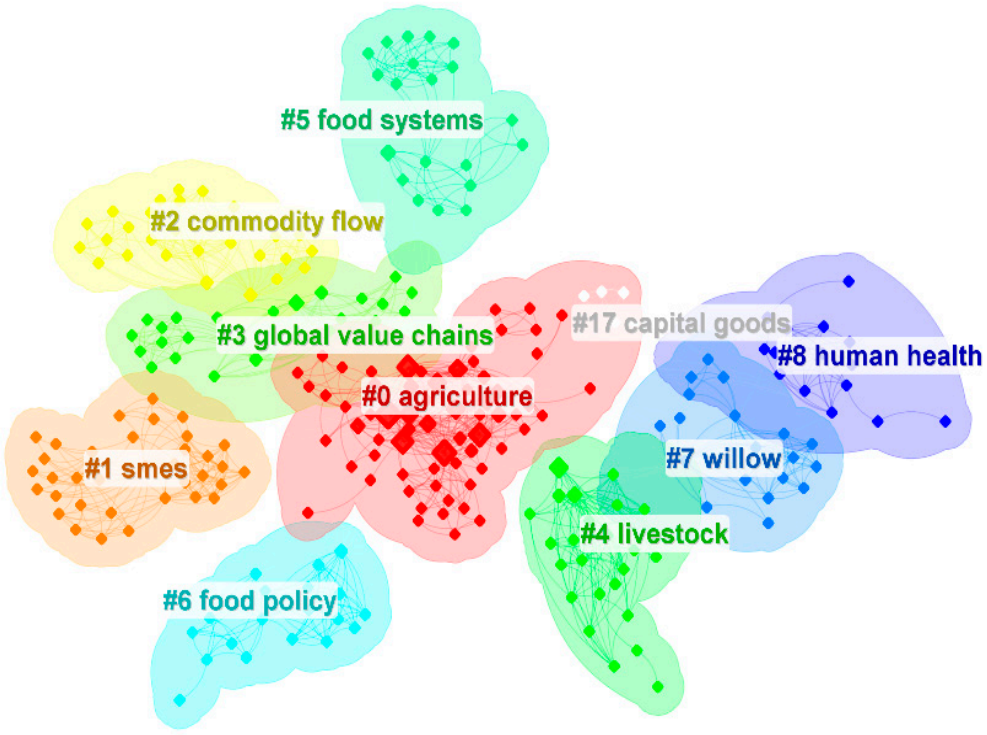

Figure 9. Keyword Clustering Map of Cross-border Agri-food Supply Chain.

The first category is the commercialization and capitalization of the cross-border agri-food supply chain. It mainly includes four clusters: #1 small and medium-sized enterprises, #2 module flow, #3 global value chain, and #17 capital goods. The main keywords involved are the global supply chain; corporate social responsibility; cross-border cooperation; small farmers, etc. To pursue profits, SMEs engaged in cross-border agricultural products continuously improve the quality and efficiency of the supply chain, enhance the level of the global value chain of agricultural products, and promote the orderly circulation of goods and capital in various countries. The main characteristics, and development trends are commercialization and capitalization. The maturity of the commercialization and capitalization of the cross-border agricultural food supply chain model can provide a large amount of financial support for the development of the model, thereby promoting the innovation of technical equipment in all aspects of the entire supply chain and achieving the goals of energy saving, quality improvement, and efficiency improvement [123], and, finally, promote the virtuous cycle of the entire cross-border supply chain system. Therefore, the commercialization and capitalization of the cross-border agricultural food supply chain have become a research hotspot for more and more international scholars. Abula et al. [124] proposed a method of improving the efficiency of information processing in China and Central Asian countries, by realizing the commercial marketization of demand and shortening the relevant payment and business links to improve the profit level of both imports and exports. Oberholster et al. [125] proposed business tools and models, such as variable value chain integration, strategic cooperation, risk management, and external financing to positively impact supply chain competitiveness.

