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Sustainable coffee supply chain management: A systematic literature review

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Abstract

Coffee, a beloved beverage worldwide, is responsible for the livelihoods of millions of people. With concerns about sustainability practices rising among policymakers and consumers alike, it is crucial that every member of the supply chain takes action. A growing body of related research in recent years highlights the growing importance of sustainable coffee supply chain management. This study aims to provide a focused overview of sustainable coffee supply chain management from a business and management perspective. A systematic literature review method is adopted, and results of descriptive and content analysis are reported. The main findings include the identification of seven main themes in the literature and an overview of the current state of research. Furthermore, several future research directions have been proposed under seven research themes. This paper contributes to the literature by providing a management-focused synthesis of sustainable coffee supply chain research, complementing existing reviews that concentrate on specific topics or adopt a broader multidisciplinary scope.

Keywords: Sustainability; Supply chain management; Coffee; Systematic literature review

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1. Introduction

Coffee is a global commodity with a significant worldwide impact. The sector is organized around a geographically dispersed "bean-to-cup" chain: cultivation and primary processing are concentrated in producing countries, whereas roasting, branding, and retail are largely controlled downstream, creating persistent challenges in value distribution, traceability, and the management of environmental and social impacts.[1] At the same time, demand has shifted beyond price-driven bulk consumption toward differentiated offerings in which quality, provenance, and credence attributes, such as ethical sourcing and sustainability, shape purchasing decisions.[2] Consequently, sustainability in coffee supply chains is no longer positioned as a reputational add-on but as an operational and strategic necessity for the sector.

Sustainable supply chain management (SSCM) integrates production, processing, distribution, and consumption with environmental, social, and economic priorities.[3] The coffee supply chain spans smallholder producers, cooperatives, exporters, traders, roasters, retailers, certification bodies, NGOs, and governments across producing and

consuming countries, making coordination, traceability, and accountability inherently difficult. The resulting tensions include low and volatile farm incomes and uneven premium distribution, labor and human-rights risks, and environmental pressures related to land use, agrochemical inputs, water use, and climate vulnerability. Regulatory and stakeholder scrutiny has increased, but no single policy or actor can address these interconnected problems. Therefore, coordinated action across supply chain stages is required.[4]

Research on sustainable coffee supply chains has consequently expanded across several domains. Some studies focus on certification and voluntary sustainability standards, their consequences for smallholders, and region or firm specific sustainability initiatives.[5-7] Others examine how firms and supply chain actors organize sustainability practices through governance arrangements,[8-10] collaboration,[11,12] and stakeholder initiatives.[13-15] A further stream considers how information infrastructures,[16,17] digital technology,[18-20] and consumer responses[21-24] support or constrain the implementation of sustainability across the coffee supply chain. However, this literature is dispersed across multiple research streams, while existing reviews tend either to concentrate on particular topics or to adopt a broader multidisciplinary perspective. As a result, it remains difficult to obtain a focused overview of how sustainable coffee supply chain management has been studied within business and management scholarship.

Existing reviews therefore leave a specific management-oriented gap. Existing reviews synthesize certification impacts,[5,6] sustainability initiatives,[7] or blockchain traceability,[25] while broader multidisciplinary reviews map a wider range of actors and sustainability challenges.[1] What remains underdeveloped is a focused synthesis that systematically identifies the principal themes of sustainable coffee supply chain management within business and management scholarship and synthesizes what has been studied within these themes. Table 1 positions the present review against this prior work. This study adopts a deliberately bounded business and management lens. It organizes and synthesizes management-oriented research on sustainability governance and practices, supply chain relationships and business models, traceability and technology, decision support and impact assessment, and market and consumer issues across the coffee supply chain. In doing so, it provides a structured overview of the existing management-oriented literature and identifies areas requiring further research. The study addresses two research questions: RQ1: What are the main themes of sustainable coffee supply chain management, and what

Table 1. Comparison of existing literature reviews on sustainable coffee supply chains and the present review

