"Transparency of sustainability disclosure in agri-food value chain management: Mapping the scientific landscape"

| AUTHORS | Bodo Steiner (iD)
Inna Makarenko (iD)
Ⓡ
Kateryna Yuhai (iD)
Ⓡ |

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Bodo Steiner, Ph.D., Professor, Food
Economics & Business Management,
Department of Economics and
Management, University of Helsinki,
Finland.

Inna Makarenko, Doctor of Economics,
Professor, University Researcher,
Department of Economics and
Management, University of Helsinki,
Finland; Associate Professor,
Accounting and Tax Department,
Sumy State University, Ukraine.
(Corresponding author)

Kateryna Yuhai, Research Assistant,
Department of Economics and
Management, University of Helsinki,
Finland.

Bodo Steiner (Finland), **Inna Makarenko** (Finland, Ukraine), **Kateryna Yuhai** (Finland)

TRANSPARENCY OF SUSTAINABILITY DISCLOSURE IN AGRI-FOOD VALUE CHAIN MANAGEMENT: MAPPING THE SCIENTIFIC LANDSCAPE

Abstract

Sustainability transparency in agri-food value chains is crucial for fostering account-ability, enhancing consumer trust, facilitating compliance with regulatory standards, and ultimately contributing to the resilience and sustainability of food systems in the face of social, environmental, and economic challenges. This paper aims to conduct bibliometric mapping and a systematic review of the scientific landscape concerning transparency of sustainability disclosure in agri-food value chains by identifying the key transparency dimensions and relevant research gaps. An analysis of 841 Scopus-indexed publications, utilizing Scopus tools, SciVal, VOS Viewer, and Biblioshiny soft-ware, yields insights into source and author mapping from 2000 to 2022. Bibliometric analysis underlines the increase in research interests in transparency of sustainability disclosure in agri-food value chains after Sustainable Development Goals adoption and the COVID-19 pandemic, following upwards trend, especially in the UK, India, and the USA. The most influential topic clusters are supply chain, environmentally preferable purchasing, and green practices, as well as Bitcoin, Ethereum, and Internet of Things with the strongest co-occurrences between transparency (as the most recent notion in scientific landscape) and sustainability, traceability, supply chains, food sup-ply, and blockchain. Systematic review highlights the evidence that transparency as boundary-spanning phenomenon is explored within the mono-country and chain re-searches, case studies and interviews methodologies from triple bottom line dimension mainly, only introducing governance criteria. Research gaps were identified regarding the role of transparency in different economic system and chains; sustainability con-ceptual framework used; transparency dimensions incorporation; technology-driven progress and other chain characteristics (traceability, resilience) intersection.

INTRODUCTION

Sustainable and alternative food economies require enhanced trans-parency, ethics, cooperation, and trust (McGreevy et al., 2022). While the concept of transparency in agri-food value chains is not new, its significance has grown in recent literature on agri-food value chain sustainability (Schäfer, 2023; Steiner, 2017, 2006; Roth et al., 2008).

Such an approach aligns with the UN 2030 Agenda and the evolv-ing debate on Corporate Sustainability Reporting (CSR) relevant to agri-food value chains. Food and nutrition security, along with food waste reduction, are key indicators in the context of Sustainable Development Goals 2 ("No Hunger") and 12 ("Responsible Production and Consumption") (United Nations, n.d.). For effective CSR, trans-

parency is vital for managing the sustainability dimensions of suppliers and buyers, impacting the economic, social, and environmental performance (triple-bottom-line thinking) of chain actors (Grimm et al., 2014; Hamprecht et al., 2005).

Moreover, CSR fosters societal legitimacy through self-regulation and regulatory compliance (Steiner, 2006; Kong, 2012). Agri-food value chain participants face increasing regulatory pressure to meet sustainability standards, necessitating greater transparency to address social and environmental challenges (Pietrobelli & Rabellotti, 2011; Grimm et al., 2016; Meemken et al., 2021).

Key transparency-focused regulations include the Australian and U.K. Modern Slavery Acts (Australian MSA, 2018; UK MSA, 2015), the U.S. Food Safety Modernization Act (FDA, 2011), the California Transparency in Supply Chains Act (State of California, 2010), the German Supply Chain Act (Bundestag, 2021), and the EU Corporate Sustainability Due Diligence Directive (EC, 2023).

Transparency is also critical for economic sustainability, as access to timely market information is vital for effective competition in global markets (EC, 2019). Digital information and communication technologies play a key role in this context (Fritz, 2020). Recent evidence indicates that AI-powered agri-food value chain systems, IoT, and blockchain solutions for traceability can enhance chain transparency, yet their overall impact on agri-food value chain sustainability transparency remains largely unexplored (Dora et al., 2022).

While the transparency of sustainability disclosure in the agri-food value chain is a complex and novel phenomenon from the highlighted above sustainability dimensions and triple-bottom-line thinking paradigm, food security and waste management, legitimacy and regulatory pressure, effective competition in global markets and digitalization tendencies, academic approaches to its definition are mixed because of multidimensional essence. Hence, the aim of this paper is to conduct bibliometric mapping and a systematic review of the scientific landscape concerning transparency of sustainability disclosure in agri-food value chains by identifying the key transparency dimensions and relevant research gaps.

1. LITERATURE REVIEW

Transparency of sustainability disclosure in the agri-food value chain (sustainability transparency) is boundary-spanning phenomenon that impacts various aspects of business and management practices (Morgan, Gabler, et al., 2023) and is essential for building a resilient alternative food economy. Chain transparency as a basic concept due to complex understanding and intersection with chain sustainability is explored from different theories and dimensions perspective.

Concepts of sustainability transparency are becoming increasingly important to the agri-food sector due to increasing requirements for food quality, safety, legitimacy and risk management (Mangla et al., 2018; Kong, 2012; Morgan, Roath, et al., 2023). Quality control information and market power are essential for agri-food value chains

actors to extend their controls throughout the information in entire value chain (Hamprecht et al., 2005; Steiner, 2007).

Starting from a traditional conceptual perspective on value creation and power, transparency in agri-food value chains can be explained from the vantage point of normative institutional pressures and thus institutional theory (Steiner, 2017; Grimm et al., 2014; Zhu & Sarkis, 2007).