The second category is food safety in the cross-border agricultural food supply chain. It mainly includes three clusters: #5 food system, #6 food policy, and #8 human health. The main keywords involved are agricultural food supply chain; vertical integration; agricultural policy; obesity; olive oil; protected geographical indications; organic products, etc. With the improvement of people's living standards and dietary structure in the world, higher requirements have been put forward for the quality of cross-border agricultural food. Countries constantly improve the relevant policies and laws of agricultural products and put forward new standards for the freshness of some fruits and vegetables, perishable

foods, and related organic foods with a short shelf-life to promote the safety of the global food system and ensure food safety and human health. Therefore, to meet the requirements of people of all countries for high-quality transnational agricultural food consumption upgrading and healthy diet, how to ensure agricultural products do not deteriorate or pollute during transportation and ensure the safety of agricultural products has attracted more and more attention and research [126]. Wang et al. [127] found that blockchain technology positively impacts the qualification rate and circulation efficiency of agricultural food. Chen et al. [128] proposed the contribution of Internet of Things technology to the cross-border agricultural food supply chain, which is of great significance for solving the safe and transparent management of fresh agricultural products and the traceability of production, transportation, and sales.

The third category is the diversification of cross-border agricultural food supply chain entities. It mainly includes three clusters: #0 agriculture, #4 animal husbandry, and #7 willow. The main keywords involved are food security; supply chain management; global value chain; agriculture; advanced biofuel technology. With the continuous development and change of world market demand, the main body of the cross-border agricultural product supply chain is no longer limited to food itself, and the cross-border transportation of various meat products, wood products, oil, aquatic products, dried fruits, and seasonal fresh fruits is endless. Many countries have begun to attach importance to a combination of agriculture and animal husbandry to improve the efficiency of the agricultural product supply chain in planting links. Black et al. [129] pointed out that the willow production system is based on the existing agricultural product supply chain, providing renewable energy and biofuels for each link of the existing supply chain to reduce the environmental impact of each link supply chain. On the other hand, willow trees can produce willow flowers, willow buds, weeping willows, and other agricultural products, enriching the categories of agricultural products and increasing the added value and profits in the trade process. How to build an efficient cross-border supply chain of various agricultural products and promote the orderly circulation of various agricultural products has become the primary subject of more and more scholars. Cao et al. [130] discussed new features of the human–machine coordination mechanism that enables agricultural and supply chain participants to share responsibilities and provide consumers in the China–Australia beef supply chain with certified traceability data. Achman-Witzer et al. [131] proposed an international supply chain model, pointing out opportunities for the application of waste value in the international tropical fruit trade.

4.3. Research Evolution Path Analysis

The primary function of a time-zone map is to take the time when keywords first appear as the time interval of keywords to show the rise and decline of different keywords, which can help researchers better grasp the research hotspots and development context in the research field [132]. Mutation words refer to keywords that suddenly appear quickly and are used frequently [133]. According to the emergence year and intensity of mutation words, we can identify the research hotspots that suddenly appear in this stage and the evolution trend of hotspots at each stage in the cross-border agri-food supply chain [134]. This paper combined the time-zone diagram (as shown in Figure 10) and sudden change word detection (as shown in Figure 11). The two research methods help each other to confirm the research hotspots and evolution trends in the cross-border agri-food supply chain field in each period and, on this basis, explore the development frontiers in this field. The figure shows that cross-border agri-food supply chain research can be divided into three stages.