Paper	Journals selected	Number of articles	Focus	Focal actor	TBL aspect
DeFries *et al.* (2017)[5]	No journal-level restriction	16	Certifications for tropical agricultural commodities	Small-scale producers	Economic, social and environmental
Meemken (2020)[6]	No journal-level restriction	97	Economic effects of sustainability standards on smallholders	Smallholder farmers in developing countries	Economic
Wright *et al.* (2024)[7]	No journal-level restriction	39	Sustainable coffee initiatives and governance dimensions	Actors influencing sustainability initiatives in coffee producing regions	Social and environmental
De Felice *et al.* (2025)[1]	No journal-level restriction, Scopus-indexed peer-reviewed journals	137	Cross-disciplinary analysis of sustainability in coffee supply chain	Actors across the coffee supply chain	Economic, social and environmental
Gomez and Garbinato (2025)[25]	No journal-level restriction	39	Blockchain technology for coffee supply chain traceability: developments and open challenges	Coffee supply chain actors involved in traceability	Economic, social and environmental
This paper	AJG-listed journals only (business and management disciplinary boundary)	79	Management-oriented synthesis of sustainable coffee supply chain management across seven themes	Actors across the coffee supply chain	Economic, social and environmental

Abbreviations: AJG: Academic Journal Guide; TBL: Triple bottom line.

has been explored within each theme? RQ2: What are the research directions?

A systematic literature review (SLR) was selected because it provides a transparent procedure for identifying, evaluating, and synthesizing a defined body of evidence.[26] Consistent with the view that review articles should move beyond aggregation to challenge and connect prior knowledge,[27] the review first maps the literature descriptively and then synthesizes the literature thematically.

This paper makes four contributions. First, it provides a synthesis of sustainable coffee supply chain research published in business and management journals, while explicitly distinguishing this analytical scope from multidisciplinary comprehensiveness. Second, it organizes the reviewed literature on sustainable coffee supply chain management into seven themes. Third, it updates the research agenda by linking coffee-specific gaps to developments in digital decision support, explainable artificial intelligence, digital twins, life cycle sustainability assessment, and digitally enabled consumption. Fourth, it derives practical implications for firms selecting sustainability governance mechanisms, managing supplier relationships, evaluating digital investments, and assessing sustainability outcomes.

The rest of this paper is organized as follows: **Section 2** presents the literature review for sustainable coffee supply chain management. **Section 3** presents the research methodology adopted for conducting the systematic literature review. **Section 4** presents the findings of this research. **Section 5** discusses key emerging themes in sustainable coffee supply chain and future research directions. **Section 6** presents managerial implications. **Section 7** concludes with contributions and limitations.

2. Literature review

Coffee, a beverage that is beloved worldwide, is also a major internationally traded agricultural commodity. Among approximately 15 species and 100 varieties of coffee, robusta and arabica are the most popular.[28] More than 100 million people are employed in the coffee growing industry,[29,30] and this number is growing as demand for coffee is predicted to reach 300 million bags by 2050.[4] At least 50 countries produce coffee commercially, and around 3 billion cups are consumed daily.[31]

The basic coffee supply chain consists of functions as follows. At the farm, the coffee cherries are harvested by farmers. Then, the cherries are sent to processing plants, unless the farm has their processing facilities. The cherries are then hulled and can be processed using a wet or dry method, producing ready-to-be-exported beans. Bags of coffee beans are sent to roasters or instant coffee manufacturers. Here, the beans are roasted to the desired level of darkness, packaged, and shipped out to consumers. Figure 1 provides an overview of the coffee supply chain from bean to cup.

As the coffee industry evolves, the focus of the sector and the power dynamics between stakeholders also change. In the early years of the 1900s, Brazil accounted for 75% to 90% of coffee production.[32] Between 1962 and 1989, the main coffee-producing and consuming nations signed the International Coffee Agreement, which regulated the coffee price.[33] The first half of the 1990s marked a significant change in the industry due to the entrance of new producing countries, such as Vietnam, and the exit of the USA. This broke the equilibrium set by the International Coffee Organization in 1989 and shifted the power downstream, in other words, buyer-driven.[28] The average quality of coffee production decreased due to the entry of new producers and farmers' reduced ability to invest.[34] Producers lost their bargaining power while international traders took advantage of the over-supply of green coffee beans, obtaining a lower purchasing price.[35] In the late 1990s, the biggest players in the industry placed their focus on coffee quality and consumers' experience.[4,28] Within the third wave of coffee from the late 1990s to early 2000s, specialty coffee gained popularity for its high quality or limited availability or different flavoring, packaging, and focus on customers' experience.[33] From the mid-2000s, there was an increased demand for differentiation: coffee differentiated by specific farm of origin rather than only by country of origin, and roasting brings out the unique flavor of each bean. Today, with social media and better access to information, consumers hold more power, pushing stakeholders to respond rapidly to ethical and quality demands.[4]