More recent works propose an agri-food value chain stakeholder value creation framework (Freudenreich et al., 2020) and point to extensions and blending of conventional approaches including stakeholder theory, the technology acceptance model, transaction cost theory, commodity theory, competing values theory, ambidexterity, the natural-resource-based view of the firm, actor-network theory and neo-institutional theory (Morgan, Gabler, et al., 2023; Morgan, Roath, et al., 2023).

Most of these theories, in their modern view, have by now intersected with the notions of sustainability, which is crucial for updating the management approaches for agri-food value chains (Beske et al., 2014), and the sustainability supply chain management field more generally (Mangla et al., 2018). Here, sustainability relates to environmental, social, and economic pillars, planet, people, profit (i.e., a triple bottom line approach) (Allaoui et al., 2019; Kong, 2012) or to environmental, social and governance criteria in the context of ESG investment strategies and its disclosure. While all these dimensions incorporate sustainability transparency' proxies, performance indicators and standard-compliance metrics as a basis of sustainability disclosure one understands transparency as a prerequisite and an inherent characteristic of supply chain participants' (stakeholder) communication, knowledge and information-sharing and decision-making and governance processes (Bastian & Zentes, 2013; Gualandris et al., 2021).

In recent papers on transparency of sustainable disclosure in agri-food value chains core question is about multidimensional transparency and sustainability intersection (Table 1). This current study is in line with Faisal et al. (2024), Morgan, Gabler, et al. (2023), and Silvestri et al. (2022) as attempt to spot transparency specifically in agri-food value chains.

From methodological perspective the key difference between the current paper and those listed in Table 1 is the hybrid approach, which combines bibliometric analysis (Yadav et al., 2023) and systematic literature review techniques (Negri et al., 2021; Rejeb et al., 2021; Silvestri et al., 2022). The application of a bibliometric tools mix (including extra in-built Scopus instruments, SciVal, VOS Viewer and Biblioshiny) gives additional perspectives above previous single-tool research (Rejeb et al., 2021; Faisal et al., 2023). A multidimensional conceptual approach to transparency of sustainability disclosure in agri-food value chain (here

Table 1. Recent papers with literature reviews in the areas of agri-food value chains transparency of sustainability disclosure in the agri-food value chain

Source	Key topic	Methodology	Scope	Software	Main findings
Beske et al. (2014)	sustainable food supply chains and dynamic capabilities	content analysis	52 papers	–	sustainability practices in the supply chain are used among others to enhance traceability and tracking and to fulfil customer demands
Ansari and Kant (2017)	sustainability in supply chain management frameworks	structural analysis	92 framework articles	–	critical gaps in the field of sustainable supply chain management frameworks
Negri et al. (2021)	sustainability and supply chain resilience	systematic literature review	456 papers	–	a major conflict exists since sustainability generally focuses on efficiency, while resilience seeks effectiveness
Rejeb et al. (2021)	big data for sustainable AFSCs	systematic literature review	128 papers	In-built Scopus instruments	potentials of the technology for agri-food businesses
Silvestri et al. (2022)	selecting indicators of measuring sustainability in agri-food sector	systematic literature review, qualitative and quantitative content analysis	99 papers	In built Scopus instruments, VOS viewer	integrated approach of indicators (environmental, social, and economic) is the best solution to ensure an easier transition to sustainability
Faisal et al. (2023)	development of transparency research in supply chain and transparency quantification	systematic literature review, PRISMA and graph theoretic approach	249	In-built Scopus instruments	four major attributes and their sub-attributes that influence transparency in supply chains, which are used to develop transparency index
Yadav et al. (2023)	supply chain sustainability and blockchain technology	bibliometric analysis, and network cluster analysis	297 papers	VOS viewer, MS Excel, and R-based apps	33 further research direction in supply chain and blockchain identified. Transparency is among them
Morgan, Gabler, et al. (2023)	supply chain transparency	literature review, focusing on 9 transparency-related theories	–	–	groundwork for future research in supply chain transparency

and after sustainability transparency as short notion), which involves exploration and mapping of the scientific landscape, is crucial for both theory and practice. It highlights the need for identifying research gaps and underscores the necessity for a structured bibliometric analysis and systematic literature review on various dimensions of transparency with sustainability intersection.

2. METHODOLOGY

Despite the growing regulatory pressure and sustainability-related importance, the theoretical description of transparency is still controversial, and the terminology still needs to be standardized (Sodhi & Tang, 2019). At first glance, 14,975 papers relevant to agri-food value chains sustainability transparency can be imported from the WoS database and 4,087 – from Scopus.

First of all, difficulties in exploring the academic landscape in agri-food value chains sustainability transparency caused the mix of approaches for understanding these value chains from management perspectives, sustainability pillars, and dimensions (environmental, social, and economic compared to ESG – environmental, social and governance) as well as transparency multidisciplinarity from the stakeholders perspectives and sustainability standard.

The study employed academic papers from the Scopus database to implement the proposed study. Data periods differ depending on the meta-analysis instrument used, but mainly, they cover all available data from 2000 to 2022.

This paper uses several specific meta-analysis instruments, including 1) SciVal and In-built Scopus instruments by Elsevier as a specific platform for bibliometric analysis; 2) Biblioshiny, VosViewer as software for network and occurrences investigation. In-built Scopus instruments were used for the preliminary selection, extraction, and filtration of publications from Scopus.

Description of the leading research areas in agri-food sectors and supply chains, sustainability, and transparency-related search terms were combined with the Boolean operator "AND," while inside, the area operator "OR" and additional search parameters like *"were used (Table 2). Difficulties in understanding agri-food value chains sustainability transparency (Schäfer, 2023) elements bring the mix of keywords and approaches.

Only 814 out of 4087 final-stage articles from the peer-reviewed journals in English indexed in Scopus were included for automized bibliometric analysis with SciVal, VOS Viewer, and Biblioshiny.

3. RESULTS AND DISCUSSION

Dynamic analysis of agri-food value chains sustainability transparency papers (Figure 1) shows the two stages of the scientific interest rising in this area. The first one began in 2017 after the adoption of SDGs in 2015 and enhanced research interests in all sustainability fields. The second one is connected to the COVID-19 pandemic and sustainability issues caused by disruptions in supply value chains and their resilience.