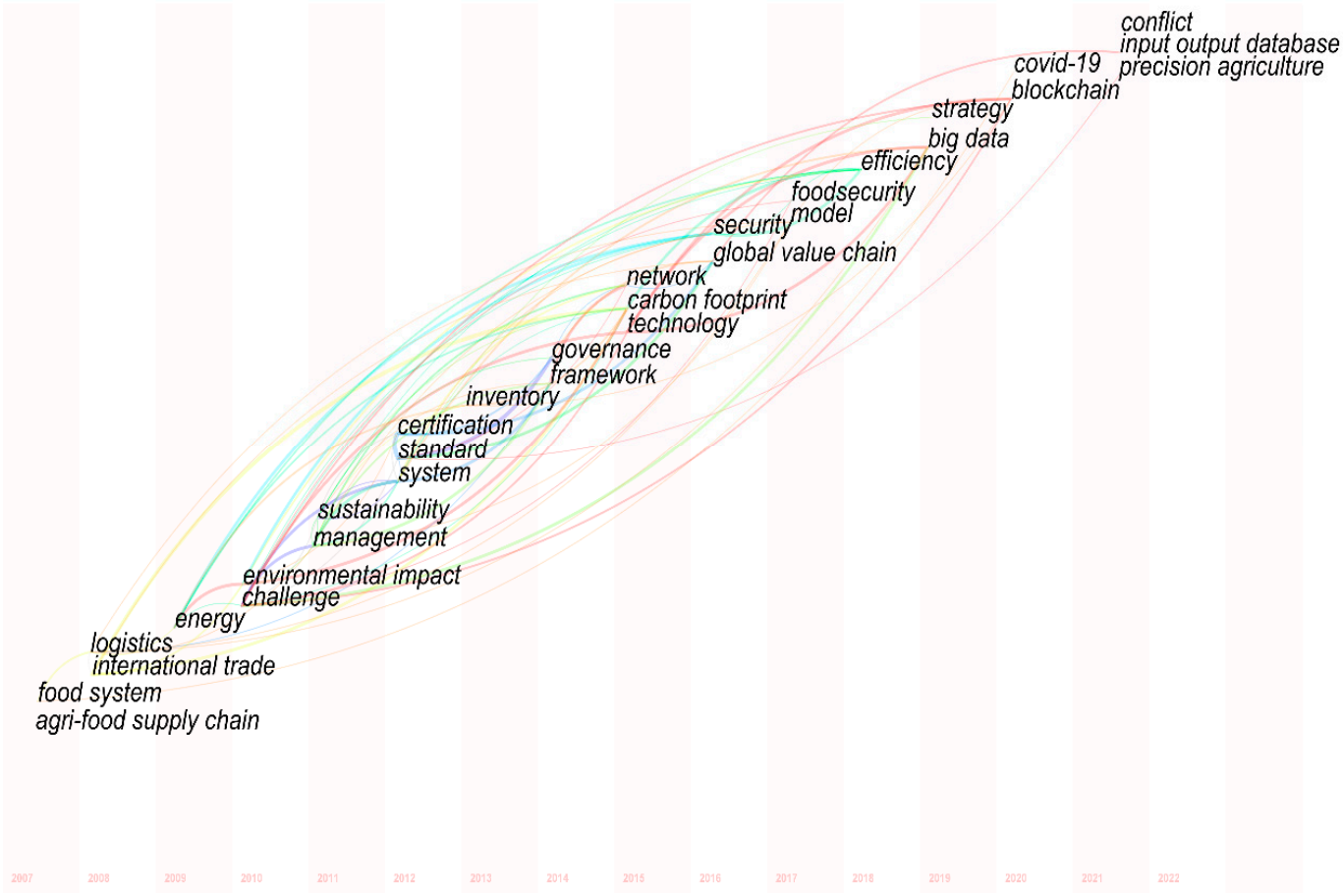

Figure 10. Research Time-zone Map of Cross-border Agricultural Supply Chain.

The first stage (2007–2012) was a period of rapid development of systematization and standardization of the cross-border agri-food supply chain and finished products of agri-food. The main keywords in the time-zone diagram at this stage were: "food system", "certification", "standard", "management", "sustainability", "logistics", and so on. The burst words at this stage are "contract", "food industry", and "industry". With the development of trade globalization, cross-border trade of agri-food became more frequent. However, the friction incidents of cross-border agri-food, such as dumping and anti-dumping, cross-border predatory pricing, single means of transportation, and complex settlement of funds, were intensifying [135,136]. To reduce the occurrence of such trade frictions, many scholars focused on how to establish a cross-border agri-food supply chain system [137]. It should be pointed out that the keyword "logistics" appears many times in the research literature at this stage. From this, we can see that in the research of the cross-border agri-food supply chain at this stage, many scholars still remained in the single link of "logistics" and "transportation" of agri-food from the departure place to the receiving place. Although the keyword "supply chain" appeared, it appeared less frequently. Therefore, we know that the "supply chain" concept was not popularized then, and the systematic development of a cross-border supply chain of agri-food was still in its infancy. The analysis of Sporleder et al. [138] focused on defining and describing the unique economic characteristics of agri-food supply chains. It provides a reference for developing the future cross-border agri-food supply chain.