Despite the coffee industry's global footprint, it faces mounting pressure to improve sustainability, covering issues such as environmental damage and economic imbalance, as well as digital turbulence and resource loss.[1] These issues have attracted growing attention. Therefore, the concept of sustainable supply chain management (SSCM) has been introduced into the coffee sector. Seuring and Müller[36] defined SSCM as "the management of material, information, and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, *i.e.*, economic, environmental and social, into account which are derived from customer and stakeholder requirements." Therefore, sustainable coffee supply chain means managing a full coffee chain, from green-bean cultivation

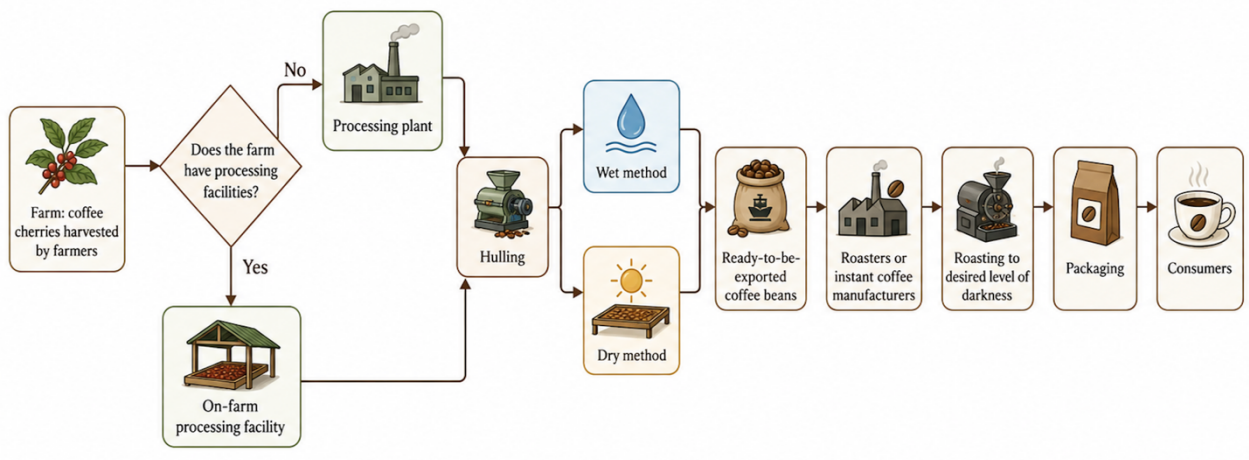


Figure 1. Overview of the coffee supply chain. Original conceptual illustration developed by the authors with generative AI assistance using ChatGPT.

through processing, trading, roasting, and retail to final consumption, while considering the environmental, social, and economic dimensions simultaneously.

The concepts of SSCM continue to evolve and improve. Early SSCM research predominantly focused on environmental improvement and green purchasing, with inadequate attention given to the social dimension and weak supply chain collaboration. Subsequently, Carter and Rogers[37] and Seuring and Müller[36] proposed SSCM frameworks, marking a shift in SSCM research from a narrow, environment-only lens to a triple bottom line (TBL) perspective that integrates environmental, social, and economic dimensions through inter-firm collaborative management. Since 2010, SSCM has moved beyond conceptual or framework discussions, giving rise to a wealth of empirical research employing methods such as questionnaires, case studies, secondary data, and modeling. This research has focused on examining driving factors and barriers,[38] the implementation of multi-tier SSCM initiatives,[39] and the relationship between SSCM practices and organizational performance.[40] Following 2020, the rapid advancement of Industry 4.0 significantly enhanced supply chain data, traceability, and analytical capabilities. And a series of "black swan" events, particularly COVID-19, alongside geopolitical and climate disruptions, exposed the vulnerability of global supply chains. Simultaneously, sustainability governance is shifting from primarily voluntary commitments toward auditable regulations (such as circular economy mandates, Scope-3 decarbonization), pushing firms to manage environmental and social impacts across multi-tier supply chain networks.[41] As the concept of SSCM continues to evolve, there is a need to apply these latest conceptual advances to the coffee sector in order both to assess the current state of knowledge on sustainable coffee supply chains and to identify gaps. At the same time, new insights emerging from the coffee industry can, in turn, enrich and extend SSCM scholarship.

