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# A bibliometric and content analysis of technological advancement applications in agricultural e-commerce

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## Abstract

Given the severe difficulties and challenges being faced during the current COVID-19 pandemic, agribusinesses must consider alternative means to market and sell agriproducts using e-commerce and advanced technologies. Agricultural e-commerce that utilizes advanced technologies can promote sustainable economic growth and gender equality and, therefore, helps achieve the Sustainable Development Goals. It also allows farmers access to new markets where they can bypass intermediaries, leading to higher income, less waste, and fresher produce for customers. The usefulness of using agricultural e-commerce depends on the efficiency of addressing the emerging challenges from merging perspectives of agricultural and e-commerce fields. Literature reviews addressed both fields from different perspectives, however, most literature addresses the agriculture and e-commerce fields separately, leading to unclarity in understanding the differences between agriproducts and other products. This study aims to present a comprehensive and robust roadmap of technological advancements and challenges in agricultural e-commerce through a thorough bibliometric and content analysis and provide a conceptual architecture for best practices. The bibliometric and content analysis sheds light on the agricultural e-commerce categories, challenges, and limitations. This study identifies the most influential research and topic trends, determines the topical discipline areas, and provides visions and directions for future research in the field of agricultural e-commerce. It discusses the challenges of agricultural e-commerce and agriproducts and how advanced technologies help solve such challenges. This study summarises the best practice implementation of agricultural e-commerce by providing strong logistics, implementing standardization, including information knowledge of agriproducts, and creating a traceability information system. The result of this paper is presented as a proposed conceptual architecture for agricultural e-commerce that addresses the abovementioned best practice concepts and utilizes the Blockchain and IoT technologies to provide innovative solutions for the agricultural e-commerce

Extended author information available on the last page of the article

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stakeholders. Finally, this study provides prospects for future research on advanced technologies in agricultural e-commerce.

**Keywords** Agriculture · e-commerce · Advanced technology · Blockchain · Internet of Things · Bibliometric

## 1 Introduction

Agriculture is critical to a country's economy, as seen by the sector's global added value of 3.6 trillion US dollars in 2020, which constitutes about 3.5% of the global Gross Domestic Product (GDP) [90]. Considering alternative means to market and sell agriproducts using e-commerce and advanced technologies is essential. This was clearly shown during the current COVID-19 pandemic, where agribusinesses face severe difficulties and challenges. Agricultural e-commerce is a multidisciplinary field that aims to facilitate buying and selling agricultural products and goods over the Internet, which is an efficient alternative to conventional agribusiness practices. The agricultural e-commerce platforms allow cultivators and farmers to access their customers directly, increasing their profits [42]. By utilizing advanced technologies, agricultural e-commerce promotes sustainable economic growth [83] and gender equality. Women play a significant role in agriculture through their roles as farmers and entrepreneurs [49]. Compared to men, they tend to run smaller farms and agribusinesses [41]. Due to the fact that agricultural e-commerce supports small agribusinesses to compete in the market, it affords women excellent prospects to start their online agribusiness, thereby helping to achieve gender equality in this industry. In fact, 26% of women-led startups business in the region of the Middle East and North Africa (MENA) are based on e-commerce [35]. In fact, the UN Sustainable Development Goals (SDG) comprise 17 goals, 10 of which are able to achieve by agricultural e-commerce, particularly goals 1, 2, 3, 4, 5, 8, 10, 12, 13, 17. Goal 9 of the SDG also affects the development of agricultural e-commerce [68]. This crucial link between the SDGs, agriculture, and e-commerce motivates academia and industry to comprehensively study the technological advancement in agricultural e-commerce.

Agricultural digital marketing generally faces several marketing-related challenges, such as production, distribution, and pricing. Other challenges also involve supply chain and information asymmetry. The current implementation of agricultural digital marketing is vague and lacks standardization. The usefulness of using agricultural e-commerce depends on the efficiency of addressing the emerging challenges from merging perspectives of agricultural and e-commerce fields. Literature research addresses the agricultural products and e-commerce fields separately, leading to unclarity in understanding the differences between agriproducts and other products. Few studies address both fields from different perspectives, such as the agricultural [14, 34, 92, 97], the technological [26, 57, 62, 70, 86], and economic perspectives [44, 101]. Zeng et al. present a review limited to only 80 papers related to agri-food e-commerce [97]. Fernando et al. limit their study to only 21 papers [32]. Banerjee et al. focus on reviewing only the price mechanism challenge of agricultural e-commerce [8]. These literature researches exhibit the importance of research in the domain of agricultural e-commerce. However, there is a lack of comprehensive studies on bibliometric and content analysis report that demonstrates the research trend, gaps and challenges, best practices, and possible future research directions in agricultural e-commerce.

The field of information science uses bibliometrics to analyze various publication attributes using statistical methods. The attributes are the author's activities, collaborations between countries, trends in publishing, and publication networks. These characteristics help colleagues who wish to do field research and look for possible co-researchers and key literature. It also demonstrates an overview of how a bibliometric analysis is performed in a field that complements traditional approaches to systematic examinations and getting fast evidence evaluations. Additionally, the bibliometric analysis also enables the identification of research clusters and demonstrates how distinct areas of thought may have developed over time based on publication attributes. These research clusters also obtain additional insights into the current research trends, gaps, and possible future research directions [30]. In summary, by conducting a bibliometric study, scholars can (a) estimate and analyse the growing body of knowledge; (b) anticipate future research and its major impact on various disciplines; (c) estimate and appraise the significance of their research and that of others [4].

This study aims to present a comprehensive and robust roadmap of technological advancements and challenges in agricultural e-commerce through a thorough bibliometric and content analysis and provide a conceptual architecture for best practices. The bibliometric and content analysis sheds light on the agricultural e-commerce categories, challenges, and limitations. This study conducts a literature search using "agriculture", "e-commerce", and "technology" as the main keywords. The collected dataset comprises 1,298 unique documents published between 2003 and 2021 in the Scopus and the Clarivate Web of Science databases. These documents are limited to journal papers, review papers, book sections, books, patents, and conference papers. The analyses of these documents are conducted from four points: descriptive analysis, authors, countries, and content analysis. The content analysis is conducted using keywords and text data [47, 48]. Finally, this study addresses the challenges and the utilization of advanced technologies in the field of agricultural e-commerce. Utilizing these advanced technologies has also ushered in new issues, producing more meaningful research directions. Consequently, this paper sheds light on several research prospects as a means to provide a valuable reference for the research of advanced technologies in agricultural e-commerce.

The main novelty of this study is creating a conceptual framework for best practices in agricultural e-commerce by benefiting from the findings of conducting a thorough bibliometric and content analysis. The following points highlight the contributions of this study as follows:

- It provides a descriptive analysis to demonstrate the basic statistics and comprehend an overview of the agricultural e-commerce literature.

- It exhibits the most contributed and productive authors in the field of agricultural e-commerce by article count, citation count, h-index, g-index, and article fractionalization metrics.
- It analyzes the impact and productivity of each country by the number of publications, single country publications (SCP), multiple country publications (MCP), MCP Ratio, total citation, and average article citations. It also scrutinizes the dynamics of collaboration between these countries.
- It scrutinizes the literature items' content using the help of Natural Language Processing (NLP) using a thematic evaluation map and other metrics.
- It identifies the most influential research and topic trends, determines the topical discipline areas, and provides visions and directions for future research in the field of agricultural e-commerce.
- It highlights the challenges of agricultural e-commerce based on content analysis and how advanced technologies help solve such challenges.
- It proposes a conceptual architecture for agricultural e-commerce which provides innovative solutions for the agricultural e-commerce stakeholders by utilizing the Blockchain and the Internet of Things technologies.
- Finally, it provides prospects for future research on advanced technologies in agricultural e-commerce.

The rest of this paper continues in Sect. 2 with a description of the structured methodology employed for the bibliometric analysis in this study. Section 3 discusses the findings from this bibliometric analysis. Section 4 discusses the background of agricultural e-commerce, its benefits, categories, challenges, the utilization of advanced technology, and the proposed conceptual architecture for the best practices for agricultural e-commerce development. Section 5 discusses the paper and the proposed conceptual architecture for the best practices for agricultural e-commerce development and provides the prospects for future research on advanced technologies in agricultural e-commerce. The last section concludes this paper and highlights future work in this field.

## 2 Methodology

Assessing and analyzing the current state of research on a certain topic are the motivations for conducting literature review studies. These studies are able to identify research questions, possible research limitations, research methodologies, and knowledge boundaries of the research field [82]. The adopted approach for bibliometric studies includes four phases: designing keywords for search, collecting the research results and creating the dataset, outlining the findings, and analyzing the findings. These four phases are able to define the relevant research areas, offer insights into current research trends, and identify the most compelling studies that give a roadmap for further research in the field. This study adopts the bibliometric analysis approach, which is demonstrated in Fig. 1. It is worth mentioning that the methodology of this study is based on the bibliometric review method, which differs

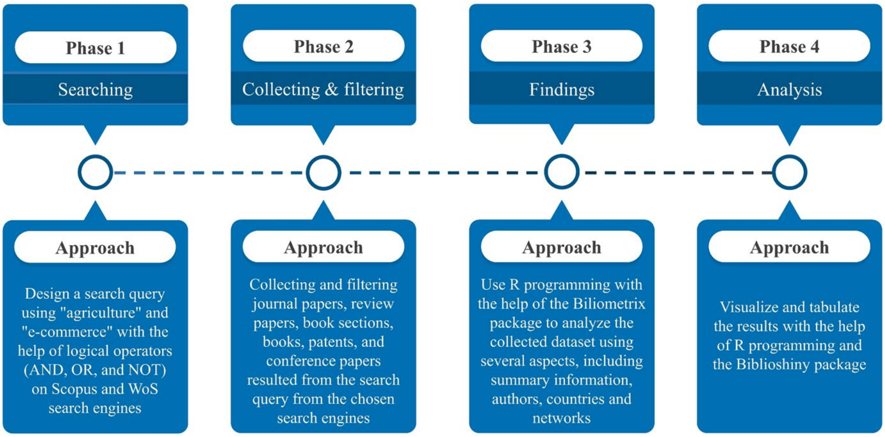



**Fig. 1** Methodology phases

from systematic literature review and meta-analysis methods. The authors of [24] addressed a comparison of these review methods in detail.

The collection of the literature starts by accessing the related databases. Only a few databases permit searching and accessing indexed journal articles, such as Google Scholar, Elsevier's Scopus, Association for Computing Machinery (ACM), IEEE Explore, Web of Science (WoS), ScienceDirect, and Springer. Scopus and WoS are the only databases that generate bibliometric data for searching for literature [2, 4]. Compared with the Scopus database, WoS boasts that its database is the most comprehensive and contains the largest number of high-impact publications [13]. Scopus is the world's largest database of peer-reviewed research literature in many research fields, and it covers over 20,000 peer-reviewed journals, including those published by Taylor and Francis, Interscience, Elsevier, Informs, Springer, and Emerald [30]. It also contains both the Clarivate Web of Science and Scopus-indexed rank papers [4]. In view of these considerations, this study uses both the WoS and Scopus databases to search for the keywords.