Keywords	Year	Strength	Begin	End	Duration	2007–2022
contract	2007	3.91	2007	2012	2	
food industry	2008	2.5	2008	2011	3	
supermarket	2013	2.64	2013	2014	1	
greenhouse gas emission	2014	4.08	2014	2017	1	
governance	2014	2.42	2014	2016	1	
climate change	2008	2.42	2016	2017	1	
industry	2008	2.42	2018	2019	1	
lca	2018	2.67	2018	2020	2	
optimization	2018	2.67	2018	2020	2	
location	2018	2.68	2018	2019	1	
input outout analysis	2018	2.91	2018	2019	1	
conceptual framework	2018	3.45	2018	2019	2	
strategy	2019	4.31	2019	2020	3	
safety	2019	2.49	2019	2020	1	
product	2019	2.59	2019	2022	3	
security	2016	2.47	2020	2022	5	

Note: Orange represents the burst intensity of mutation words. The longer the bar chart, the higher the burst intensity; Green represents the length of the burst duration of the mutant word. The longer the bar chart, the longer the duration; Red represents the time range of the burst of mutation words; Dark-green represents the time range in which keywords first appear and last but do not burst; Light green represents the time range of keywords not appearing and bursting.

Figure 11. Burst Word Detection of Cross-border Agri-food Supply Chain Research.

The second stage (2013–2017) was the development and prosperity period of modeling, framing, and technological innovation integration of the cross-border agri-food supply chain system. At this stage, the keywords in the time-zone diagram mainly included: "framework", "model", "network", "technology", "efficiency", "innovation", "carbon footprint", "governance", "global value chain" and so on. The burst words at this stage are "greenhouse gas emission", "governance", and "supermarket". With the large-scale development of the cross-border agri-food supply chain, problems such as relatively low efficiency, extensive management, disordered transportation routes, environmental pollution, and the financial crisis became increasingly prominent [139,140]. Therefore, scholars focused on building the system framework and model in this field and optimizing the network structure of each supply chain link through technological innovation to improve the overall efficiency and resilience against risks of the whole agri-food supply chain, such as the SCOR supply chain model, agile supply chain model, customized supply chain model, efficiency supply chain model, and continuous supply chain model [141,142]. Porter, SD et al. [143] studied the reliable quantification challenges of food waste and inefficient consumption in the supply chain and their related greenhouse gas emissions.

The cross-border agri-food supply chain's third stage (2018–2022) is an intelligent technology-oriented development stage with information digitalization and big data as the main body. The keywords in the time-zone diagram at this stage mainly include: "strategy", "big data", "digital agriculture", "blockchain", "input-output database", "precision agriculture", "COVID-19", "conflict", and so on. The burst words at this stage are "optimization", "input-output analysis", "strategy", "safety", and so on. As Klaus et al. [144], founder and executive chairman of the World Economic Forum, observed, the fourth industrial revolution is coming. The fourth industrial revolution will integrate physical space, cyberspace, and physical space brought about by innovations such as artificial intelligence, life sciences, the Internet of Things, robots, and intelligent manufacturing. By

comparing and analyzing the time-zone map and keyword emergence map at this stage, we can see that many keywords in the cross-border agri-food supply chain are the same as those defining the fourth industrial revolution. In addition, we also find that the impact of black swan events such as "COVID-19", "the trade conflict between China and the United States", and "The Russia-Ukraine War", which became popular in late 2019 and early 2020, on the cross-border agri-food supply chain, has also attracted the attention of many scholars at this stage. Therefore, many scholars focused on applying information technologies such as the Internet of Things, blockchain, and big data in agri-food supply chains to improve the security of the whole supply chain and the resilience of sustainable development. Shen et al. [145], aiming at the problems such as lagging construction of agri-food supply chain network facilities, and safety of agri-food, combined with big data technology, studied the intelligent supply chain system of agri-food and adopted network equilibrium method to build a supply chain network model. Coluccia et al. [146] and others formulated appropriate strategies for the agri-food supply chain to ensure the resilience of the cross-border agricultural supply chain in these unprecedented times.