3. Methodology

This paper uses the systematic literature review (SLR) method to assess existing research and identify gaps for future study.[26] Systematic review, or SLR, was first introduced in the medical academic field.[42] Cochrane[43] first described how researchers might draw conclusions based on the evaluation and synthesis of several studies. Later, Mulrow[44] refined these recommendations to encourage a more methodological approach, and systematic reviews became an essential part of expanding medical knowledge. Today, SLRs have become a crucial component in other fields as well.[42]

In management studies, Tranfield *et al.*[26] developed a protocol for systematic reviews. The purpose of systematic reviews is to offer collective knowledge of fields and subfields through theoretical synthesis.[26] Unlike non-systematic reviews, a high-quality SLR follows defined steps for selecting and analyzing literature, aiming to provide new insights and guide future research.[45] SLRs often follow six steps: (1) define research question, (2) select article criteria, (3) collect the initial database, (4) apply inclusion/exclusion filters, (5) synthesize the studies, and (6) report the results.[42]

This paper follows the procedure above. First, two research questions are defined. Second, search terms are selected to find articles about sustainable coffee SCM. Third, these keywords are applied in the selected databases of Scopus and Web of Science to obtain the initial dataset, then duplicates in this set are removed. Fourth, the titles

and abstracts of the articles are screened, and inclusion and exclusion criteria are applied to obtain articles relevant to the research. Fifth, the full text of articles in the final dataset are read, and the studies are organized into main themes. Sixth, the findings in each theme are reported, the results are discussed, and future research directions are presented. The article identification, screening, and scope delimitation process is summarized in Figure 2.

3.1. Define search terms

The search string for the topic has three elements. First, the keywords for sustainable-related terms are "sustainab*", "biodivers*", "environ*", and "green". The second keyword is "coffee". Last, the keywords for supply chain-related terms are "supply chain*", "value chain*", and "logistic*". All three elements were combined to capture the most relevant articles.

Scopus and Web of Science were chosen as databases, as they are widely used and together cover 95% of academic articles.[46] The authors applied the search string within the article title, abstract, and keywords. Inclusion criteria limited results to peer-reviewed journal articles published in English, excluding conference papers and book chapters. Articles published up to the end of 2025, were considered, with no restrictions on the start date.

3.2. Search results

The initial search process identifies 1610 articles, with 707 from Scopus and 903 from Web of Science. After removing duplicates using Excel and basic coding, 991 unique articles remained. Data on each article's title, author, journal, year, and abstract were recorded.

Next, eligibility screening was conducted by reviewing titles and abstracts. Articles excluded are either: (i) not related to coffee, (ii) about coffee but not related to sustainability, (iii) about coffee but not related to SCM, or (iv) lacked business insights. This screening resulted in 307 substantively eligible articles. These records formed the eligible pool before the application of the management-oriented journal-scope boundary described in **section 3.3**.

3.3. Data analysis

For the core descriptive and thematic analysis, the authors retained articles published in journals listed in the 2024 Academic Journal Guide (AJG). The AJG, formerly known as the ABS Guide, is a widely used journal guide within business and management research. Articles published in journals across all AJG rating bands: 1, 2, 3, 4, and 4* were eligible, and no minimum rating threshold was imposed. The AJG criterion was used to delimit the disciplinary scope of the review rather than as a proxy for