Collecting related literature from databases requires a query. The query comprises two parts: keywords and Boolean operations. Since the study focuses on technologies in agricultural e-commerce, "agriculture", "e-commerce", and "technology" were the main keywords of the query. The operator AND separates these main keywords. Each of these has synonymous keywords that authors frequently use in the field. The operator OR is used to separate these keywords within each group. The keyword includes agriculture keywords group ("agriculture", "e-agriculture", and "agri-food", "agri-product"), the e-commerce keyword group ("e-commerce", "ecommerce", "electronic commerce"), and the technology keywords group ("technology", "digital", "ICT", "online", "internet"). The Boolean operators AND and OR are used to restrict the scope of the resulting topics. This study collects all scientific research types, such as journal papers, review papers, book sections, books, patents, and conference papers published from 2003 to 2022 (the past two decades), from both the WoS and Scopus databases. The final collected dataset of literature contains a total of 1,298 unique documents.

Various tools allow scholars to perform a bibliometric study, such as HistCite, Pajek, Gephi, Excel, VOSviewer, BibExcel, and the bibliometrix package in R. The HistCite software does not support Scopus data [30]. Gephi has the edge over Pajek, Excel, and VOSviewer due to its efficiency and versatility. Gephi lacks the functionality necessary for data preparation, and therefore, scholars must resort to third-party programmes like BibExcel for this task [30]. The BibExcel is a very complex tool in terms of its operational environment, which requires high experience to conduct simple analyses [30]. For these reasons, we conducted the bibliometric analysis of this study using the well-known software for statistical computing, R, with the help of the bibliometrix package [6]. This paper uses the Biblioshiny software, a shiny app providing a web interface for the bibliometrix package, in which many studies from various scientific domains utilized for bibliometric analysis [4, 5]. The Biblioshiny facilitates the research by allowing this study to conduct reference tracing, reference selection, reference processing, synthesizing, content analysis, corpus pre-processing, and the representation of the study's findings. It also allows to merge WoS and Scopus datasets and generates one unique dataset for analysis by using the "mergeDbSources" building function of the bibliometrix library. Duplicated records will be removed automatically by setting the "remove.duplicated" variable as "True".

**Table 1** Descriptive analysis of the literature in the analyzed dataset

| Description of the dataset | Value |
|---|---|
| Timespan | 2003:2022 |
| Sources (Journals, Books, Conferences, etc.) | 811 |
| Documents | 1298 |
| Average citations per document | 4.088 |
| References | 34,086 |
| Keywords Plus | 4120 |
| Author's keywords | 3325 |
| Authors | 2601 |
| Author appearances | 3526 |
| Authors of single-authored documents | 201 |
| Single-authored documents | 302 |
| Documents per author | 0.499 |
| Authors per document | 2 |
| Co-Authors per documents | 2.72 |
| Collaboration index | 2.41 |

# 3 Findings

## 3.1 Descriptive analysis

The descriptive analysis section gives basic statistics about the collected literature. It is important to demonstrate a holistic picture of such data in order to comprehend an overview of the agricultural e-commerce literature. Table 1 summarizes the major characteristics of the 1298 documents published between 2003 and 2022. The collected documents were published by 811 sources comprising various books, conferences, and journals. Regarding the content analysis, there were 3,325 authors' keywords and 4,120 Keywords Plus. The authors' keywords are the frequently appeared terms from the document itself, while Keywords Plus is calculated by the most frequent terms that appear in the titles of a literature's references.

Regarding authors' statistics, the dataset contains 2601 authors. Only 7.7% of these authors wrote single-authored literature. The percentage of single-authored documents was more than 23%. The proportion of authors and co-authors per document was 2 and 2.72, with a collaboration rate of 2.41. The average citation for the document is relatively low (4.088 citations per document). The total cited references from all the 1,298 documents was 5302.

Table 2 enumerates more descriptions regarding the types of the collected documents. About half of the documents on the dataset are articles, which may indicate a high scholarly value of the literature in the field of agricultural e-commerce. More than a quarter of the dataset comprises conference papers, while the book chapters, books, reviews, and conference reviews were less than 10% of the analyzed dataset.

## 3.2 Subject area

Subject area analysis breaks down the literature fields of the analyzed dataset into subject areas within the agricultural e-commerce field. This analysis enables the comparisons of each subject area's performance based on the rates of publications and shows the magnitude of the research community in each area. This section uses multidisciplinary counting for the documents on each subject area. Table 3 enumerates the subject areas of the documents and their percentage shares in the analyzed

**Table 2** Types of documents and their proportion in the analyzed dataset

| Description of the dataset | Value | % of dataset |
|---|---|---|
| Article | 528 | 48.1 |
| Book | 4 | 0.3 |
| Book chapter | 36 | 2.8 |
| Conference paper | 360 | 27.7 |
| Conference review | 73 | 5.6 |
| Proceedings paper | 231 | 17.8 |
| Review | 24 | 1.8 |
| Others (Early Access, Note, Editorial) | 42 | < 1 |

**Table 3** Number of documents in each subject area and their proportion in the analyzed dataset

| Subject area | Value | (%) of dataset |
|---|---|---|
| Computer science | 518 | 39.9 |
| Engineering | 339 | 26.1 |
| Business, management and accounting | 286 | 22.0 |
| Social Sciences | 152 | 11.7 |
| Agricultural and biological sciences | 149 | 11.5 |
| Decision sciences | 128 | 9.9 |
| Environmental science | 104 | 8.0 |
| Economics, econometrics and finance | 102 | 7.9 |
| Mathematics | 88 | 6.8 |
| Medicine | 51 | 3.9 |

dataset. The computer science subject area, with 518 items, has the largest share of the documents in the dataset, followed by the engineering and business subject areas, with 339 and 286, respectively. Taking these top three together, 88% of the dataset's documents fit at least one of these disciplines. The computer science articles focus on the utilization of Blockchain, big data, IoT, data mining, social media, cloud computing, and 5G technology. This subject also addresses issues and challenges related to agricultural e-commerce, such as supply chain, transparency, traceability, and dynamic pricing. The engineering subject aria addresses challenges in agricultural e-commerce, such as agricultural robots, cultivation, corps, and cost-effectiveness. The business management and accounting field constitutes 22% of the documents and addresses agricultural e-commerce from the perspective of business solutions, online sales, rural economy, and electronic services. The social science subject area constitutes more than 10% of the documents in the field of agricultural e-commerce. Many of these pieces of literature highlighted the social impact of e-commerce on the quality of agricultural production and distribution, especially in rural areas in developing countries. Agricultural e-commerce also impacts the economy and the environmental subject areas.

The mathematical subject area includes 88 documents, many of which investigate the application of machine learning and neural network to enhance the performance of the agricultural e-commerce sector. Examples of such items entitled "Framework for agricultural e-trading platform adoption using neural networks", "Lateral inventory share-based models for IoT-enabled E-commerce sustainable food supply networks", and "Enhancing Online Store in Aggregator Model for SME in Multi Categories using Django Channels". Finally, the medicine subject area, surprisingly, contributes to the field of agricultural e-commerce. These 51 documents address the health risk and food security of purchasing agriproducts using online platforms. Examples of recent studies of this subject area are: "Research on cold chain logistics risk in e-commerce using text mining technology", "Research on logistics distribution path optimization of fresh agricultural products under e-commerce background", and "Big Data Impacting Dynamic Food Safety Risk Management in the Food Chain".

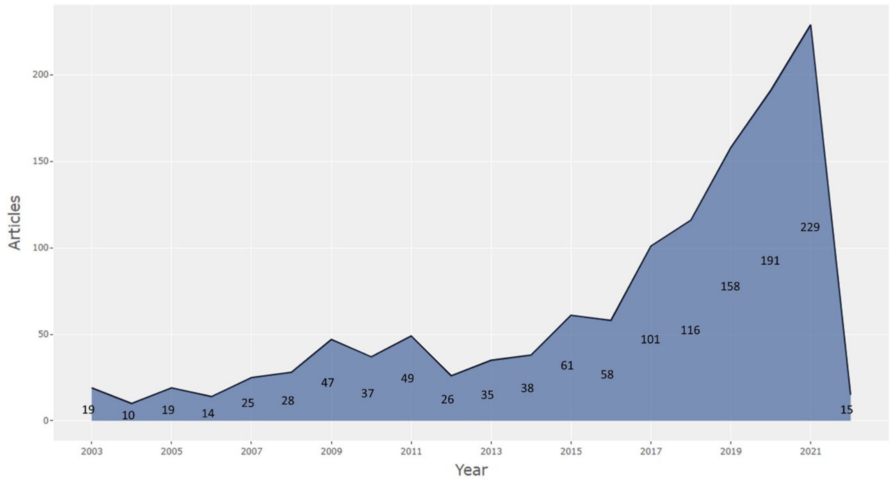



**Fig. 2** The annual growth of publications in the field of agricultural e-commerce in 10 years

### 3.3 The annual growth of publications

The annual growth rate metric is calculated by taking the average amount of literature published in the defined period (2003–2022). The annual growth of the analyzed dataset is 14.83%. Figure 2 shows that the trend of agricultural e-commerce research is increasing. The increase in the rate was minimal before 2015, with less than 50 publications per year. After 2016, the growth rate dramatically increased to its peak in 2021, with more than 220 publications per year. In January 2022, the number of publications was only 15, and the growth is predicted to continue. This

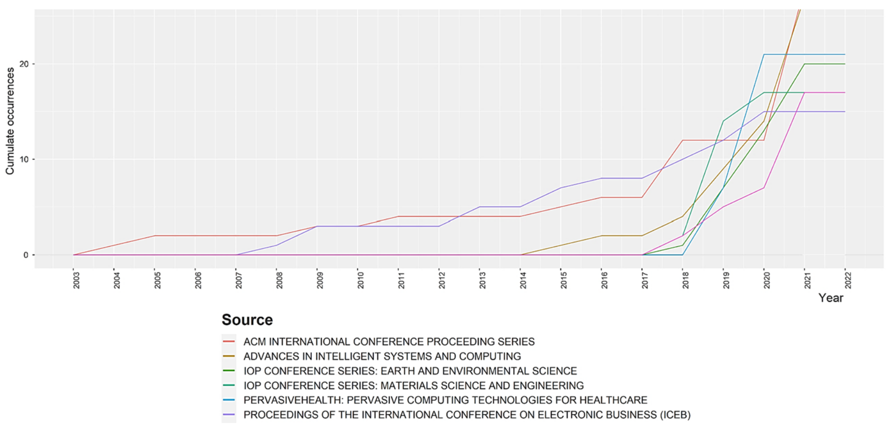



**Fig. 3** The cumulative growth of the documents in the top 7 sources in the dataset

indicates the rise of academia and industry's interest in the challenges and issues in the field of agricultural e-commerce.

Scrutinizing the growth, Fig. 3 exhibits the cumulative growth of the documents in the top 7 related sources in the dataset. The publication growth of the ACM International Conference Proceeding Series source was the highest among all the sources. It is worth mentioning that the growth of this source started the earliest among the top 7 sources in 2004, and four of these sources started their publications after 2017. The Journal of Advances in Intelligent Systems and Computing recorded the second-highest growth, which started publication in 2014 only. Other sources' growth rates were very similar.