Table 2. Defining searching strings in agri-food value chains sustainability transparency

Area	Keywords	Searching string
Agri-food value chains linked	Agri*, Food, "Supply chain", "Value chain", "Closed loop"	(agr* OR food "supply chain" OR "value chain" OR "closed loop")
Transparency linked	Disclosure, Discourse, Standard, Reporting, Transparency, Accountability, Traceability, Trust, Communication, Stakeholder, Assurance, Legitimacy	(Disclosure OR Discourse OR Standard OR Reporting OR Transparency OR Accountability OR Traceability OR Trust OR Communication OR Stakeholder OR Assurance OR Legitimacy)
Sustainability linked	Sustain* (sustainability), Resilien*(resilience), ESG, Environmental, Social, Governance, Ethic*, "SDGs", "Sustainable Development Goals", Responsib* (responsibility), Green, Non-financial, Corporate Social Responsibility, CSR, Corporate Digital Responsibility	(sustain* OR resilien* OR ESG OR environmental OR social OR governance OR ethic* OR"SDGs" OR "Sustainable Development Goals" OR green OR responsib* OR non-financial OR "Corporate social responsibility" OR CSR OR "Corporate digital responsibility")

Figure 1. The dynamic of the agri-food value chains sustainability transparency publications in 2000–2022 papers

The tendency is generally upward, with a significant increase in publication activity in agri-food value chains sustainability transparency in 2017 and 2020. In Table 3, the top-10 journals by output prove this tendency, and 25% of all Scopus-indexed papers are concentrated. Most of these journals are devoted to the food and agriculture business. Some niche journals cover the supply chain management directions. The leading journals are the Journal of Cleaner Production and British Food Journal, where 71% of the output of the ten abovementioned journals is presented.

SciVal analysis was performed on the 547 publications (70.5%) of filtered Scopus publications in the most actively published years (2017–2022). The prevalence of the UK, India, and the USA institutions characterizes top institutions mapped by output (Figure 2).

Figure 2. Agri-food value chains sustainability transparency publications in 2000–2022: Top countries by institutions output, papers

Table 3. Top-10 journals by output in papers of agri-food value chains sustainability transparency search strings in 2002–2022

Source: Scopus in-built instruments.

Journal	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Journal Of Cleaner Production						1		2		1	1			6	8	14	17	9	11	18	12	100
British Food Journal		1					2		2		4	4	4	6	2	5	1	2	6	8	4	51
International Journal Of Production Economics							1	1					6		1		3	2	1	2	4	21
Food Policy	1			1		1	1			1	1	1	3		1	1	1		3	1	3	20
International Food And Agribusiness Management Review			1				1			1	1	5			1	1	2	1	1	3	2	20
International Journal On Food System Dynamics									1	1		4		2	1	2	1	1	3	1		17
Ecological Economics		1									1	1		1	1		2		1	3	5	16
International Journal Of Supply Chain Management																1	3	5	6			15
Supply Chain Management			2										2		2			4	1	1	3	15
Total	1	1	1	1	0	2	5	3	2	3	7	10	13	12	13	21	24	14	22	32	25	212

Nevertheless, comparing institutions' citation indicators (Table 4), two British academic institutions (Brunel University, London and the University of Plymouth) and three French institutions (INRAE, CNRS from the government sector, and Université Paris-Saclay from the academic sector) have leading positions in agri-food value chains sustainability transparency research. Particular attention should be given to the University of Plymouth and CNRS with the relevant papers' highest Citations per Publication and Field-Weighted Citation Impact (FWCI). All top-10 presented institutions have the FWCI in agri-food value chains sustainability transparency research area higher than 1, proving the area's relevance to the expected world average for the subject field, publication type, and year.

The most influential topic clusters by output and share of publication in agri-food value chains sustainability transparency (Table 5) are supply chain,

Table 4. Top-10 institutions by output in agri-food value chains sustainability transparency publications, 2017–2022

Source: SciVal.

Institution	Sector	Country	Output	Citations	Authors	Citations per Publication	FWCI
INRAE	G	France	15	256	27	17.1	1.29
University of Kassel	A	Germany	12	125	16	10.4	1.02
Wageningen University & Research	A	Netherlands	12	239	18	19.9	1.4
University of Plymouth	A	United Kingdom	10	531	8	53.1	5.55
CNRS	G	France	9	801	17	89	7.95
Université Paris-Saclay	A	France	9	205	14	22.8	1.63
Brunel University London	A	United Kingdom	8	250	12	31.3	3.13
University of Bologna	A	Italy	8	169	19	21.1	1.88
Royal Melbourne Institute of Technology University	A	Australia	7	65	10	9.3	1.07
Swiss Federal Institute of Technology Zurich	A	Switzerland	7	189	11	27	3.98

Note: A – academic sector, G – government sector.

Table 5. The top-10 topics worldwide by prominence in agri-food value chains sustainability transparency publications in 2017–2022

Topic Cluster	Topic Cluster Number	Scholarly Output	Publication share	FWCI	Prominence percentile
Supply Chain; Environmentally Preferable Purchasing; Green Practices	T.2569	75	1.16	3.2	99.933
Bitcoin; Ethereum; Internet Of Things	T.27660	35	0.14	7.89	99.982
Fair Trade; Global Value Chains; Global Production Networks	T.3538	29	0.91	1.86	98.926
Food Loss; Waste Prevention; Community Participation	T.28338	27	1.19	3.47	99.647
Community Supported Agriculture; Urban Agriculture; Local Food Systems	T.3195	25	0.52	1.77	99.543
Contract Farming; Farmers; Market Participation	T.9535	22	0.85	0.75	97.957
Internet Of Things; Food Supply Chain; Agricultural Products	T.10967	19	0.96	2.74	98.484
Community Participation; Farmers' Markets; Willingness to Pay	T.5301	17	0.7	1.31	99.336
Buyer-supplier Relationships; Opportunism; Supply Chain	T.694	15	0.71	1.25	98.622
Cause-Related Marketing; Corporate Social Responsibility; Corporate Philanthropy	T.184	12	0.1	1.42	99.942

environmentally preferable purchasing, and green practices. However, the Bitcoin, Ethereum, and Internet of Things cluster has the smallest share of publications, but its FWCI (689% more than the world average citation) and the prominence percentile is the highest (99.982). Blockchain-related aspects of agri-food value chains transparency are mostly investigated in this cluster publication.