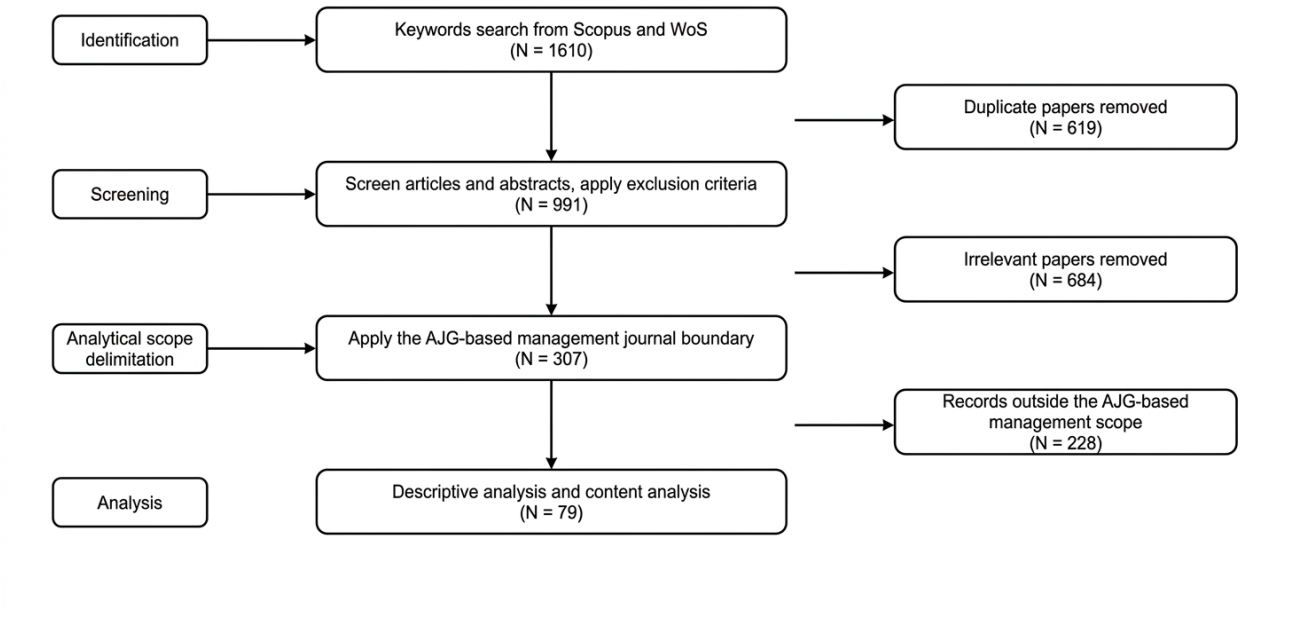


Figure 2. Framework for systematic review. Flowchart developed by the authors based on the review procedure and screening results of this study.

the methodological quality of individual articles. Applying this boundary reduced the analytical corpus from 307 substantively eligible articles to 79 articles.

This boundary gives greater analytical prominence to organizational governance, business models, interorganizational relationships, traceability, decision support, and market-facing issues within sustainable coffee supply chains. Conversely, research published in agricultural economics, development studies, agronomy, food science, and other non-AJG outlets may be underrepresented, particularly work on farm-level agronomic practices, rural livelihoods, and development-oriented outcomes. The findings should therefore be interpreted as a synthesis of management-oriented scholarship rather than an exhaustive account of the multidisciplinary coffee sustainability literature.

The full texts of the 79 articles were reviewed and coded by two authors. Initial coding identified the focal sustainability problem, actors, governance or managerial mechanism, method and theoretical lens in each article. The coding results and emerging thematic structure were subsequently reviewed and discussed by the full author team. Where differences in coding interpretations or theme assignments arose, the relevant articles and coding decisions were revisited and discussed until consensus was reached. Related codes were then grouped into seven higher-order themes: (i) certification schemes, (ii) sustainability initiatives, (iii) sustainable business models, (iv) supply chain strategy, (v) traceability and technological solutions, (vi) decision support and impact assessment, and (vii) sustainable consumption.

Results are presented in two steps in the next section: a descriptive analysis and a thematic analysis, as recommended by Tranfield *et al.*[26] Descriptive analysis reports a basic set of categories for example, the number of articles per year, leading journals, research regions. Thematic analysis is reported after reading the full text of the final set of articles. It provides information about what has been studied in the literature and what consensus is shared. Tranfield *et al.*[26] also recommended finding emerging themes and suggesting future research avenues, which will be covered under discussion.