### 3.4 The top 15 impacting sources

There are only a few metrics that measure the impact of scientific sources. By utilizing multiple metrics, this section provides a complete picture of source impact and productivity in the field of agricultural e-commerce. The analyzed dataset contains 811 sources; about half of them (375) published only one literature item. The top 15 sources published more than 7% of the analyzed dataset. These results indicate that there is more diversity among the sources of publications than concentration. Table 4 enumerates the top 15 scientific sources with their h-index, g-index, number of publications (NP), total citations (TC), and publication year started (PYS). The highest number of publications was by the *Sustainability* journal, which published 13 documents in the field of agricultural e-commerce. This

**Table 4** The h-index, g-index, NP, TC, and PYS for the top 15 sources publishing literature on agricultural e-commerce

| Source | h-index | g-index | NP | TC | PYS |
|---|---|---|---|---|---|
| Sustainability | 4 | 13 | 15 | 188 | 2018 |
| British food Journal | 7 | 12 | 12 | 162 | 2016 |
| Journal of Retailing and Consumer Services | 6 | 8 | 8 | 280 | 2003 |
| ACM International Conference Proceeding Series | 2 | 2 | 7 | 11 | 2009 |
| Advances in Intelligent Systems and Computing | 2 | 2 | 7 | 12 | 2016 |
| CEUR Workshop Proceedings | 3 | 4 | 7 | 22 | 2011 |
| Agris On-Line Papers in Economics and Informatics | 3 | 4 | 6 | 18 | 2012 |
| American Journal of Agricultural Economics | 4 | 6 | 6 | 130 | 2006 |
| IFIP Advances in Information and Communication Technology | 2 | 4 | 6 | 18 | 2007 |
| International Food and Agribusiness Management Review | 3 | 6 | 6 | 63 | 2005 |
| International Journal of Innovative Technology and Exploring Engineering | 2 | 2 | 5 | 10 | 2019 |
| China Agricultural Economic Review | 4 | 4 | 4 | 47 | 2019 |
| Computers and Electronics in Agriculture | 4 | 4 | 4 | 70 | 2005 |
| International Journal of Information Management | 4 | 4 | 4 | 123 | 2019 |
| IOP Conference Series: Earth and Environmental Science | 2 | 2 | 4 | 6 | 2019 |

source also has the highest g-index (13) and the second-highest citation number (188). After that, the *Journal of Retailing and Consumer Services* received 280 citations. This indicates the dominance of this source in the field of agricultural e-commerce, even though it only started publishing in this field in 2018. The *British Food Journal* recorded the highest h-index (7), followed by the *Journal of Retailing and Consumer Services* (6). The second-highest number of publications was the *Journal of Retailing and Consumer Services*, followed by the Science of the *British Food Journal*. These three sources appear in all top 3 based on all metrics indicating their dominance. It is worth mentioning that *Information and Software Technology* journal received the third-highest number of citations, even though it has only 1 publication in this field.

### 3.5 Top cited literature items

This section analyzes the citation metric, which is essentially the total citations received for a document since its publication. It also calculates the two types of citation: local citation (LC) and global citation (GC). The local citation is the total citation of an article within the analyzed dataset, whereas the global citation is the overall citation from all sources. Table 5 enumerates the top 20 locally cited publications with global citation scores. The sort of the items is based on their local citation score, which does not reflect their global citation score. The normalized citation score is the actual count of citing a literature item by the expected citation rate for literature items in the same year of publication. Some researchers argue that the citation count does not indicate the impact of the literature as the normalized citation metric [12]. More than 50% of the documents in the analyzed dataset have received no global citation until the time of writing this paper. In fact, less than 250 documents received at least the average citation per document of the analyzed dataset, which was 4.088. The article with the highest citation is entitled “Competitive Factors of the Agro-Food E-Commerce” and has received the highest local citation number with 7 citations and only 18 global citations. It is worth noting that the article “From Land Consolidation and Food Safety to Taobao Villages and Alternative Food Networks: Four Components of China’s Dynamic Agri-Rural Innovation System” obtained the highest normalized local citation score, even though it has only received 1 local citation and 2 global citations. Notably, among the top 2 publications, 16 were published in 5 years, indicating the increase in academic interest in agricultural e-commerce.

### 3.6 Top contributing affiliations

The publication count metric of affiliations measures its academic contribution and impact on the research field of agricultural e-commerce. It is merely the count of the number of literature outputs by academic authors affiliated with an academic institution. Figure 4 illustrates the top 15 affiliations and the number

**Table 5** The top 20 local cited articles, their global citation, and their normalized local citation scores

| Title | Year | LC | GC | NLC |
|---|---|---|---|---|
| Competitive Factors of the Agro-Food E-Commerce | 2011 | 7 | 18 | 49 |
| Rural cooperatives in the digital age: An analysis of the Internet presence and degree of maturity of agri-food cooperatives' e-commerce | 2020 | 3 | 23 | 57.3 |
| An Economic Model of the Evolution of Food Retail and Supply Chains from Traditional Shops to Supermarkets to E-Commerce | 2018 | 3 | 23 | 43.5 |
| An empirical framework developed for selecting B2B e-business models: the case of Australian agribusiness firms | 2005 | 3 | 16 | 11.4 |
| Like throwing a piece of me away: How online and in-store grocery purchase channels affect consumers' food waste | 2018 | 3 | 14 | 43.5 |
| Online Grocery Retailing in Germany: An Explorative Analysis | 2017 | 2 | 15 | 50.5 |
| Was the economics of information approach wrong all the way? Evidence from German grocery r(E)tailing | 2017 | 2 | 12 | 50.5 |
| The spatial aggregation of rural e-commerce in China: An empirical investigation into Taobao Villages | 2020 | 2 | 7 | 38.2 |
| Electronic Trade in Foods from the Customer's Perspective | 2016 | 2 | 2 | 58 |
| Consumers' perceptions, purchase intention, and willingness to pay a premium price for safe vegetables: A case study of Beijing, China | 2018 | 1 | 62 | 14.5 |
| The changing role of information technology in food and beverage logistics management: beverage network optimization using intelligent agent technology | 2005 | 1 | 44 | 3.8 |
| Edible processed insects from e-commerce: Food safety with a focus on the Bacillus cereus group | 2018 | 1 | 28 | 14.5 |
| Towards food platforms? An analysis of online food provisioning services in Italy | 2020 | 1 | 11 | 19.1 |
| Are Ex-Ante Hypothetical Bias Calibration Methods Context Dependent? Evidence from Online Food Shoppers in China | 2019 | 1 | 9 | 158 |
| In search of the 'good life': Understanding online grocery shopping and everyday mobility as social practices | 2020 | 1 | 9 | 19.1 |
| The impact of e-commerce capabilities on agricultural firms' performance gains: the mediating role of organizational agility | 2020 | 1 | 6 | 19.1 |
| Research on spatial spillover effect of E-commerce information system in China's agricultural industry | 2020 | 1 | 3 | 19.1 |

**Table 5** (continued)

| Title | Year | LC | GC | NLC |
|---|---|---|---|---|
| From Land Consolidation and Food Safety to Taobao Villages and Alternative Food Networks: Four Components of China's Dynamic Agri-Rural Innovation System | 2021 | 1 | 2 | 229 |
| Applying Rough Set Theory to Evaluate Network Marketing Performance of China's Agricultural Products | 2010 | 1 | 2 | 37 |
| An Evolutionary Game Model for Online Food Safety Governance Under Two Different Circumstance | 2020 | 1 | 2 | 19.1 |

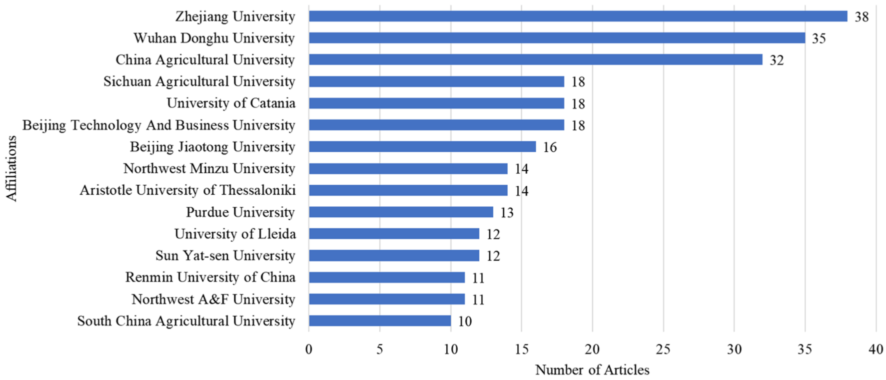



**Fig. 4** The top 15 contributing affiliations

of documents published by their academic staff. The total number of affiliations in the analyzed dataset was 1,439, more than 56% of which contributed to one document only. The Zhejiang University from China recorded the highest number of publications, followed by Wuhan Donghu University and China Agricultural University, with a noticeable difference from other affiliations. In fact, the total number of documents published by these top 15 affiliations is about 21%, which is a remarkable contribution considering that they constitute only 1% of the total contributed affiliations. Among the top 15 contributed affiliations, 11 are in China, 1 is in Greece, Italy, Spain, and the USA. This indicates that the focus of developing countries in the field of agricultural e-commerce is significantly higher than that of developed countries. The following sections analyze the countries' contributions in detail.

### 3.7 Authors

Various metrics measure the scientific production and impact of the authors, such as article count, citation count, h-index, g-index, and article fractionalization. This section addresses the analysis of these metrics and highlights the topic of 5 contributing authors in the field of agricultural e-commerce, as enumerated in.

**Table 6** The top 5 authors based on the publication number, with their h-index, g-index, TC, article fractionalization score, and PYS

| Author | NP | h_index | g_index | TC | AF | PYS |
|---|---|---|---|---|---|---|
| Alessandro Scuderi | 6 | 3 | 5 | 32 | 3.08 | 2011 |
| Luisa Sturiale | 6 | 3 | 5 | 31 | 3.17 | 2011 |
| Zacharoula Andreopoulou | 4 | 3 | 4 | 37 | 1.07 | 2011 |
| Judith Hillen | 3 | 2 | 3 | 10 | 3.5 | 2019 |
| Marta Arce-Urriza | 3 | 3 | 3 | 94 | 1.33 | 2010 |

Table 6. The article count and citation count are basically the total number of literature outputs by each author in the analyzed dataset. Many researchers argued that the mere count does not reflect the actual impact of the author because each authored or co-authored article gets a score for each literature item, disregarding the number of co-authors the article has. For this reason, the article fractionalization metric divides the contribution among co-authors. It gives each author or co-author a score of 1 divided by the number of authors an article has. This metric has been used in several journals and institutions, such as *Nature* [59]. The other two commonly used metrics are the h-index and the g-index. The h-index is "A scientist has index h if h of his/her number of papers (Np) have at least h citations each, and the other (Np – h) papers have no more than h citations each" [37]. The g-index is an improvement of the h-index metric, which is "given a set of articles ranked in decreasing order of the number of citations that they received, the g-index is the unique largest number such that the top g articles received together at least $g^2$ citations" [28].

By investigating the results of these metrics on the analyzed dataset, we noticed a few worth mentioning information. Over 92% of the authors have only one publication in the field of agricultural e-commerce, and about 96% of the authors have less than 1 article fractionalization. This raises the question of whether academic authors published many unique articles or merely appeared to do so through co-authoring without an actual increase in their contributions. In fact, the lowest article fractionalization in the analyzed dataset was 0.1, which means there were 10 co-authors for a single literature item. The author Judith Hillen from the Agroscope research institute has the highest article fractionalization with 3.5, followed by Luisa Sturiale with 3.17. Alessandro Scuderi and Luisa Sturiale scored the highest number of publications from the University of Catania. Each Andrew Cimino, Francesco Marcelloni, and Andrea Tomasi received the most citation score, with 189. These results indicate that there is no dominant author in the field of agricultural e-commerce.