5. Knowledge Base Analysis of Cross-Border Agri-Food Supply Chain

Classical literature in a particular field is often quoted repeatedly, a critical research achievement that constitutes the knowledge base in this field [147]. The high frequency of co-cited literature, or critical literature, is a research result generally recognized by most scholars in a particular field [148]. Therefore, the co-citation analysis of the literature in the cross-border agri-food supply chain field is helpful to examine the knowledge base in the cross-border agri-food supply chain field and grasp the research hotspots and development contexts in this field at a deeper level. In this paper, the "CiteSpace" analysis was used to obtain highly co-cited literature in the cross-border agricultural supply chain field, which was defined as those cited ten times or more, and the results are shown in Table 6.

Table 6. Analysis Table of Highly Co-cited Literature in the Field of Cross-border Agri-food Supply Chain.

Rank	Year	Frequency	Centrality	Academic Paper Title
1	2019	27	0.04	Food in the Anthropocene: The Eat-lancet Commission on Healthy Diets from Sustainable Food Systems
2	2018	25	0.23	Reducing Food's Environmental Impacts Through Producers and Consumers
3	2020	18	0.01	Food Supply Chains During the COVID-19 Pandemic
4	2019	12	0.00	The Rise of Blockchain Technology in Agriculture and Food Supply Chains
5	2020	11	0.01	COVID-19 Risks to Global Food Security
6	2018	11	0.03	Options for Keeping the Food System Within Environmental Limits
7	2017	11	0.00	Big Data in Smart Farming-A review
8	2020	11	0.11	Resilience of Local Food Systems and Links to Food Security—a Review of Some Important Concepts in the Context of COVID-19 and Other Shocks
9	2018	10	0.05	Future Challenges on the Use of Blockchain for Food Traceability Analysis
10	2020	10	0.00	Achieving Sustainable Performance in a Data-driven Innovation Supply Chain: a Review for Research and Applications
11	2020	10	0.04	Agri-food 4.0: a Survey of the Supply Chains and Technologies for the Future Agriculture

Through careful study and analysis of the above highly cited literature, it can be seen that the knowledge base of the cross-border agri-food supply chain mainly focuses on three aspects.

The main line of research is the sustainability of the cross-border agri-food supply chain and the high-quality development of the global food system. Walter et al. [149] presented a comprehensive framework for the sustainable development of the cross-border agri-food supply chain and global food system and defined a safe space for its healthy development. Poore et al. [150] outlined the environmental impacts of the whole food supply chain by

establishing a multi-indicator global database. Measures such as environmental labeling and taxes or subsidies of the environmental costs in agri-food prices were put forward to reduce the negative impacts of the agri-food supply chain on the environment. An analysis by Marco et al. [151] showed that, due to the expected changes in food consumption and production, the impacts of the cross-border agri-food supply chain on the environment may increase significantly. Sachin et al. [152] examined weak links in the agricultural food supply chain, proposing an application framework for practitioners involved in the agri-food supply chain.

The frontier research hotspot is the trend of digital technology applications such as blockchain, big data, and the Internet of Things. Andreas Kamilaris et al. studied the impact of blockchain technology in agriculture and the cross-border agri-food supply chain, outlining ongoing projects and plans [153–155]. Research by Sjaak Wolfert et al. [156] showed that the application scope of big data in intelligent agriculture extends beyond primary production and that its radiation scope traverses the entire agri-food supply chain. Juan et al. [157] observed that tracking and certifying the cross-border supply chain of agri-food in order to understand the source will play a crucial role in identifying and solving pollution sources in the global food supply chain. A study Mario et al. [158] focused on four major technologies: the Internet of Things, blockchain, big data, and artificial intelligence, and suggested that the application of these technologies will improve the efficiency, flexibility, resilience, flexibility, and sustainability of the whole supply chain from farmers to end customers.

The hot spot of mutation is the resilience against risks in emergencies such as "COVID-19". Jill et al. [159] made an early assessment of the impact of the pneumonia epidemic in COVID-19 on the food supply chain and supply chain elasticity. Finally, considers whether the pneumonia epidemic in COVID-19 will have a long-term impact on the nature of the cross-border agri-food supply chain. David et al. [160] outlined the main threats posed by COVID-19 to food security, such as supply chain interruption and trade restrictions, and put forward crucial countermeasures that policymakers should consider, such as subsidies to encourage food transportation and logistics, to prevent this global health crisis from becoming a global food crisis.