4. Results

4.1. Descriptive analysis

The 79 articles were published between 2004 and 2025. Figure 3 shows that the number of articles increased until 2022, temporarily declined in 2023–2024, but rebounded again in 2025. Initially, only 1 to 2 articles were published each year except 2012. From 2017, this figure rose to 4 to 9 articles per year, peaking in 2022. This aligns with the increasing call for sustainability, with the notable UNDP 17 sustainable development goals. Sustainable coffee supply chain management has developed from a small and intermittent literature into a more established, although

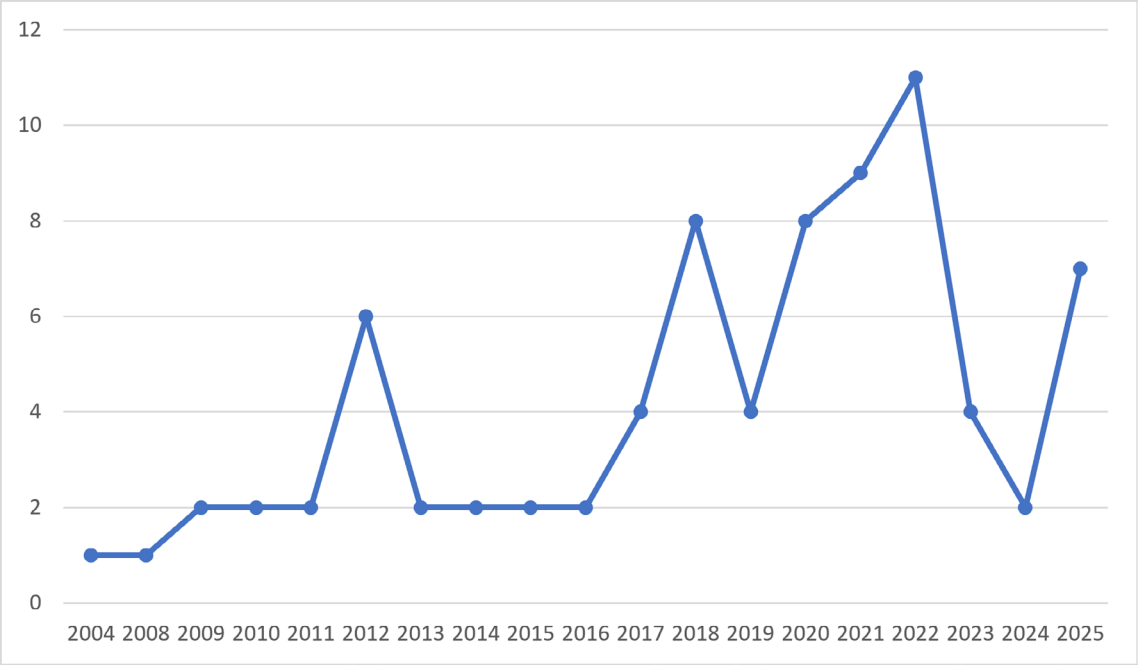


Figure 3. Number of articles published per year (N = 79)

still uneven, research stream.

The articles were published in 42 journals, with the top 8 listed in Table 2. These journals accounted for 44 articles, representing 55.7% of the 79 articles.

Table 2. Top 8 journals contributing to sustainable coffee supply chain management

Journal	Number of articles
Journal of Cleaner Production	8
World Development	8
Ecological Economics	7
Business Strategy and The Environment	6
British Food Journal	5
Journal of Rural Studies	5
Supply Chain Management: An International Journal	3
International Journal of Operations Production Management	2

Articles that analyze producing regions focus on Latin America, Africa, and Southeast Asia. The main consuming regions in the literature are Europe, North America, and Asia Pacific. Among producing countries, Brazil is the most studied, and the USA has the most research for consuming countries. Figure 4 illustrates the distribution of articles across the regions above.

Furthermore, of the 79 articles, 16 (accounting for 20%) utilized theoretical lenses to solve research problems (see Table 3). Among them, the decoupling lens and the Theory of Planned Behavior (TPB) were used twice respectively, while the other theories were used only once. Compared to disciplines such as economics, finance, and marketing, supply chain management seems to lack a dominant theory. However, given the complex, multinational scope, and interdisciplinary nature of sustainable coffee supply chains, the topic naturally provides opportunities for the application of theories such as institutional theory, complex adaptive system (CAS) theory, and actor network theory (ANT). Most theories are used to illuminate a single actor, intervention, or outcome rather than to connect governance choices, interorganizational relationships, institutional contexts, consumer behavior, and sustainability performance. The theoretical opportunity is therefore not simply to import more theories, but to specify which level of analysis each theory explains and how complementary lenses can account for multi-level and cross-theme mechanisms. Table 3 also maps these theoretical lenses across the seven themes. This shows that theoretical applications are unevenly distributed across themes, with some areas drawing on a broader range of theories than others.