The largest cluster by prominence among top-10% of worldwide topic clusters in agri-food value chains sustainability transparency in 2017-2022 is almost the same supply chain, supply chain management, and industry (Figure 3). The second largest cluster is corporate social responsibility, corporate governance, and firms; and the third – cryptography, authentication, and data privacy.

That is why among 50 key phrases by relevance (Figure 4), based on automatically selected 500 publications, the most frequently used in the scholars' paper are food supply, supply chain, supply chain management, blockchain, value chain, and sustainability.
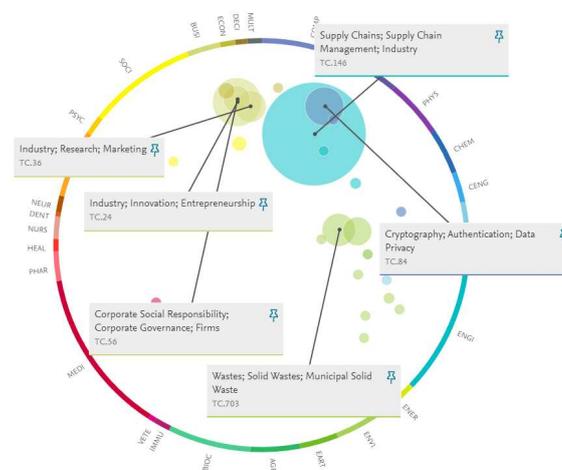
Figure 3. Top 10% of the worldwide topic cluster by prominence on agri-food value chains sustainability transparency in 2017–2022
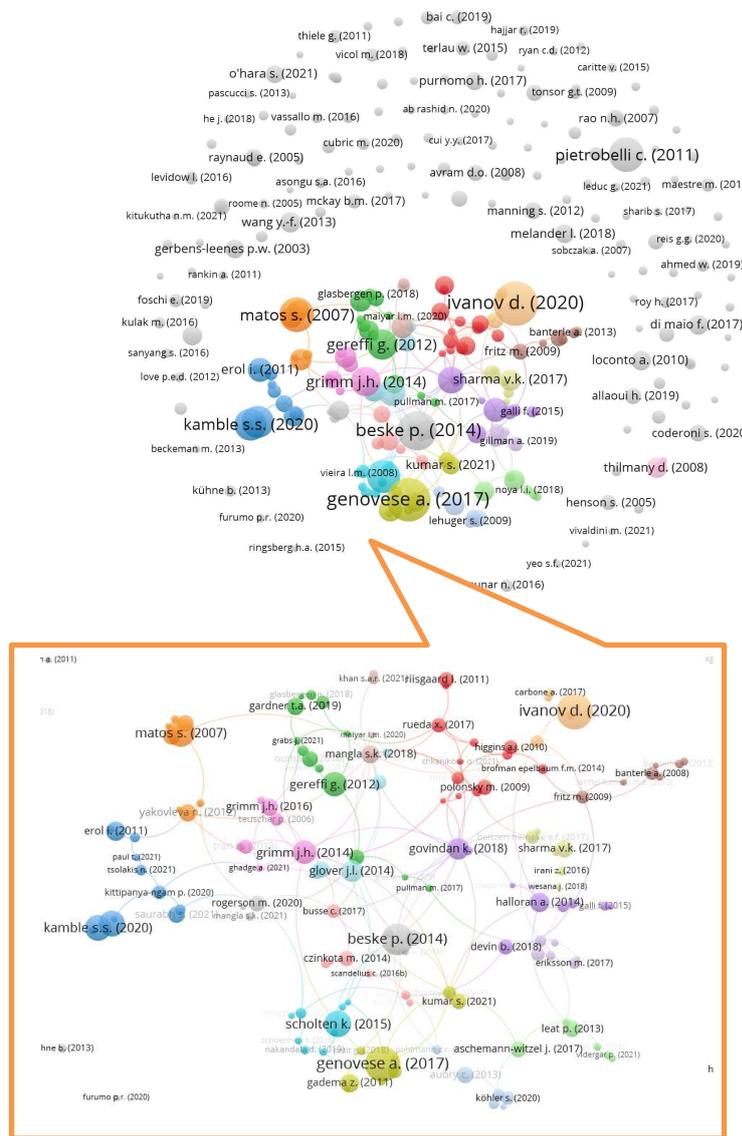
Figure 4. Relevance and growth rate of critical phrases in agri-food value chains sustainability transparency, 2017–2022

Figure 5. Keywords co-occurrence bibliometric map on agri-food value chains sustainability transparency publications in 2000–2022 (network mode)

VOS Viewer (version 1.6.19) processed 814 Scopus-indexed publications giving a more precious structure of the keywords' occurrences (Figure 5) organized into three main groups – supply chains (blue), food supply (green), and sustainability (red).

The largest group by co-occurrences is the sustainability one, which clearly aligned with qualitative characteristics of global food chains and industry such as transparency, traceability and resilience as well as the elements of the stakeholder theory (communication, collaboration).

There are also several types of the strongest co-occurrences characterized by the transparency node – with sustainability, traceability, supply chains, food supply, and blockchain and agricultural supply chains (Figure 6). The last type of co-occurrences is the most recent one in the analyzed set of the paper in chronology mode. At the same time, transparency is a relatively new concept emerged in the late 2020s.

Figure 7 gives clear evidence in favor of authors and co-authorship collaborations in agri-food value chains sustainability transparency for the last 22 years.

Figure 6. Keywords co-occurrence bibliometric map on agri-food value chains sustainability transparency publications in 2000–2022 (chronology mode)

Figure 7. Co-authorship bibliometric map on agri-food value chains sustainability transparency publications in 2000–2022

Co-citation and authorship analysis (Figure 8) give the most active authors in agri-food value chains sustainability transparency publications in the 2000–2022 central group. Among these authors, Beske et al. (2014), Genovese et al. (2017), Kamble et al. (2020), Matos and Hall (2007), Scholten and Schilder (2015) should be mentioned.