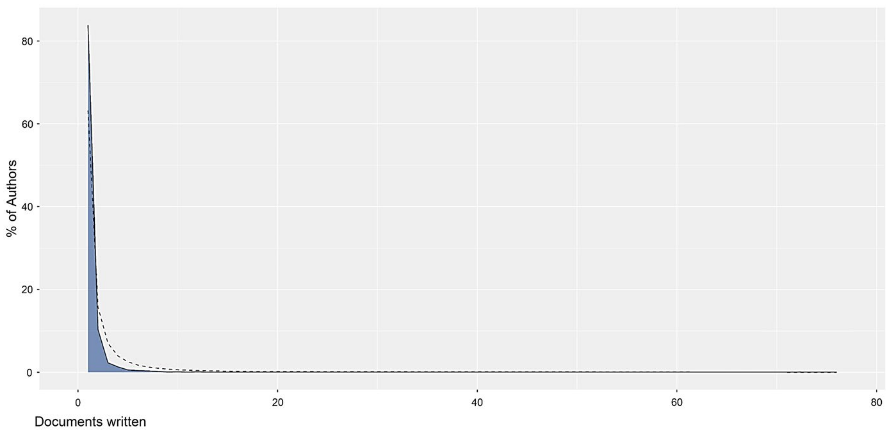



**Fig. 5** Frequency distribution of publications in the analyzed dataset through Lotka's law

Figure 5 supports the arguments mentioned above of whether academic authors published many unique articles or merely appeared to do so with the help of Lotka's law. Lotka's law is an application of Zipf's law that describes the frequency of published documents by authors and enables us to determine whether or not the analysed area is one in which the majority of production is concentrated in a small number of authors. The results of the analysed dataset in the field of agricultural e-commerce are diverse, with the majority of authors (about 90 per cent) having only one publication (2341 out of 2601). The distribution demonstrates that contributions to scientific publications are not concentrated among a small group of authors but rather are dispersed among the total number of authors. Figure 5 visualizes Lotka's law results on the analysed dataset and shows that the contribution of 90% of the authors was only by one document, while less than 8% of the contribution was by authors who contributed two documents.

## 3.8 Countries

### 3.8.1 Countries' impact and productivity

This section analyzes the impact and productivity of each country. The analysis of this section assigns each document to the country of its corresponding author only, which means one document is assigned only to one country. Assigning articles to a single country allows us to calculate both single country publications' (SCP) and multiple country publications' (MCP) metrics. By applying the MCP ratio, these metrics give us a better understanding of the countries' collaboration ratios. This section also addresses both the citation counts and the average citation counts per document metrics for each country, as Table 7 enumerates.

In order to understand the level of interest in the field of agricultural e-commerce in a different group of countries, the countries are grouped by their development in the above-mentioned metrics. Table 7 enumerates the top 10 contributed developing countries, and Table 8 enumerates the top 10 developed

**Table 7** Developing countries' contribution, SCP, MCP, MCP ratio, total citations, and average article citations of the top 10

| Developing country | NP | SCP | MCP | MCP ratio | Total citations |
|---|---|---|---|---|---|
| China | 458 | 422 | 36 | 0.0786 | 1348 |
| India | 59 | 56 | 3 | 0.0508 | 202 |
| Indonesia | 26 | 25 | 1 | 0.0385 | 21 |
| Korea | 22 | 19 | 3 | 0.1364 | 117 |
| Malaysia | 17 | 17 | 0 | 0 | 239 |
| Poland | 12 | 9 | 3 | 0.25 | 70 |
| Thailand | 10 | 9 | 1 | 0.1 | 2 |
| Iran | 9 | 8 | 1 | 0.1111 | 16 |
| Ukraine | 9 | 9 | 0 | 0 | 14 |
| Turkey | 8 | 8 | 0 | 0.000 | 24 |

**Table 8** Developed countries' contribution, SCP, MCP, MCP ratio, total citations, and average article citations of the top 10

| Developed Country | NP | SCP | MCP | MCP ratio | Total citations |
|---|---|---|---|---|---|
| USA | 74 | 65 | 9 | 0.1216 | 631 |
| Italy | 30 | 30 | 0 | 0 | 374 |
| Spain | 23 | 22 | 1 | 0.0435 | 164 |
| United Kingdom | 19 | 18 | 1 | 0.0526 | 194 |
| Germany | 17 | 16 | 1 | 0.0588 | 101 |
| France | 15 | 10 | 5 | 0.3333 | 210 |
| Australia | 11 | 10 | 1 | 0.0909 | 106 |
| Greece | 9 | 8 | 1 | 0.1111 | 105 |
| Canada | 8 | 8 | 0 | 0 | 20 |
| Czech Republic | 8 | 8 | 0 | 0 | 9 |

countries. As a comparison, the contribution differences between developing and developed countries are noticeable. The top 10 developing countries produce almost 50% of the collected dataset, whereas the top 10 developed countries produce less than 17%. China publishes the highest number of documents in the analyzed dataset, which are 458 articles, followed by the United States, India, Italy, and Indonesia, which published 74, 59, 30, and 26, respectively. China received the highest number of citations, with 1,348, followed by the United States, Italy, and Malaysia, with 631, 374, and 239, respectively. Among the top 15 countries, France, Sweden, and Poland have the highest MCP ratio, with 0.33, 0.28, and 0.25, respectively. Italy, Malaysia, Ukraine, Canada, and the Czech Republic recorded zero MCP ratio, indicating that these countries' research works solo in agricultural e-commerce. Only 19% of the countries received zero citations. Given these factors, there is clearly no dominant country in the field of agricultural e-commerce.

### 3.8.2 Collaboration between countries

This section uses two-time frames to scrutinize the dynamics of collaboration between countries in the field over time: "2003–2016" and "2016–2022". This section uses the annual publication growth from Sect. 3.1 to define these time frames. Figure 6 illustrates both time frames by generating two choropleth maps based on the collaborations of the countries. The time frame from 2003 to 2016 shows only a few collaborations, mainly related to China, Spain, the United Kingdom, and the United States. The highest number of collaborations in this time frame was between Spain and the United Kingdom.

Many other collaborations emerged on the map in the time frame of "2016–2022". The majority of collaborations were related to China, the United Kingdom, Australia, and the United States. Unlike the previous time frame, the highest number of collaborations in this time frame was between China and the United States. It is also noticeable that Asia Pacific collaborations too increased in this time frame. For instance, the collaborations between China and India, Turkey and India, and

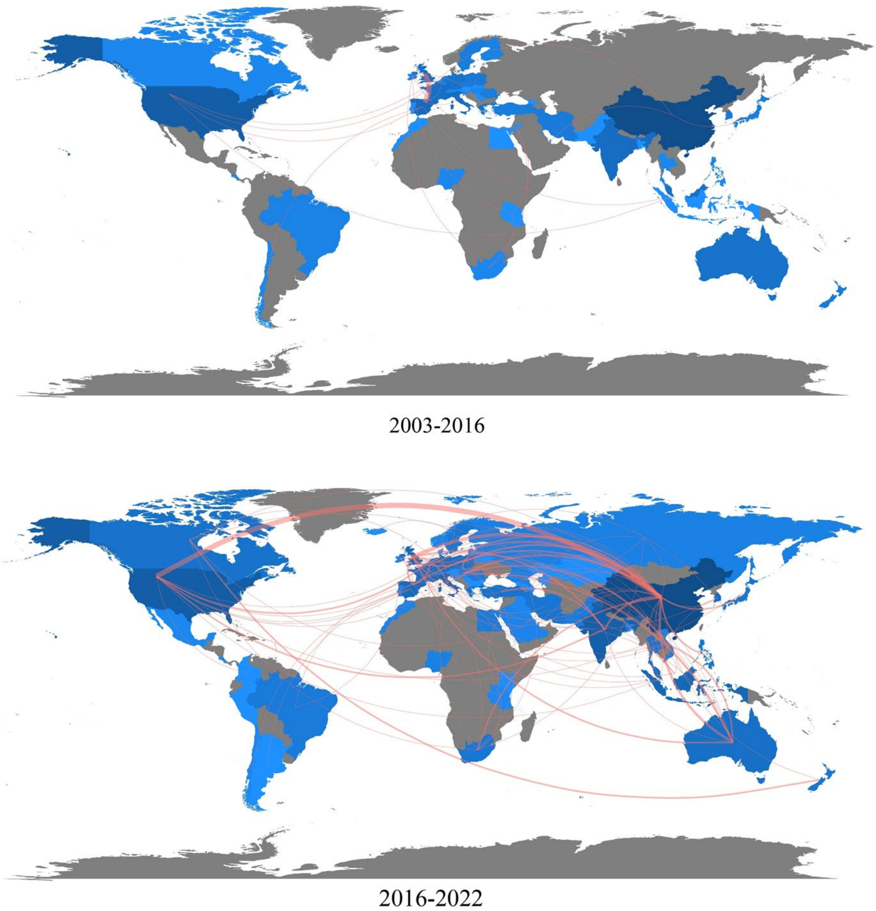



**Fig. 6** Dynamic analysis for the countries' collaboration represented by the choropleth map

**Table 9** Top 20 author-keywords occurrences

| Keyword | Occurrence | Keyword | Occurrence |
|---|---|---|---|
| Electronic commerce | 357 | On-demand delivery | 26 |
| Internet | 78 | Social media | 26 |
| Agricultural products | 73 | Trust | 25 |
| Internet of Things | 70 | Supply chain | 25 |
| Agriculture | 69 | Last-mile delivery | 25 |
| Blockchain | 32 | Covid-19 | 24 |
| Electronic commerce platform | 32 | Fresh agricultural products | 24 |
| Information technology | 29 | Standardization | 23 |
| Marketing | 28 | Big data | 22 |
| Information security | 27 | Asymmetry | 21 |

China and Malaysia. The density of collaborations between European countries also increased. Russia and the African countries tend to have lower collaborations in both time frames. This evaluation of the countries' collaborations suggests that the interest in the topic of agricultural e-commerce is growing within and between various countries, especially in China.