6. Discussion

6.1. Research Implications

This study provides important implications for researchers and practitioners in cross-border agricultural supply chains. First, we described the current situation and research hotspots in the field of cross-border agricultural product supply chain and predicted future research directions, which will help researchers to grasp future research directions and focus on research hotspots in this field. Practitioners in related industries can gain inspiration from our research and gain insights into the leading trend of digital technology reshaping the cross-border agricultural product supply chain. Second, this paper will help researchers and practitioners to fully understand the application status of new technologies and management models in this field. For example, which technologies and management models are widely used to promote the development of this field? What is the effect of applying new technology and management modes in this field? Third, this paper introduced, in detail, the countries, institutions, and journals that have made significant contributions to the research of cross-border agricultural supply chains. The results should help researchers and practitioners to consider where more cooperation opportunities may be available, and where to seek for more valuable information and help.

6.2. Future Research Directions

After discussing and analyzing the above research results, future research in the cross-border agricultural supply chain field should be enlightened in research methods, research mechanisms, research subjects, and research frontiers.

(1) Research Methods: Change from a Single Research Method to a Combination of Multiple Research Methods

Various research methods can be comprehensively used, and the scientific and applicable research results in this field can be enhanced by each research method's complementary advantages and disadvantages. Although the research achievements in cross-border agricultural supply chains have entered a rapid growth stage in recent years, the research methods adopted by most existing studies in the literature are relatively single. Moreover, most are mainly subjective analyses and interpretations, and the proportion of objective analyses using scientific measurement tools is small. Therefore, research methods in this field should be enriched and expanded upon in future research. For example, we should pay attention to the application of the experimental methods in this field, which can reveal the deeper mechanisms and dynamic processes in the operation process of the cross-border agri-food supply chain.

The existing research method only collected the status and data of the cross-border agri-food supply chain at a particular link or a specific time node. It takes work to systematically integrate the real-time status of the agri-food supply chain, such as production, processing, transportation, and distribution systems. On the other hand, the existing research perspective is mainly from a cross-section seen from a static perspective. Therefore, in future research, we should pay attention to the application of vertical and three-dimensional research methods in this field, adopt vertical and cross-time research methods to integrate the state of each link of the supply chain, and build its dynamic integration model, to enrich the research results of the cross-border agri-food supply chain.

(2) Research Mechanism: Highlighting Collaborative Innovation and Exerting the Cluster Effect of Cooperative Research by Authors and Institutions

In cross-border agri-food supply chain research, multi-agent and cross-industry cooperation is vital in the current knowledge production mode. In the research in this field, the author's cooperation group, institutional cooperation group, and national cooperation group still need to form a close non-institutionalized cooperation state and academic community. Therefore, in future research in this field, efforts should be made to strengthen the exploration of multi-agent and cross-industry knowledge production mode, build a multidisciplinary and cross-disciplinary scientific research cooperation platform, encourage universities, scientific research institutions, social organizations, and government research departments to cooperate and give full play to the cluster effect of scientific research production and academic theoretical research from a multi-perspective;

(3) Research Theme: Deepen the Safety Chain, Ecological Chain, and Sustainable Chain of Cross-border Agri-food

In November 2022, the Bali Summit of G20 leaders adopted a declaration promising to build a sustainable and resilient food and agriculture system and global supply chain and take concerted actions to solve global food security problems. Combined with the research hotspots and mutation words obtained from the previous analysis, "safety", "security", and "human health" have become new research positions in recent years. Therefore, in future research, a key challenge will be establishing a cross-border agri-food supply chain that is resilient and sustainable and can resist risks. On the other hand, global climate change is intensifying. To cooperate with the United Nations to achieve the goal of "carbon neutrality" in 2060 and build an "ecological and sustainable" global agri-food supply chain. How to realize the transformation from "efficiency development" to "eco-efficiency coordinated development" of the cross-border agri-food supply chain is a topic that scholars should pay more attention to and study;

(4) Research Frontier: from "industrialized Thinking" to "digital Intelligence Thinking"

In the statistics of the 761 samples from the literature, the authors find that although some scholars have applied blockchain, the Internet of Things, and other technologies to this field, the proportion is tiny. For example, blockchain technology is used 12 times, and Internet of Things technology is used 9 times, accounting for only 1.5% and 1.1% of the sample literature, respectively. The application practice of digital intelligence technologies

of artificial intelligence such as blockchain, Internet of Things, big data, and ChatGPT in this field should be actively promoted, as should the use of digital intelligence thinking to deepen the digital transformation of the cross-border agri-food supply chain and build a digital intelligence supply chain of cross-border agri-food. The operational efficiency and transparency of each link in the supply chain should be improved, thereby enhancing the security, resilience, and sustainability of cross-border agri-food supply chain and global food system and realizing more efficient overall allocation and circulation of agri-food international supply chain resources.