In current analysis, Biblioshiny is used for the detection of unconventional dependencies in academic literature in agri-food value chains sustainability transparency regarding authorship, sources, countries, and keywords. Identified dependencies are described by quantitative flows and transmissions associations and visualized with Sankey diagrams. Top-10 most productive and cited authors (presented

Figure 8. Authors co-citation bibliometric map on agri-food value chains sustainability transparency publications in 2000–2022

as the most significant nodes in Figure 7 and inter-related with their output and citation in Figure 9) are the basis of these Sankey diagrams (Figures 10-11).

For example, Figure 10 shows the relationship between abovementioned authors, authors' countries and keywords in authors' papers. It corresponds to Figure 2 in terms of the leadership countries (the UK, India, Italy, and the USA are the host countries with the highest output in agri-food value chains sustainability transparency).

Supply chain (food supply), sustainable development (sustainability) and supply chain management (Figures 10 and 11 that correspond to Figure 2), as well as food waste, circular economy and blockchain, are the most critical keywords defining the research area, the most influential publications and sources, like Journal of Cleaner Production, Resources, Conservation and Recycling, International Journal of Production Economics (Figure 11).

Even though transparency as a characteristic of agri-food value chains is not represented on Sankey diagrams (Figures 10 and 11), and Figure 12 describes the frequency of the keywords over the timeline, it can be identified as a part of
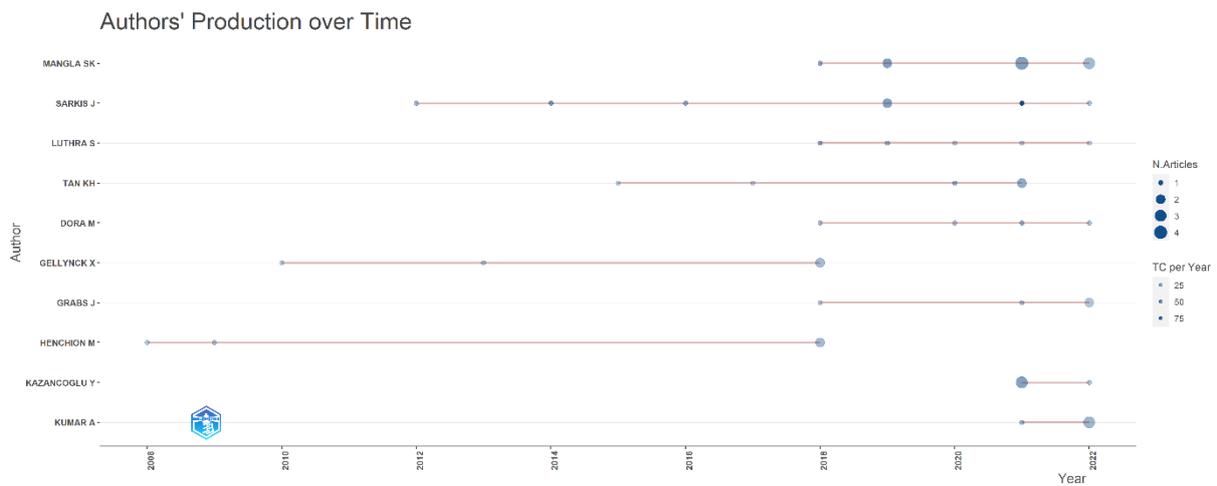
Figure 9. Author's production in agri-food value chains sustainability transparency in 2000–2022
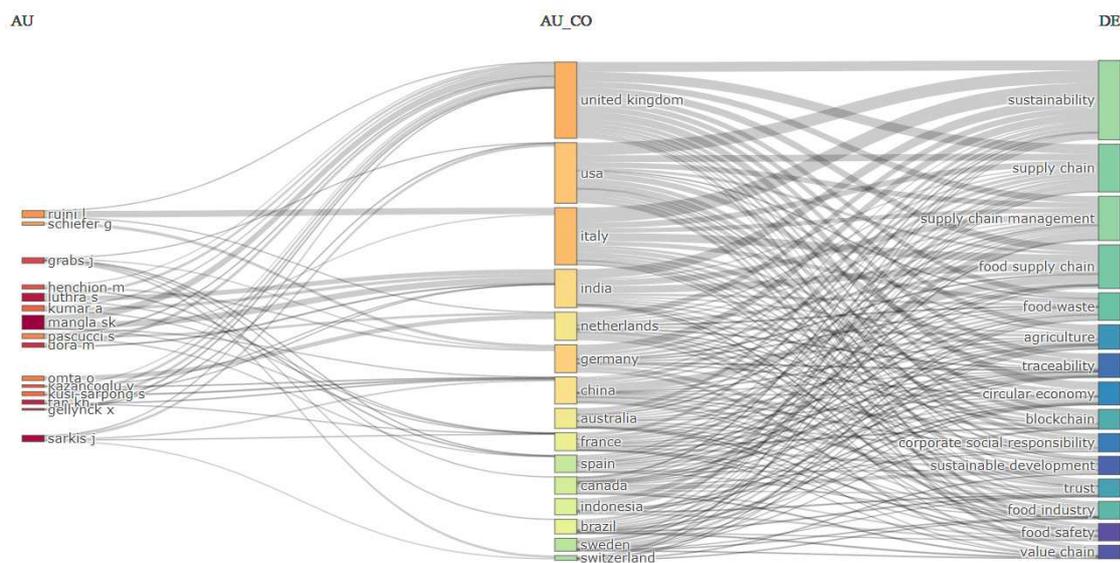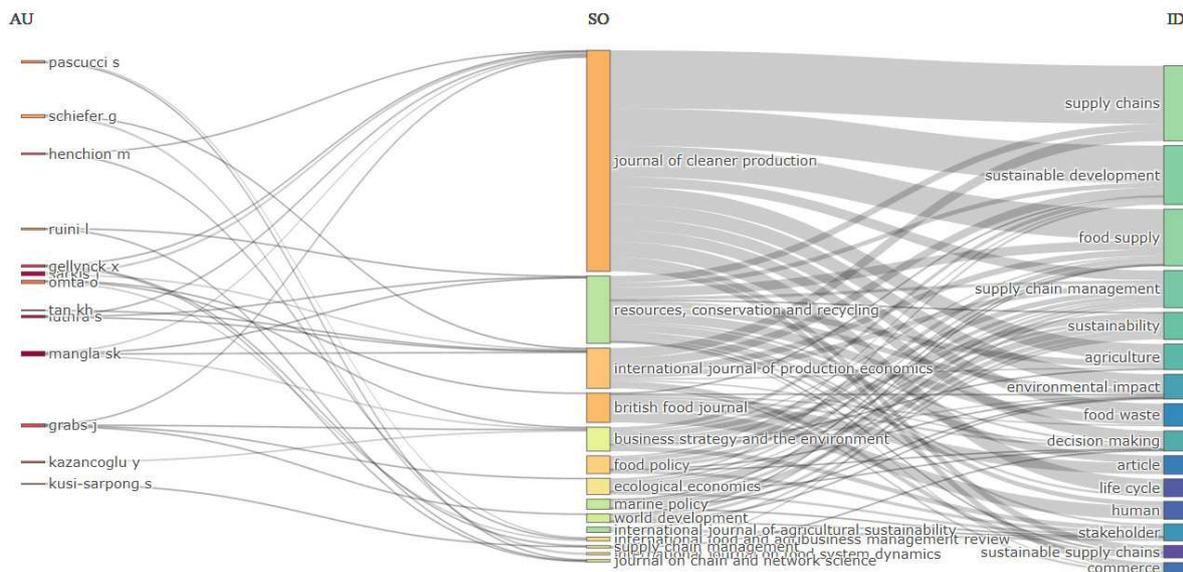
Figure 10. Three field plots (Sankey diagram) on authors (left), countries (middle) and keywords (right) on agri-food value chains sustainability transparency publications in 2000–2022