## 3.9 Content analysis

### 3.9.1 Author's keywords

Analyzing the content of the literature items based on the author keywords is essential to identify the focus of researchers on a set of research trends in the studies of agricultural e-commerce. Table 9 provides an initial overview by listing the top 20 keywords provided by the authors in their literature items and their occurrences across all the documents of the analyzed dataset. The total number of authors' keywords in the analyzed dataset is 3,325, over 82% of which only occur once in all the documents. They may indicate that the authors of this field tend to use uncommon keywords. The analyzed dataset most frequently used the keyword "Electronic commerce" as it appeared 357 times, followed by the keywords " Internet", " Agricultural products", and "agriculture", which appeared 68, 58, and 49 times, respectively. It is noticeable that few advanced technology terms appear on the list, such as "Internet of Things" and "Blockchain". The following Sect. (4.3) examines these

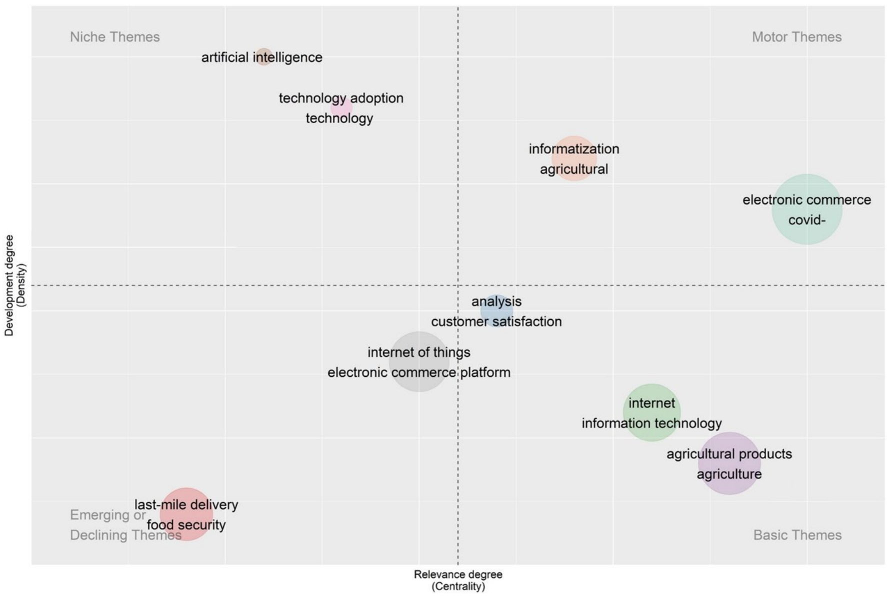



**Fig. 7** Thematic map of author-keywords in the field of agricultural e-commerce

technologies in the agricultural e-commerce field in detail based on these results. The top author keywords also include a few terms such as: "on-demand delivery", "fresh agricultural products", "trust", "last-mile delivery", "standardization", and "asymmetry". These terms signify the challenges that this field face. These challenges are addressed in the following sections (§4.2).

This section further investigates the authors' keywords by applying the thematic evaluation map. This evaluation is inspired by [18]. In this section, the thematic map visualizes four typologies of themes based on the authors' keywords network analysis and clustering, as illustrated in Fig. 7. The top-right quadrant theme is the motor theme, representing the high centrality and density keywords. "Informatization", " agricultural ", "electronic commerce", and "covid-19" are the keywords that tend to be the most developed in the field of agricultural e-commerce. Although the research on Covid-19 started in early 2020, the covid-19 keywords occur in this theme. This indicates the significant effect of the pandemic on the agricultural e-commerce field. The Niche theme contains a few technology terms such as "artificial intelligence", "technology adoption", and "technology". This theme indicates the high centrality and relevancy to the field of agricultural e-commerce; however, they are yet to be well developed. With reference to the bottom-right theme, terms such as "agricultural products", "agriculture", "internet", and "information technology" tend to have a high density among researchers, but they are still undeveloped and centralized. Finally, the bottom-left quadrant is called the emerging or declining theme. This theme contains challenges-related keywords such as "last-mile delivery" and "food security". This may indicate that the challenge of agricultural e-commerce is still emerging in the research, but it has irrelevant external links with other keywords. This theme also contains the IoT and e-commerce platform terms with a higher density and relevance degree. This raises the attention to enhancing the adoption of IoT technology in these agricultural e-commerce platforms, especially when it directly


**Fig. 8** Word-cloud of the most 100 frequent Keywords Plus

relates to the last-mile delivery and trust challenges, as the following section (4.3.2 illustrates.

### 3.9.2 Keywords plus

There are other alternatives to analyzing literature items' contents in the analyzed dataset, such as Keywords Plus. With the help of Thomson Reuters editorial experts, a special algorithm generates the Keywords Plus for each piece of literature based on its content and the titles of its references. The algorithm generates a normalized set of keywords, emphasizing the content of literature items in depth [22, 99].

This section uses two metrics to analyze and visualize the Keywords Plus. The first metric is the frequency evaluation of each keyword, which Fig. 8 illustrates using the word-cloud visualization. It is clearly shown that "agriculture" is the dominant Keywords Plus across the analyzed dataset, which is understandable since it is the keyword in the research query. Other keywords are prominent, such as "agricultural products", "online shopping", "artificial intelligence", "decision making", "customer satisfaction", "supply chain", and "websites". It seems that both the supply chain and the website development fields are very closely related to the field of agricultural e-commerce. Also, artificial intelligence and decision-making systems have significant attention in this field. This evaluation also shows a few interesting technologies that are related to this field, such as "Blockchain", "internet of things", "big data", and "data security". The following Sect. 4.3 investigates the utilization of such technologies in the field of agricultural e-commerce.

The second metric is the co-occurrence network analysis, which evaluates the collective relationship between the terms based on their paired presence within

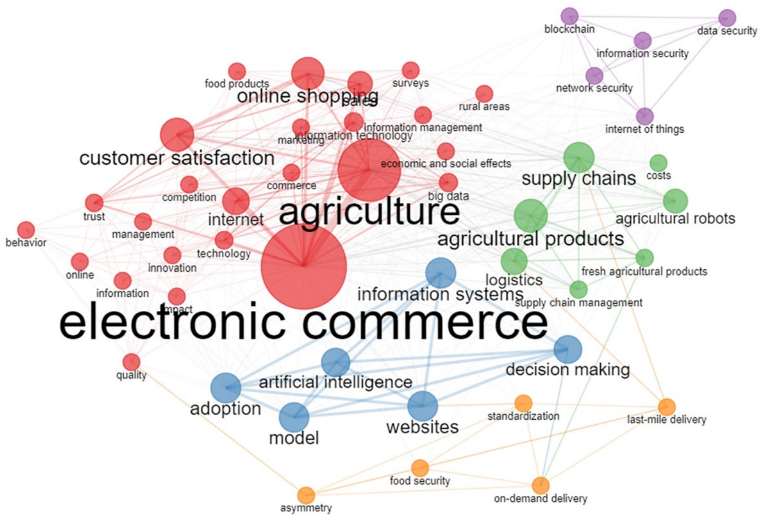



**Fig. 9** Co-occurrence between Keywords Plus shown in a network graph

the Keywords Plus. This section adopts the network graph approach to visualize and evaluate this metric. The graph clusters the Keywords Plus by colouring the nodes. Each node has its size, representing the node's weight in the graph. Also, each node has several edges with different thicknesses based on the bilateral co-occurrence weight with other nodes. The depiction of Keywords Plus and their co-occurrences are illustrated in Fig. 9.

Figure 9 groups the Keywords Plus into five clusters. The red cluster contains the highest number of keywords, with the "electronic commerce" and "agriculture" keywords dominating this cluster. Other keywords such as "online shopping", "internet", and "customer satisfaction" have a high weight, and the co-occurrence weight among them is high. These results also show the relationship between "customer satisfaction", which consider a challenge for e-commerce agribusiness, and "trust", "quality", "technology", and "behaviour". This relationship highlighted the importance of customer satisfaction as a challenge for e-commerce agribusiness and the impact of trust, technology, and information to overcome this challenge. Another interesting relationship in this cluster is between "online shopping", "marketing", "information technology", "information management", "economic and social affects", and "big data". The relationship indicates the impact and effect of these terms on online shopping.

The second cluster is the green one, which contains no dominant keyword. This cluster contains supply chain-related terms, such as fresh agricultural products, logistics, and costs. It clearly indicates that the freshness of agricultural products is bound with the supply chain issue. The third cluster is the blue cluster. The co-occurrence of this cluster's nodes is relatively high. This cluster contains terms related to technology adoption in this field, such as artificial intelligence, decision-making, and websites. The purple cluster is related to advanced technology terms like Blockchain and the Internet of Things. As the cluster illustrates, these two terms are bound with the security issue. These two clusters prove the correlation between these advanced technologies and agricultural e-commerce. This correlation

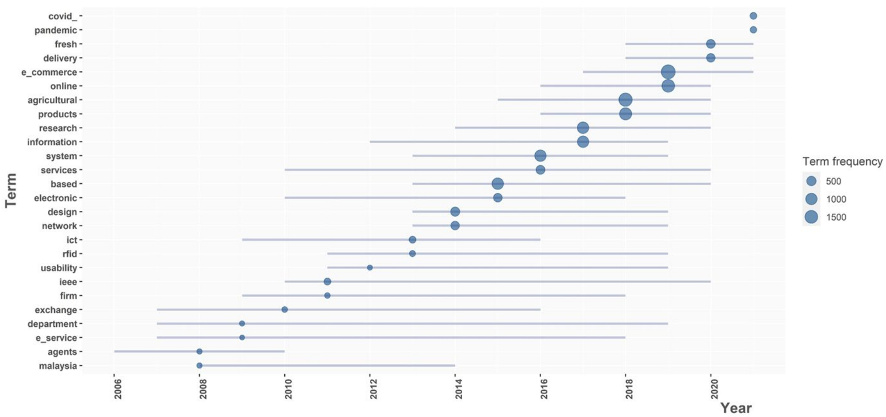



**Fig. 10** Trend Topics over time for the analyzed dataset

is addressed in detail in the following sections. Finally, the orange cluster contains a few keywords related to the challenges of this field, and they have low co-occurrences with the other nodes.

#### 3.9.3 Abstract contents

Article abstracts provide a full and comprehensive summary of the literature. They usually contain the research problem and the study's overall aim, a brief methodology design, and the literature's main findings. Analyzing the contents of these abstracts gives us a rich and effective understanding of the research trends and defines the shortcomings of the agricultural e-commerce field.

This section extracts the topic trends of the literature items' abstracts by benefitting from the better means of Natural Language Processing (NLP). This analysis uses both the 1-gram (unigram) and the tokenization models to preprocess the data of the abstracts. Figure 10 depicts the topic trends that have been drawn from the abstracts of the literature items. The line represents a topic trend timeline, and the circle radius is proportional to the number of documents that follow a topic trend. The darker the circle's colour, the higher the number of citations that a topic trend received. The topic two topics each year are represented; however, the topic frequency must exceed 25 times to be presented in the graph. The trend started in 2008 only with the "Malaysia" and "agents" topics. The trend of topics then evolute to represent the related to the Internet of Things (IoT) technology in 2013, which was the beginning of the IoT research trend overall. The online shopping and online delivery trend started after 2015. In 2018, the freshness of agriproducts seemed to be the attention of the research in the agricultural e-commerce field. The Covid-19 and pandemic trends started in 2020, which is expectable since the pandemic has a severe effect on almost every field.

## 4 Agricultural E-commerce

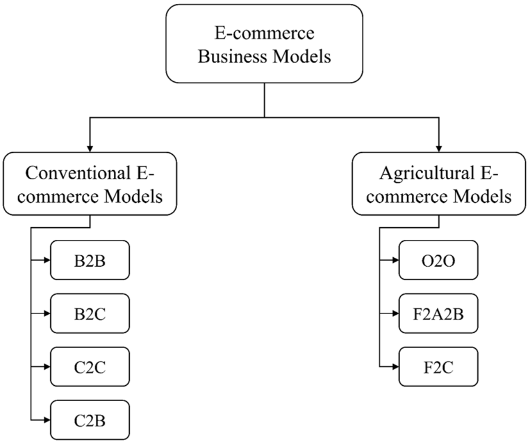
Electronic commerce, referred to as e-commerce, includes business activities for both consumers and suppliers. E-commerce business activities are more complex than traditional commerce. This is due to several service providers' involvement in finance, infrastructure, logistics, marketing, online payment, credit certification, and technology. In 2020, the e-commerce market share was 4.28 trillion US dollars and was predicted to grow to 5.4 trillion US dollars in 2022 [17]. In fact, during the recent COVID-19 pandemic, the significant impact of e-commerce on all products becomes apparent, especially agricultural products [36].