7. Research Conclusions, Limitations and Prospects

7.1. Research Conclusions

This paper evaluated the relevant literature on the cross-border agri-food supply chain from 2007 to 2022 using CiteSpace. The analysis included: the annual number of papers, countries, and institutions of papers; core authors and author cooperation networks; high-frequency journals; research methods within the literature; hot spots and evolution trends; and the knowledge base in the field of cross-border agri-food supply chain. The results are as follows:

(1) From 2007 to 2016, the number of related documents in the cross-border agri-food supply chain has fluctuated, and the annual number of documents has grown slowly, often by less than 40 articles/year. From 2017 to 2022, research results surged, and this field showed a strong development trend;

(2) The institutions with a large number of articles included Wageningen University and Research (46 articles); CGIAR (26 articles); The University of California System (23 articles); and The Food and Agriculture Organization of the United Nations (FAO) (15 articles). The density of the cooperation network is only 0.0064, which shows that the degree of cooperation among research institutions in this field is still shallow. Sample literature was distributed over 102 countries and regions, among which 12 countries had more than 30 articles. The United States ranked first with 115 articles, accounting for 20.3% of the total achievements. China ranked second with 96 articles, accounting for 12.6% of the total achievements. Furthermore, Italy ranked third with 87 articles;

(3) Most of the JCR divisions of hot journals published in this research field are in Q1 and Q2, which showed that the quality and grade of hot journals in this field are high. Hot journals mainly focused on food, the environment, and sustainability. This also shows that the research direction in this field is mainly the coordinated and sustainable development of the cross-border supply chain of agri-food such as grain and environment;

(4) The lifecycle assessment method (LCA, 63 times), multi-region input-output model (MRIO, 25 times), and various heuristic algorithms (18 times) are among the top three research methods in the related literature in this field.

(5) Research hotspots in this field included: the sustainable development of the cross-border agri-food supply chain; the commercialization and capitalization of the cross-border agri-food supply chain; the food safety of cross-border agri-food supply chain; and the innovation of cross-border agri-food supply chain model and management method. In the past 15 years, this field has experienced three stages of characteristic evolution. The first stage (2007–2012) was a period of rapid development of systematization, standardization, standardization, and finished products of agri-food. The second stage (2013–2017) was a prosperous period of modeling, framing, and technological innovation integration of the supply chain system. The third stage (2018–2022) was an intelligent technology-oriented development stage with informatization, digitalization, and big data as the main body of research;

(6) The knowledge base of the cross-border agri-food supply chain mainly focuses on three aspects. The main line of research is the sustainability of the cross-border agri-food supply chain and the high-quality development of the global food system.

The frontier research hotspot is the trend of digital technology applications such as blockchain, big data, and the Internet of Things. The hot spot of mutation is the resilience against risks in emergencies such as "COVID-19".

7.2. Research Limitations and Research Prospects

Although we try our best to ensure the objectivity and scientificity of the research, some things could still be improved. First, the time radiation range of literature sources needs to be increased. The authors only analyzed relevant sample literature from 2007 to 2022. The study period for the historical context of this field needs to be increased. Second, the types of literature considered in the study were limited by the requirements of CiteSpace software. Sample literature sources in this study were comprised of only journal papers such as SCI and SSCI, and did not involve monographs, academic papers, newspapers, and other types of literature. This may have had specific impacts on the analysis results. To enhance the accuracy of analysis results, various scientific research results in the research category should be considered in future research. Third, data sources were limited. This study only used the data resources available in the Web of Science and did not use data from well-known databases such as Scopus and Engineering, so the number, and breadth, of the original samples from the literature in this study were limited to a certain extent. Based on the above limitations, future research conducted by the authors in this area will focus on tracking the historical context, hot spots, and frontier trends of the cross-border agri-food supply chain more profoundly and comprehensively.

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