sustainability-related keywords or blockchain-related. Transparency is shown in Figures 5 and 6 as a novel node with strong co-occurrences linkage to relevant research clusters such as sustainability, blockchain and technology adoption (Figure 12).

The top 10 most cited papers (corresponding to core authors from Figure 8) and 30 papers belong-ing to the most productive authors (Figure 9) in the agri-food value chains sustainability transparency field were explored for systematic literature review with sub-criteria relevant to the transparency dimension research question. Among the criteria are the following: country and agri-food value chains type; theoretical, conceptual, and methodology framework used; and transparency dimensions.

Figure 11. Three field plots (Sankey diagram) on authors (left), sources (middle) and keywords (right) on agri-food value chains sustainability transparency publications in 2000 – 2022
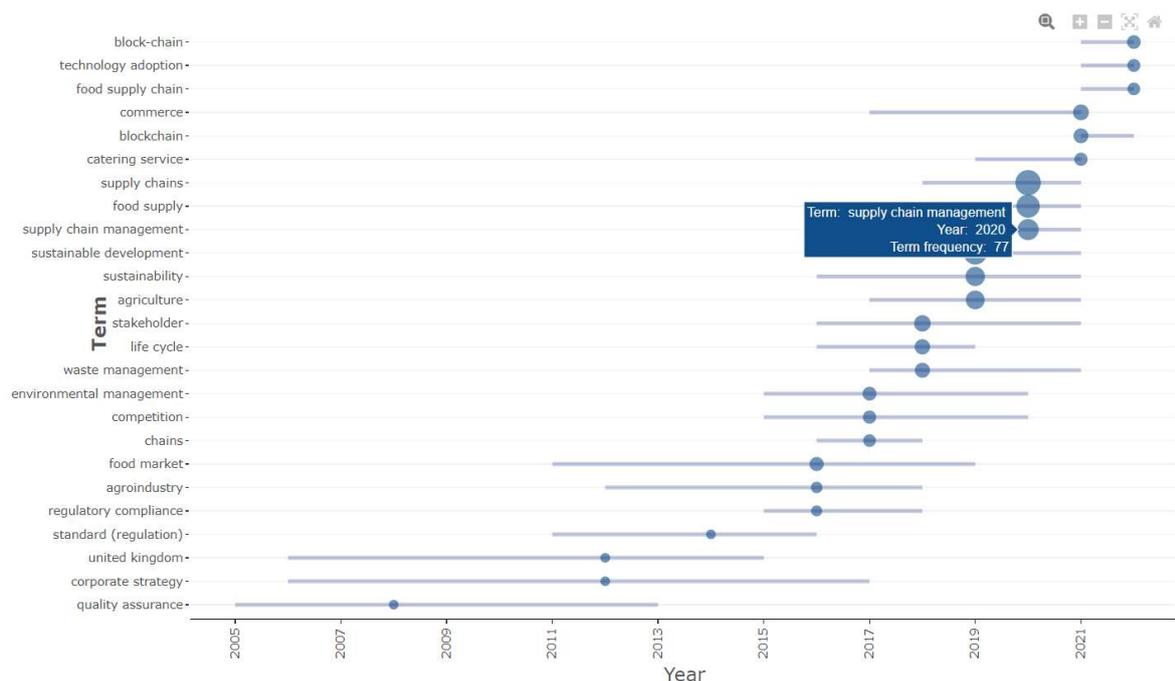
Figure 12. The most frequent keywords on agri-food value chains sustainability transparency publications in 2000–2022

3.1. Country and agri-food value chain perspective

From country and agri-food value chains types perspective, mono-country focus is preferable in the paper sample. Most of the papers in the agri-food value chains sustainability transparency describe the peculiarities of one country:

• China (Gereffi & Lee, 2012; Gong et al., 2015; Bai et al., 2019).

- India (Mangla et al., 2018; Singh et al., 2019; Sharma et al., 2019; Dora et al., 2022; Kumar et al., 2022a; Mangla et al., 2022).

- Ireland (Devaney & Henchion, 2018a, 2018b).

- Uganda (Kabbiri et al., 2018; Wesana et al., 2018).

- Thailand (Kittipanya-ngam & Tan, 2020; Tsolakis et al., 2021).

- Malaysia (Ali et al., 2021).

- Turkey (Kumar Mangla et al., 2021; Kazancoglu et al., 2021).

Cross-country evidence in agri-food value chains is presented with EU countries (Fischer et al., 2008; Fischer et al., 2009; Molnár et al., 2010; Kühne et al., 2013; Allaoui et al., 2019) and developing countries comparison (India, Brazil and China (Mangla, Bhattacharya, et al., 2021). Transparency is one of the characteristics of the supply chain, supply chain networks, intertwined supply chain networks (supply chain ecosystem (Ivanov & Dolgui, 2020) and global value chains.