The field of agriculture plays an essential role in the national economy, and the enhancement of this field has become a necessary responsibility for both developed and developing countries. The market share of agriculture was 3.6 trillion US dollars in 2020, and it likely increases in the future [39]. Agricultural e-commerce is a multidisciplinary field that aims to facilitate the buying and selling agricultural products and goods over the Internet. Although the agricultural industry, and many other industries, benefited from e-commerce technology, agriproducts have particular complications that general e-commerce platforms cannot address.

Agricultural products are sophisticated and highly perishable, bringing high transportation, storage, and delivery constraints [77]. After yielding agriproducts, farmers have a limited amount of time. Furthermore, due to the geographical separation between the source of agriproducts and consumers, it is challenging for farmers to find their consumers, except with the help of intermediate distributors such as e-commerce [11, 50]. There are limited e-commerce platforms that support agriproducts. Also, the e-commerce platforms that support agriproducts rely on third-party logistics distributors, increasing delivery time. This delay negatively affects the freshness and quality of agricultural products. All in all, this resulted in dissatisfaction of the consumers about the agriproducts, and therefore, a loss for farmers and e-commerce platforms. This unsatisfaction makes traditional e-commerce unable to meet the fierce market constraints on agriproducts [98].

Agricultural products and services complication requires a special e-commerce, agricultural e-commerce. Agricultural e-commerce considers the constraints of buying and selling agricultural products and services to provide an efficient and suitable platform. Such platforms are essential in order to grow agricultural economic development, improve the flow of agricultural information, and expand the agricultural market [21, 34]. In fact, agricultural e-commerce has several astonishing advantages, which are: (a) greater information exchange; (b) improve farming techniques and best practices which enhance the yield and reduce the cost of inefficiency [58]; (c) increase productivity and predicting the agriproducts supply and demand which to an extent fight against food insecurity and reduce wastage [29, 43]; (d) facilitate e-trading of aquatic products, whole grains, and fresh commodities [51]; (e) minimizing logistics distribution intermediaries and transaction costs; (f) overcoming asymmetric information of agricultural products and services [34].

**Fig. 11** Taxonomy of E-commerce business models



### 4.1 Agricultural e-commerce categories

Due to the differences and the needs of agricultural e-commerce, few business models have emerged the common models. Literature research adopts the common models for e-commerce, which are Business-to-Business (B2B), Business-to-Consumer (B2C), Consumer-to-Consumer (C2C), and Consumer-to-Business (C2B) [60]. Qin et al. address these categories in detail [66]. However, these models fail to fulfil the requirements of agricultural e-commerce, which raise the need for new models. Examples of such new models that previous studies proposed are Farmer to Consumer (F2C), Farmer to Association to Business (F2A2B), and Online to Offline (O2O). Figure 11 illustrates the taxonomy of e-commerce business models that literature research adopts. The following subsections address these emerging business models, benefits, and challenges. The suitability of each model regarding the product type, type of buyers, supply chain models, and target markets are also addressed.

#### 4.1.1 Farmer to consumer model

The Farmer to Consumer (F2C) model is developed between the farmer and consumers and refers to the farm's direct supply mode. This model is a unique combination of B2C and C2C business models, where Farmer can reach potential consumers without intermediaries. This model is suitable for targeting the domestic market, where it faces severe problems targeting the export market. The buyers in this model are mostly the consumers themselves rather than businesses and associations. The characteristics of this model facilitate small agricultural businesses, family farmers, or even a single farmer to act as a Farmer in this model [42]. The model is also suitable for fresh, organic, and raw material agriproducts, which consider essential points in agricultural e-commerce. This model creates a new and helpful channel between farmers and consumers by providing direct supply and sales. This channel reduces the circulation costs and the gap between agriproducts and consumers and eliminates intermediaries [74]. It also, to some extent, reduces the need for physical agriproducts markets and avoids the situation of regional oversupply [38].

This model, however, raises a few challenges, such as legal regulations due to direct marketing, where farmers are required to register and license their businesses [89]. This model also created challenges regarding farmers' personal skills, especially the ability to communicate with consumers using traditional or technological channels.

#### 4.1.2 Farmer to association to business model

The Farmer to Association to Business (F2A2B) model has been used recently in the Chinese market. It is also referred to as the Peasants to Cooperative to Business (P2C2B) model [87]. This model involves agricultural associations and professional cooperative organizations. These agrarian associations and cooperatives play a paramount role in organizing the production of farmers and peasants by applying the agricultural market supply and demand insights. They also provide agricultural technical guidance for peasants and establish a traceability system for agriproducts to assure their quality. Supporting these peasants enhances the fair market competitiveness for those farmers and peasants [42]. This model is suitable for targeting both domestic and export markets with the help of associations and cooperatives. The buyers in this model are mostly the consumers and can support the small agribusiness industry. The characteristics of this model facilitate small to large-scale agricultural enterprises with fair market competitiveness. The model is more suitable for processed agricultural products rather than fresh and organic agriproducts, especially if the target is export market.

These agricultural associations and cooperatives can also play as a third party in the market on behalf of the farmers and peasants [54]. This step allows farmers and peasants to focus on their production. At the same time, agricultural associations and cooperatives concentrate on marketing, packing, and building a self-logistic service based on consumers' particular needs. These agricultural associations and cooperatives act as the third party to assure the interests of farmers and peasants by guiding their production and accelerating their pace of agricultural industrialization. Despite these benefits, this model faces a few challenges in terms of the ability of the agricultural associations and cooperatives to keep pace with the technology development [19].

### 4.1.3 Online to offline model

The Online to Offline model (O2O) concept uses online agricultural e-commerce to entice consumers to purchase agriproducts using offline methods [42]. O2O model is a unique form of Business to Customer (B2C) model to create a simplified and convenient model for consumers to purchase agriproducts. In this model, consumers can shop, order, and get information about agricultural products and services using agricultural e-commerce, while payments and logistics are completed offline. This model results in a convenient, trustworthy, and secure consumer experience. Several agricultural industries have adopted this model, especially in China [56]. This model is suitable for targeting only the domestic market, while it faces severe problems targeting the export market. The buyers in this model are mostly the consumers, and the sellers can be small businesses and family farmers. The model is also suitable for all agriproducts, however, this may vary since this model mainly relies on the used offline delivery method.

Social media, such as Instagram, LinkedIn, Twitter, WeChat, and Facebook, played a significant role in developing the O2O model and became important channels for agriproducts [76]. Using the O2O for agriproducts emerges a few challenges, such as brand building, whereas sellers on social media require accurate positioning of customer groups in order to establish customer awareness of their brand, thus reducing the trust risks. This model also raises the delivery and distribution challenges of the agriproducts since the O2O model does not include a supply chain. This model's lack of regulation and monitoring may result in an uneven distribution of benefits and information asymmetry [88]. These challenges are addressed in the following Sect. 4.2.

### 4.2 Challenges

The findings of analyzing the collected dataset (Sect. 3.4) highlighted a few challenges that have been addressed in the agricultural e-commerce field. E-commerce, in general, faces several challenges due to technical, business, logistics, and economic factors. Such challenges include pricing mechanisms, privacy and security, and supply and demand prediction [8]; [31]. Agricultural e-commerce also faces these common challenges, besides a few more challenges handling agriproducts.

This section sheds light on these special challenges regarding agricultural products. The literature on agricultural e-commerce addresses several issues and challenges from different perspectives. This study addresses the challenges brought up from the consumers' and farmers' perspectives, and only the ones associated with the marketing and shipment business processes, independent of the utilised value chain model. This study synthesis these challenges in the following points:

#### 4.2.1 Demanding delivery time

This challenge is related to the "on-demand delivery" keyword in the top 20 author keywords. Agricultural e-commerce requires shortening agricultural product circulation time, especially for cold chain transportation systems [50]. Such products include fresh meat, fresh berries, and fresh milk. The current solutions focus on increasing the route frequency of deliveries, which causes a high operational cost, especially for small orders [91]. The delivery time influences consumers' decisions to purchase products [31]. Shortening delivery time is essential to enhance agricultural e-commerce platforms, increasing consumer satisfaction and trust. Agricultural e-commerce can optimize the delivery route using IoT technology and big data, thus shortening the time [10]. They can also provide purchasing agriproducts prior to the harvest process by using smart farms, eliminating the waiting time after the harvest process.

#### 4.2.2 Insecurity and untrustworthiness

The other challenges mentioned in this section all affect the trust and insecurity of consumers to buy agriproducts from agricultural e-commerce. This challenge is related to the "trust" keyword in the top 20 author keywords. Although existing e-commerce platforms focus on increasing the trustworthiness of their platforms among consumers, consumers often feel insecure about purchasing through e-commerce, especially food and agriproducts [53]. For instance, given the unpredictable physical look of fresh produce, most consumers still choose to purchase agriproducts in person rather than online [43]. Insecure and untrustworthy are the most common reasons for customers not purchasing agriproducts on agricultural e-commerce. These reasons increase the importance of facing all the current challenges to provide a trustworthy marketplace for consumers. Solving the challenges mentioned above by using advanced technologies increases the trustworthiness of agricultural e-commerce.

### 4.2.3 Last-mile problem

Existing agricultural e-commerce platforms use data analysis and data mining to overcome the last-mile challenges. The term "last mile" is used in logistics to refer to the final leg of delivery, which includes the movement of products between a transportation hub and a consumer location. This term occurs as the "last-mile delivery" keyword in the top 20 author-keywords. These platforms use many services to improve the solutions to the last-mile challenge, such as real-time status updates, proof of delivery, and audit key metrics. However, the cost of last-mile delivery is still high and causes severe issues for current e-commerce platforms. Although this challenge is common in the e-commerce logistics process, agricultural products increase their severity due to the characteristics of agriproducts (Joiner & Okeleke, [43, 91 , 98, 100]. Solving this challenge is significant for agricultural e-commerce to provide cost-efficiency, and energy reduction, thus green manufacturing and clean production [20, 27]. Applying advanced technologies such as IoT and big data can notably decrease the cost of last-mile delivery, thus increasing these platforms' profit. United Parcel Service (UPS) saved millions of dollars by applying big data and IoT to their system (ORION). This system also helps the UPS company save over 39 million gallons of fuel every year and reduce engine idle time by 10 million minutes [69].

### 4.2.4 Perishability and freshness

Freshness is a major focus in the research in this field. The findings show that the keyword "fresh agricultural products" occurs in the top 20 author-keywords and the keywords plus. The current practice of delivering agriproducts begins with picking, harvesting, storing, and promoting on e-commerce. After the products are ordered, the cultivators then prepare the order for shipping inventory. This process may be efficient for long shelf-life agriproducts such as potatoes, onions, and peanuts. However, many agriproducts, such as fresh meats and fruits, are perishable over a short time. These perishable agriproducts have certain hindrances due to the perishability and complexity of such products, which current systems are unable to overcome [71, 92]. Also, different agricultural products have other characteristics, which add an extra burden to the logistics process [21, 43]. Since the freshness of agriproducts is essential for consumers in agricultural e-commerce platforms, this constitutes one of their significant challenges. Agricultural e-commerce, with the help of advanced technologies, shortens the delivery processes of perishable agriproducts. For instance, linking the IoT technology with the agricultural e-commerce platform allows cultivators to promote and sell agriproducts before harvesting them. This step reduces the period between harvesting the products and receiving them by the consumers, thereby delivering more fresh products.