The global level of agri-food value chains was also widely investigated (Pietrobelli & Rabellotti, 2011; Dietz et al., 2018; Ivanov & Dolgui, 2020; Grabs & Carodenuto, 2021).

An essential part of the researchers focused on the agri-food or food chains as a whole (Molnár et al., 2010; Beske et al., 2014; Grimm et al., 2014; Scholten & Schilder, 2015; Dietz et al., 2018; Kouhizadeh et al., 2021). Otherwise, the focus of single supply-chain or single-chain participants is also widespread as a single-country research in the sample. For example, agricultural biotechnology (Matos & Hall, 2007); pig meat, beef and cereals chains (Fischer et al., 2008; Fischer et al., 2009); food retailers (Grimm et al., 2016; Genovese et al., 2017); vegetable and fruit (Mangla et al., 2018); diary (Kabbiri et al., 2018; Bai et al., 2019); coffee (Wesana et al., 2018); fish (Tsolakis et al., 2021); halal food (Ali et al., 2021); cocoa (Bai et al., 2022); meat (Ersoy et al., 2022) were an object in chain-specific papers.

The current mix of countries and agri-food value chains evidence brings challenges in the interpretation of the sustainability transparency from different economic systems (developed and developing countries), sustainability and SDGs progress achieved, transparency in supply chain regulation and sustainability standards level of compliance, as well as transferability and comparability of the chain specifics.

3.2. Theoretical, conceptual, and methodology framework perspective

From theoretical, conceptual, and methodology framework perspective, the sustainability concept is the most frequently used in this sample, especially after SDG adoption in 2015. Several papers directly connected to agri-food value chains opportunities for facilitating the 2030 Agenda, SDG 2 and 12 (Mangla, Kazancoglu, et al., 2021; Mangla, Bhattacharya, et al., 2021; Tsolakis et al., 2021; Kumar et al., 2022b).

Circular economy, in close conjunction with the sustainability concept, gives clear support for food waste minimization (Kumar et al., 2022b); assessment of circular food production systems (Genovese et al., 2017); 9 R of the circular economy, knowledge and information hiding (Kumar Mangla et al., 2021; Ersoy et al., 2022), managing stakeholder communication and relationship (Bloise, 2020) across agri-food value chains.

The dynamic capability theory (Beske et al., 2014; Yadav et al., 2022), system dynamic theory (Kazancoglu et al., 2021) and dynamic game-theoretic modelling (Ivanov & Dolgui, 2020) has a close intersection with sustainable supply chain management in agri-food value chains from the perspective of reaching transparency as one of the chain participants' competitive advantages.

As a result of country, chain and theoretical framework review, first research gap emerges with respect to the need to integrate circular economy thinking, accounting perspectives, stakeholder theories, and the role of digitalization techniques to arrive at a more holistic theoretical approach to transparency of sustainability disclosure in agri-food value chains from different economic sys-

tems and agri-food chains transferability with respect to difference in country-to-country sustainability disclosure regulation.

A case study is the most frequently used methodology framework in agri-food value chains sustainability transparency and data collection technique (Table 6). Different types of interviews (including semi-structured) are the second most frequently used framework for this purpose.

Table 6. Methodological framework and datasets used for agri-food value chains sustainability transparency

Framework/ methodology	Authors
Interview (semi-structured)	Scholten and Schilder (2015); Gong et al. (2015); Bloise (2020); Kumar et al. (2022a)
Case study	Matos and Hall (2007); Scholten and Schilder (2015); Grimm et al. (2016); Mangla et al. (2018); Sharma et al. (2019); Tsolakis et al. (2021); Ali et al. (2021); Kazancoglu et al. (2021); Mangla, Kazancoglu, et al. (2021)
Structural equation modelling (PLS-SEM)	Fischer et al. (2008); Fischer et al. (2009); Fu et al. (2017); Kabbiri et al. (2018)
Binary logistic regression	Molnár et al. (2010); Kühne et al. (2013)
Analytic Hierarchy Process	Yakovleva et al. (2012); Mangla et al. (2022)
Content analysis	Beske et al. (2014)
Compliance analysis	Grimm et al. (2014)
Cluster analysis	Kühne et al. (2013)
Life cycle assessment	Genovese et al. (2017)
Regression analysis	Gong et al. (2015)
Delphi method	Devaney and Henchion (2018a, 2018b); Sharma et al. (2019)
Decision-Making Trial and Evaluation Laboratory (DEMATEL)	Kamble et al. (2020); Kouhizadeh et al. (2021); Mangla, Bhattacharya, et al. (2021)
Grey based analysis technics	Singh et al. (2019); Yadav et al. (2022)
Dynamic game-theoretic modelling	Ivanov and Dolgui (2020)
Fuzzy logic methods (Fuzzy C-means clustering, TOPSIS)	Bai et al. (2019); Yadav et al. (2021); Kumar et al. (2022b)

For the data analysis, the most frequently used are structural equation modelling, DEMATEL and fuzzy logic methods. Nevertheless, their applicability for analyzing big data across the more globalized and cross-dimensional data in real-time mode is questionable, as well as the implementation of AI-powered technologies for that purpose.

3.3. Multidimensional perspective

From multidimensional perspective, transparency in the publications is widely spread closer to 2015 after SDGs adoption and agri-food value chains digital technologies' rapid development. However, it is still considered indirectly, through the prism of sustainability and TBL dimensions, as a basis of sustainable management of the supply chain in agri-food value chains. However, from the point of view of disclosure, measuring, monitoring and compliance with sustainability standards, these dimensions (Table 7) help identify chain participants' adherence to transparency practice. With the references to previous research, this study is in line with Faisal et al. (2023), Morgan, Gabler, et al. (2023), Silvestri et al. (2022) as attempt to spot transparency specifically in agri-food value chains.

Table 7. Sustainability transparency dimensions in the researched sample

Authors	Pillars		
	Environmental	Social	Economic
Yakovleva et al. (2012)	+	+	+
Beske et al. (2014)	+	+	+
Grimm et al. (2014)	+	+	
Genovese et al. (2017)	+		
Gong et al. (2015)	+	+	+
Mangla et al. (2018)	+	+	+
Kabbiri et al. (2018)		+	+
Devaney and Henchion (2018)	+		
Dietz et al. (2018)	+	+	+
Wesana et al. (2018)	+	+	
Allaoui et al. (2019)	+	+	+
Sharma et al. (2019)	+	+	+
Bai et al. (2019)	+		
Yadav et al. (2021, 2022)	+	+	+
Kumar et al. (2022b)	+	+	+

Most recent papers incorporate all three sustainability of TBL pillars (Kumar et al., 2022b), using composite indices for assessment of agri-food value chains compliance with voluntary sustainability standards (Dietz et al., 2018), various key performance indicators for improving agri-food value chains sustainability and sustainability dimensions weights (Yadav et al., 2021, 2022), sustainability indicators for determining of importance ratings (Yakovleva et al., 2012).

However, several studies solely focus on the environmental and social aspects of agri-food value chains. For example, Genovese et al. (2017) use greenhouse

gas emissions as a leading environmental impact indicator and a carbon map as a methodological tool for its assessment. Devaney and Henchion (2018a, 2018b) justify the need for robust environmental sustainability assessments in food chains. The environmental friendliness of agri-food value chains is a core focus of Molnár et al. (2010). Kabbiri et al. (2018) emphasized social and economic pillars, in contrast to the social focus of Kazancoglu et al. (2021).

While all sustainability pillars and TBL dimensions of transparency are incorporated in the literature, it seems that governance criteria from ESG are frequently missing. Agri-food value chains's good governance-related publications include Pietrobelli and Rabellotti (2011) and Grabs and Carodenuto (2021). A second research gap relates to the challenges of interpreting transparency of sustainability disclosure in agri-food value chains from multidimensional perspective, incorporating not only TBL, but also governance criteria.

Mangla et al. (2022) used alternative agri-food value chains transparency dimensions: environmental, strategic and technological. Following the approach where traditional dimensions (as it was employed by Mangla et al. (2018) and Silvestri et al. (2022) with traditional TBL classification of transparency dimensions) could be completed with governance criteria, the current study's technological side of the agri-food value chains studies is treated as an emerging and prominent topic cluster in this field (Table 5). The Bitcoin, Ethereum, and Internet of Things cluster has the smallest publications share, but the highest prominence percentile.

The potentially crucial role of big data, block-chain, IoT in meeting social awareness in terms of sustainability has been highlighted by Mangla et al. (2022), whereas other works have concentrated on their role for improving information efficiency, transparency in agri-food value chains (Kouhizadeh et al., 2021; Mangla, Kazancoglu, et al., 2021; Bai et al., 2022). Furthermore, the role of such technologies supporting chain's good governance (Kumar et al., 2022a), and the benefits of real-time data-driven agri-food value (Kamble et al., 2020). Applicability of sustainability transparency concepts in the technology field, in particular with respect to big data in real-time, and considering AI-powered and blockchain technologies is the third research gap identified.

From the above evidence, it seems that these technologies can support trust, traceability, and transparency, and thereby make a valuable impact towards all dimensions of sustainability across agri-food value chains. But it is still unknown how agri-food value chains sustainability transparency concerning these technologies interact with trust and traceability (blockchain technology has been regarded as a substitute for trust, but also as its antecedent and consequence (Secinaro et al., 2021; Batwa & Norrman, 2021). Taking into account this fourth gap, in contrast to previous research, transparency is not secondary, but primary chain characteristic, compared to traceability (Beske et al., 2014); resilience (Negri et al., 2021); disclosure, driven by technology (Rejeb et al., 2021; Yadav et al., 2023) with the necessity of comprehensive transparency metrics system.

CONCLUSION

This paper conducts a bibliometric mapping and systematic review of transparency in sustainability disclosure within agri-food value chains, analyzing 841 Scopus-indexed publications from 2000 to 2022. The findings reveal two significant stages of increased research interest: one following the adoption of the SDGs in 2015, and another triggered by the impact of COVID-19 on value chains. Publication activity surged notably in 2017 and 2020, with leading journals like the Journal of Cleaner Production and British Food Journal accounting for a substantial portion of output and the UK, Indian, and the USA institutions as leading institution by output. Key clusters identified include supply chain, environmentally preferable purchasing, and green practices, with blockchain-related topics demonstrating high citation impact despite fewer publications. Strong co-occurrences are noted between transparency (which is the most recent notion), sustainability, traceability, and blockchain. From a theoretical, conceptual, and methodological standpoint, the sustainability concept is the most commonly employed in this sample, particularly following the

adoption of the SDGs in 2015. The case study and interview is the dominant approach used in researching sustainability transparency with the TBL dimensions mostly.

The study highlights several gaps: the need for integrating circular economy principles and digitalization into sustainability transparency frameworks; challenges in interpreting transparency across developed and developing economies; and the applicability of transparency concepts in emerging technologies like AI and big data. Furthermore, understanding how these technologies enhance trust, traceability, and overall chain resilience is critical for aligning sustainability transparency with triple-bottom-line thinking.

The above research gaps and conclusions have practical value for regulators and policymakers for framing the process of integration of emerging technologies toward greater transparency of sustainability disclosure in agri-food value chains. They hold value for agri-food value chains stakeholders in aiming for better sustainability standards and pillars compliance, and hence more effective managerial decision-making and governance dimension incorporation toward better SDG 2 and 12 progress. This work faces several limitations, including technical limitations related to the period of analysis and the use of the Scopus database and bibliometric software. While the bibliometric techniques employed in this paper have identified several research gaps, further studies could extend the analysis by adding paper selection from other databases (WoS, Google Scholar) while extending the period of research.

AUTHOR CONTRIBUTIONS

Conceptualization: Bodo Steiner, Inna Makarenko.
Data curation: Inna Makarenko.
Formal analysis: Kateryna Yuhai.
Funding acquisition: Inna Makarenko.
Investigation: Inna Makarenko, Kateryna Yuhai.
Methodology: Inna Makarenko.
Project administration: Inna Makarenko.
Resources: Kateryna Yuhai.
Software: Inna Makarenko, Kateryna Yuhai.
Supervision: Bodo Steiner.
Validation: Bodo Steiner.
Visualization: Inna Makarenko.
Writing – original draft: Inna Makarenko, Kateryna Yuhai.
Writing – review & editing: Inna Makarenko, Bodo Steiner.

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