#### 4.2.5 Standardization

Although standardization attracted the researcher's attention in the analyzed dataset and was one of the top 20 author-keywords, the agricultural products in current online marketplaces lack standardization [56, 77]. For instance, fruits in e-commerce platforms have variant colours, freshness, shapes, tastes, and nutrition. Standardization in agriculture combines agricultural science, technology, and managerial techniques with the promotion of agricultural technology, business activities, production activities, and standardization management, in line with the unified administrative requirements and techniques of agricultural production [14]. This lack of standardization is due to the characteristics of agriproducts, which are cyclical, regional, and seasonal [52]. Another reason is the lack of market concept and market information of small and individual farms, which causes a random and uneven quality of agricultural production [40]. Solving this challenge is essential for agricultural e-commerce to bring scalability, portability, and affordability to their businesses [77]. By using Blockchain technology, agricultural e-commerce is able to involve cooperative organizations. These organizations may provide the necessary standardization for cultivators and farmers. Cooperative organizations can also play a monitoring role in ensuring agriproduct standardization and avoiding asymmetry of information.

#### 4.2.6 Information asymmetry

The findings showed that the keyword "asymmetry" occurs more than 20 times in author-keywords. Information asymmetry refers to the study of decisions in transactions where one party has more or better information than the other (Aboody & Lev, [1]). In agricultural e-commerce, the seller usually has more information about their agriproducts than the buyer. Although e-commerce platforms allow sellers to share information about their agriproducts' quality, nutrition, and source, buyers lack information. This lack of information is due to several reasons, including sellers being obsessed with their interests, irrational buyers, insufficient monitoring regulations by e-commerce platforms, and the lack of sellers' moral and legal understanding [55]. The influence of moral hazard issues arising from asymmetric information on trust in e-commerce may negatively affect the virtual market's survival [9, 25]. This issue has become a fundamental cause of agriproducts' quality and safety [106]. Agricultural e-commerce has to effectively share the information from the origin farms with the supplier and consumers [98]. This is challenging due to fluctuating agricultural product and service information [98]. By benefiting from the immutability transparency of Blockchain technologies, cooperative organizations and third-party services are able to monitor and supervise agriproducts' information to avoid information asymmetry. Additionally, providing real-time information of products in a smart farm is possible with the help of IoT technology, which reduces the information asymmetry between sellers and buyers of agricultural e-commerce [96].

### 4.3 Utilities of advanced technologies as a solution

Agriculture and e-commerce fields, in general, benefit from several technologies. These technologies facilitate the process, enhance effectiveness, solve challenges, or provide new solutions. Such technologies include sensors, GIS, recommendation systems, decision support systems, semantic web, data mining and inventory, big data, the Internet of things, and Blockchain. Most of these technologies interfere with each process of both agriculture and e-commerce fields. This section sheds light on advanced technologies that appeared in the analysis of the literature items dataset in the field of agricultural e-commerce. Based on the finding of the content analysis (ꞵ3.4), the research focuses on both Blockchain and IoT technologies. This section addresses the utilization of both technologies and their benefits in this field. Notice that the given solutions of utilizing the advanced technologies are generic as a unifying construct for agricultural e-commerce, regardless of the countries, actors, type of products, level of processing, and usage.

#### 4.3.1 Blockchain

Blockchain technology tends to appear in all content analyses of the analyzed dataset. This technology is decentralized, innovative, and distributive and maintains the availability, transparency, and integrity of all data in the network (Dutta et al., [26]). Agricultural e-commerce is one of the beneficial fields of this technology and its applications.

There are many utilities of Blockchain technologies in agriculture in general and the field of agricultural e-commerce in specific. Such general utilities include food safety and traceability, improving visibility for the food supply chain, and commodity management platforms for agricultural products. Although these applications benefited the agriculture industry in general, the utilization of Blockchain in the agricultural e-commerce field was outweighed. Blockchain applications in this field can improve consumer surplus and social welfare (Dutta et al., [26]). There are two main drawbacks of utilizing Blockchain technology; it is still in its infancy and does not integrate directly with existing legacy systems [91]. The following sub-sections address each utilization and its benefits.

#### 4.3.2 Data storage

E-commerce customers tend to require trust to purchase products online. Data is essential to build successful and trustworthy agricultural products. Trustworthy data provides several insightful knowledge to all stakeholders of agricultural e-commerce. Examples of such knowledge are sources and nutrition information of agriproducts, farm monitoring, product and purchase traceability, market analysis, and decision-making. In order to achieve this trustworthiness, the data of agriproducts, farms, stakeholders, orders, and consumers must be secured, trusted, and unmodified. It is challenging for agricultural e-commerce to provide such data, which raises a severe issue [61]. Utilizing distributed ledger technology can provide the required secure data.

Blockchain technology is a distributed ledger which can act as a database to store and retrieve data. By creating distributed and shared databases for agricultural e-commerce, users can ensure data validity with the help of data encryption. The ledger provides private key encryption, a powerful tool that provides authentication requirements [93]. Therefore, it links the data of all aspects of planting and harvesting agricultural products safely and unchangeably [91]. The data will be unaltered and uncorrupted, which makes it immutable. The immutable data provided trusted and confirmed data to the consumers by tracking the provenance of the purchased agricultural products.

#### 4.3.3 Logistics process

Logistics in e-commerce is one of the main processes involving several tasks, such as picking, storing, and shipping inventory for the online marketplace. Logistics in agricultural e-commerce additionally involve the harvesting task. Logistics faces many issues in agricultural e-commerce due to the complexity of handling perishable products. The agricultural products also increase the severity of the "last-mile" and reverse logistics problems. These issues cause massive operating costs for agricultural e-commerce companies, and avoiding them is essential [91]. The utilization of Blockchain technology shifts the entire logistics process system.

Blockchain-based product return management helps to enhance the reverse logistic processes by improving the trace of the location of the materials and authenticating all stakeholders involved in the recycling process [45, 46, 94]. This fosters sustainable reverse logistics and closed-loop for recycling, value recovery, and reuse, providing a circular economy, green manufacturing, and clean production [20, 27]. By benefiting the recycling, value recovery, and reuse process, Blockchain technology also enhances the last mile efficiency and affectivity [26]. The author [75] provides an in-depth discussion on the usage of Blockchain technology in the logistic process.

#### 4.3.4 Cryptocurrency-based online payment system

The majority of agricultural e-commerce platforms use e-payment systems, which refer to paperless monetary transactions. These platforms use several methods of e-payments, such as credit cards, debit cards, e-cheques, and e-wallet payments. Although such payment methods are secured and can protect against fraud and security threats, security breaches are possible. Examples of such breaches are viruses, worms, Trojan, denial-of-service attacks (DoS), phishing and pharming, Man-in-the-middle attacks, and spoofing attacks. Being vulnerable to such preaches negatively affects agricultural e-commerce platforms, so an alternative payment system is required.

Blockchain recorded the group of transactions, called blocks, as part of its database. These blocks are unaltered and uncorrupted, which makes Blockchain technology suitable for cryptocurrencies. Cryptographic currencies use complex encryption to provide a transparent money exchange for goods and services amongst their users. Cryptocurrencies benefit agricultural e-commerce by speeding up and simplifying payments in their platforms, especially cross-border payments [26]. Cryptocurrencies also enable automatic payment upon physical delivery of agricultural production, making the concept of "cash on delivery" more convenient and trustworthy for e-commerce companies [73]. Thiruchelvam et al. proposed an example of such agricultural e-commerce [80]. Using the cryptocurrency concept, agricultural e-commerce companies can also create complementary currency for their consumers' societies, such as commodity currency [3].

#### 4.3.5 Transactions through Blockchain.

Transactions of agricultural e-commerce include selling and purchasing agricultural products and services. These transactions occur between all stakeholders, such as farmers, consumers, third-party organizations, and governments. E-transactions are transactions conducted over the Internet, whether the payment is conducted online or offline [84]. Examples of e-transactions are ordering, payment, cancelling, and delivering transactions. Agricultural e-commerce platforms are based on e-transactions, which are important to be securely stored. Building these e-transactions based on secure and immune technology is essential.

As aforementioned, Blockchain recorded the group of transactions as part of its database. Using transactions based on the Blockchain provides agricultural e-commerce to enable digital assets. These assets can generate crypto stamp that replaces the physical stamp during circulation. Due to the Blockchain features, using such crypto stamps helps keep immutable, decentralized, and consensus records of all purchases of agricultural goods and services [95], increasing the transaction's credibility.

Using blockchain transactions also supports agricultural e-commerce systems in adopting sophisticated fractional calculus models [16], which secures the protocols of e-transactions and reduces the tracking cost and time of transactions [26, 105]. Such systems include the Belt and Road Blockchain Consortium [65] and the Agri-Digital platform [81]. Using such transaction in agricultural e-commerce eventually motivate users to recycle agricultural products and services through transaction-based reward programs such as tokens. This also impacts society positively [72].

#### 4.3.6 Internet of things

Internet of Things (IoT) is one of the identified trend topics in the analyzed dataset of agricultural e-commerce, which has been ranked as the fourth most used keyword in the literature items. The IoT generally uses smart monitoring, tracking, identification, and positioning. It also helps agricultural production by applying innovative farming systems to enhance agriproduct production and distribution quality. Applying IoT devices to collect and integrate data is convenient for larger farms; however, the expenses are inconvenient for small farms and agribusinesses [91]. The following sub-sections address each IoT utilisation in agricultural e-commerce and its benefits.

### 4.3.7 Traceability system

Traceability in agricultural e-commerce refers to retrieving and tracking each transaction made by any stakeholder of the platform. Establishing trust is a significant challenge for agricultural e-commerce, which is complex due to the characteristics of the agricultural product, and traceability is the key to solving this issue. Traceability in IoT includes not only delivery tracing but also commodities and farming tracing [71].

Farms powered by IoT provide real-time data of their agricultural products, even before crop picking and harvesting. This creates the opportunity for e-commerce to enable e-farm in their platform to simulate the ideal way for consumers to get agrifood by personally picking them at convenient farms. Since the ideal way is impossible for those living in urban areas, the e-farm simulation provides consumers with similar experiences. It gives all the necessary data of all agriproducts on the farm, enabling consumers to purchase these products before picking them and delivering them directly. This increases the satisfaction of the consumers and gains their trust [71]. This also significantly reduces the multiple intermediaries between farmers and consumers, reducing the expenses of the agriproducts and improving their freshness.

### 4.3.8 Logistics distribution

Logistics distribution in agricultural e-commerce, as aforementioned, involves harvesting, picking, storing, and shipping inventory for the online marketplace. The most critical element of an e-commerce logistics chain is its efficiency and simplicity. Besides benefiting from Blockchain technology, IoT technology also significantly improves efficiency and reduces agricultural e-commerce logistics chain costs. It also optimizes the agriproducts' logistics flow and tracks them in real time [79, 96].

Beyond profitability, the need to tackle the last mile is vital. Additionally, there are environmental impulses. By using RFID technology, consumers can trace the logistics flow of their agriproducts. This technology also empowers the IoT to innovate last-mile distribution of agricultural e-commerce logistics flow by using sensors to update delivery locations, destinations, and potential traffic impacts.

## 4.4 4.4. Proposed conceptual architecture

To elaborate on this study's proposed agricultural e-commerce conceptual architecture, we shed light on the current state-of-the-art literature's solutions and best practices. The literature addresses several aspects of the best practice of e-commerce in general. Examples of such common aspects are pricing mechanisms, branding, and the prediction of supply and demand [15]. Aside from the common aspects, this study focuses on agriproducts-related practices and solutions. The following points highlight the main aspects that the literature considered in order to build a best practice agricultural e-commerce solution. Some literature also addresses the other few aspects that may benefit agricultural e-commerce, such as brand awareness, payment systems, cash on delivery (Chen, [15]), and Internet talent enhancement [40].

### 4.4.1 Strength of logistics

The current literature acknowledges the importance of the logistics process and its effects on agricultural e-commerce [14, 42, 103]. Solving this challenge, especially the "last mile" dilemma, will be the key factor in developing a successful platform. As aforementioned, advanced technologies such as the Blockchain and IoT will expedite and facilitate the logistics process, reducing the cost and maintaining the freshness of the purchased agriproducts. To some extent, these reduce energy and fuel consumption [78].

### 4.4.2 Implementation of standardization

Standardization is one of the challenges that agricultural e-commerce is facing now. The current literature argues that the standards are prerequisites for providing consumers with trustworthy agricultural products and services [14]; [77]. The significance of standardization makes it an essential countermeasure in developing the best practices for agricultural e-commerce [104]. Cooperative organizations are responsible for generating, regulating, and monitoring such standards. Involving these organizations to achieve standardization is essential for agricultural e-commerce platforms.

### 4.4.3 Include information knowledge of agriproducts

The previous studies ensured the importance of sharing information and knowledge among stakeholders in agricultural e-commerce platforms. This information is related to both the farmers and the consumers. Farmers and cultivators require access to information about various crops, soil conditions, weather, and pesticides. Also, daily market information, such as minimum, maximum and modal prices for commodities and their varieties, is helpful for them [7]. Providing such information increases the awareness of farmers and cultivators and enlightens them to produce quality agriproducts and increase their profits.

Agricultural e-commerce also provides consumers with traceability logistics information, detailed product provenance information, nutrition, origin, and authenticity assurances. Such information increases the consumers' satisfaction and trust in agricultural e-commerce and, therefore, is a key success factor in creating agricultural e-commerce [106]. To some extent, this enhances food security for society [29], which helps achieve the SDGs.

### 4.4.4 Traceability e-commerce

An essential aspect of best practices is the ability of agricultural e-commerce to create a traceability information system for the logistics process [77]. With the help of

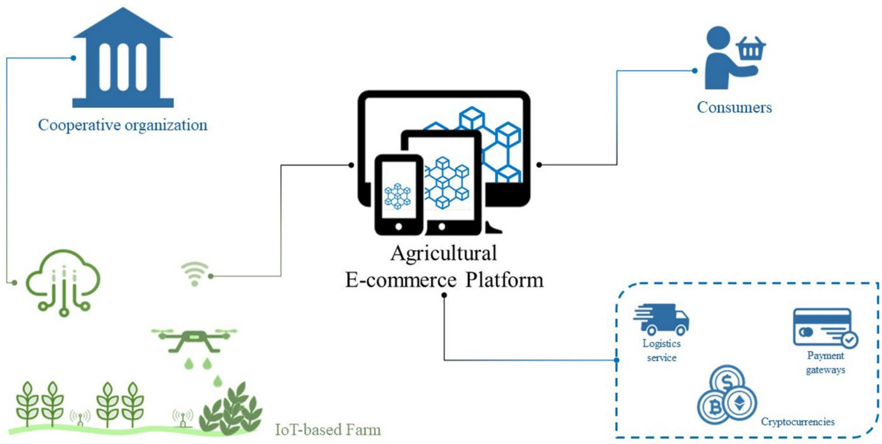



**Fig. 12** The conceptual architecture for agricultural e-commerce

IoT technology, providing accurate information on delivery estimation, location, and qualification of the purchased agriproducts is applicable [106]. Such information increases the traceability quality and, therefore, gains the consumers' trust. Consumers' trust is essential for successful agricultural e-commerce.

#### 4.4.5 Conceptual architecture

The proposed conceptual architecture of agricultural e-commerce is inspired by the aforementioned best practice aspects and solutions. The findings of the collected dataset indicate the important aspects in the field of agricultural e-commerce, which the proposed architecture addresses. It also relies on a few previous studies [67, 85, 102]. Although few previous studies proposed interesting architectures, these architectures missed one or more essential components of agricultural e-commerce. For instance, the authors of [23] only focus on data integration in blockchain architecture. The authors of [64] do not address advanced technologies, cooperatives, and farms in their architecture. Both authors of [33, 63] include the essential components of agricultural e-commerce, however, they have not addressed the significant role of agricultural associations and cooperative organizations.

The proposed conceptual architecture includes advanced Blockchain and IoT technologies, agricultural associations and cooperative organizations, stakeholders, third-party services, and consumers. Figure 12 illustrates the proposed agricultural e-commerce conceptual architecture of this study, and it includes the following components:

### 4.4.6 Agricultural e-commerce platform

The agricultural e-commerce platform is based on a Hyperledger network. This network contains User Interface (UI) as a website and a mobile application and connects all platform end users using local nodes. Each node maintains transaction data, such as block numbers and hash codes. The network helps agricultural e-commerce to ensure transparency, reduce risks and fraud agreements between third parties, and autogenerate smart contracts for each transaction. The double chain structure of the Hyperledger network helps enhance the efficiency and traceability of the system.

### 4.4.7 Agricultural associations and cooperative organizations

The role of this node in the network is to provide information sharing, standardization, and avoiding asymmetry. Agricultural associations and cooperative organizations help ensure the interests of farmers and peasants by guiding their production and accelerating the pace of agricultural industrialization. In the case of individual farmers and family farmers, the role of these cooperative organizations becomes essential to help in marketing, packing, and building a self-logistic service based on consumers' particular needs. This role enhances the fair market competitiveness for those farmers. As other end users, these cooperative organizations connect to the platform through the Hyperledger network.

### 4.4.8 Stakeholders

Stakeholders are the sellers, employers, and managers of the platform. Sellers can be individual farms, farmers, small agribusinesses, or large enterprises. Each stakeholder is represented as a node in the Hyperledger network. The network allows these stakeholders to connect with other third-party nodes, cooperative organization nodes, and consumer nodes. Moreover, in the case of associating a farm with a farmer in the platform, the farmer is able to control and manage the farm remotely with the help of an IoT-based farm.

### 4.4.9 Consumers

This node represents all types of customers of agricultural e-commerce. These customers use the UI to access the agricultural e-commerce platform.

### 4.4.10 Third-party services

Using the blockchain and IoT, the proposed architecture facilitates the integration and communication of these third-party services with agricultural e-commerce, farmers, customers, and cooperative organizations. These services help agricultural e-commerce enhance marketing, security, customer support, customer behavioural analysis, payments, and accounting. Examples of such services are social media management, advanced technology management, product information management, content marketing, delivery system, bookkeeping and accounting, and customer help desk.

## 5 Discussion

The findings of this study observe several interesting indications in various aspects of agricultural e-commerce. The findings prove the rise of the academia and industry's interest and the growth of interest, however, countries' collaboration in the field of agricultural e-commerce was low. This calls for more collaborations, especially in terms of global marketing and supply chain standardisation. The findings also elaborate on the assumptions of whether academic authors published many unique articles or merely appeared to do so. The results show that the majority of authors (about 90 per cent) have contributed to only one publication (2,341 out of 2,601), and the average fractionalization of the authors was very low (0.49).

The content analysis shed light on the relationship between terms and highlighted the challenges and issues that emerged by utilizing advanced technologies in agricultural e-commerce. The results show the importance of customer satisfaction and its relation to the agriproducts' quality and freshness. It clearly indicates that the freshness of agricultural products is bound to the supply chain. It also shows the importance of advanced technologies in online shopping. Finally, the findings show that future research should consider the development of agricultural e-commerce and truly and accurately reflect the benefits and challenges of utilizing advanced technologies. Further investigation is required for the utilization of the advanced technologies in term of countries, actors, type of products, level of processing, and the usage.

This study shed light on the ushered challenges resulting from utilizing advanced technology in agricultural e-commerce, which has produced more meaningful directions for future research. Based on these findings and the current state-of-the-art, this paper sheds light on the following research prospects as a means to provide a valuable reference for future research of advanced technologies in agricultural e-commerce.

- Security and privacy: How advanced technologies affect agricultural e-commerce platform security in terms of network, endpoint, application, and data security?
- Data sparsity: How can big data help to utilize the high heterogeneity of agricultural e-commerce data?
- Distributed and incremental computing: How agricultural e-commerce platform addresses the challenges of scalability and real-time processing for their recommendation system.
- Interoperability of systems: How to provide an interoperable Hyperledger network that include variety of sub-systems and networks.
- Transition and integration: How does agricultural e-commerce transit and integrate the variety of stakeholders, processes and advanced technologies?

- Lack of talents: How cooperative organizations can support the lack of technological culture and limited information technology (IT) knowledge among rural farmers and small agribusinesses.
- Complexity: How to reduce the complexity of utilizing advanced technologies to handle a large number of stakeholders involved in agricultural e-commerce platforms.

## 6 Conclusion

Certain agricultural e-commerce challenges contribute to the emergence of more serious issues, such as information asymmetry, non-standardization, agriproduct perishability, and food insecurity. These challenges call for agricultural e-commerce research to establish a means of providing consumers with a high-quality and efficient online shopping experience for agricultural products. The bibliometric analysis of agricultural e-commerce research described in this study identifies clusters of research and researchers, indicating how distinct areas of thought may have emerged over time. Additionally, these clusters provide information on the current research interest, research deficit, and future research directions. It may also be beneficial for colleagues who intend to conduct field research and are looking for key literature and potential research collaborators or informants. This study conducted bibliometric analysis from four perspectives: descriptive analysis, authors, countries, and contents. The analysis was performed on 1,298 unique literature items published in the last decade.

The descriptive analysis resulting from the findings provides the basic statistics about the analyzed dataset of literature, such as the top impacting sources, literature items and affiliations, subject areas, and publication growth. The author analysis elucidates the most productive authors, and evaluates their impact by using the h index, the g index, total citations, and the fractionalization of their articles. The country analysis highlights the countries' impact and productivity using the number of publications, SCP, MCP, MCP ratio, total citations, and average article citation metrics. It also addresses the collaborations between countries by using a network analysis graph. Finally, the content analysis sheds light on the documents using the authors' keywords, Keywords Plus, and abstract contents.

After analyzing these characteristics using various metrics, this study revealed the differences between agriproducts and other products. In addition, it highlighted special agricultural e-commerce business models, including the F2C, F2A2B, and O2O models. Following that, this study discusses the issues and challenges associated with agricultural e-commerce and the application of advanced technologies in this field. As a result of the findings, this study points out the best practices and solutions to consider in agricultural e-commerce platforms. It proposes a conceptual architecture for agricultural e-commerce which utilizes the Blockchain and the Internet of Things technologies. This architecture provides innovative solutions for the agricultural e-commerce stakeholders such as cultivators, consumers, small and medium agribusinesses, cooperative agricultural organizations, and third-party service providers. Finally, this study discusses the bibliometric analysis results and provides prospects for future research on advanced technologies in agricultural e-commerce.

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## Declarations

**Conflict of interest** The authors of this study have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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