Finally, according to the identified seven themes, Certification schemes have the most articles, accounting for 34.18%, followed by Sustainability Initiatives. Sustainable consumption has the lowest number of articles, with six articles in this theme, representing 7.59%. The total percentage exceeds 100% because some articles belong to more than one theme.

Figure 5 illustrates the thematic classification of the review dataset, and Figure 6 presents the thematic analysis regarding the sustainable coffee supply chain management.

4.2. Content analysis

4.2.1. Certification schemes

The coffee industry's most common sustainability governance mechanism is Voluntary Standard Systems

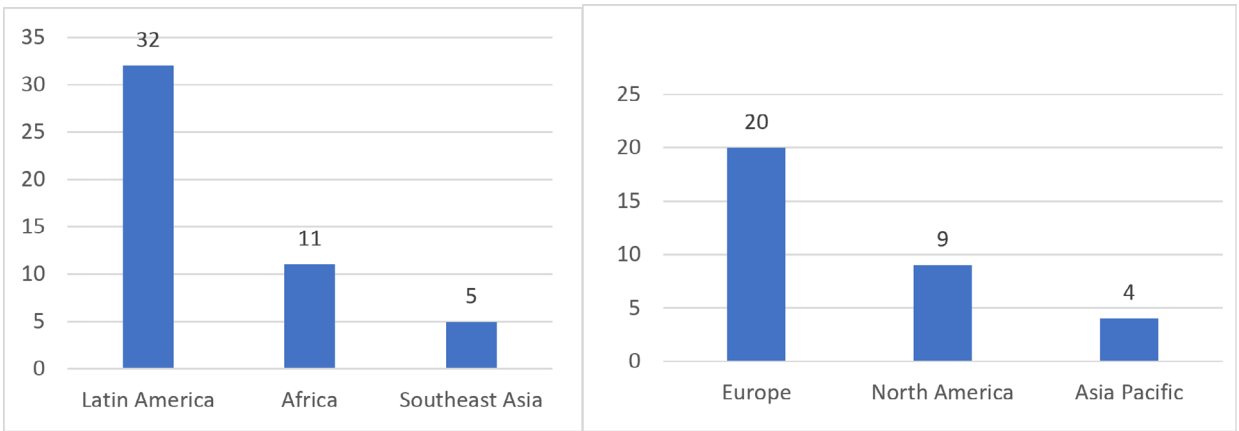


Figure 4. Main producing (left) and consuming regions (right) of coffee

Table 3. Theories adopted in articles

Theory	Number of uses	Ref.	Theme(s)
The lens of decoupling	2	Dietz *et al.* (2021), Renard (2022)	Certification schemes
Theory of Planned Behavior (TPB)	2	Chen (2020), Dionysis *et al.* (2022)	Sustainable consumption, Traceability and technological solutions
Co-evolutionary theory and organizational field perspective	1	Manning *et al.* (2012)	Certification schemes
Human ecology viewpoint	1	Fontana and Pisalyaput (2022)	Supply chain strategy
Institutional theory	1	Pereira *et al.* (2023)	Certification schemes
Knowledge-based view	1	Silva *et al.* (2023)	Supply chain strategy
Legitimacy theory	1	León-Bravo *et al.* (2022)	Traceability and technological solutions
Relational view	1	Pereira *et al.* (2021)	Supply chain initiatives
Social brokerage	1	Quiñones-Ruiz (2021)	Supply chain strategy
Socio-legal theorization	1	Grabs (2025)	Sustainability initiatives
Stakeholder theory	1	Bager and Lambin (2020)	Sustainability initiatives
Structural hole theory	1	Johnsen *et al.* (2022)	Supply chain strategy
Theoretical concept of proximity	1	Edelmann *et al.* (2022)	Sustainable business models
Transaction Cost Economics (TCE) and collective	1	Abdullah *et al.* (2025)	Supply chain strategy

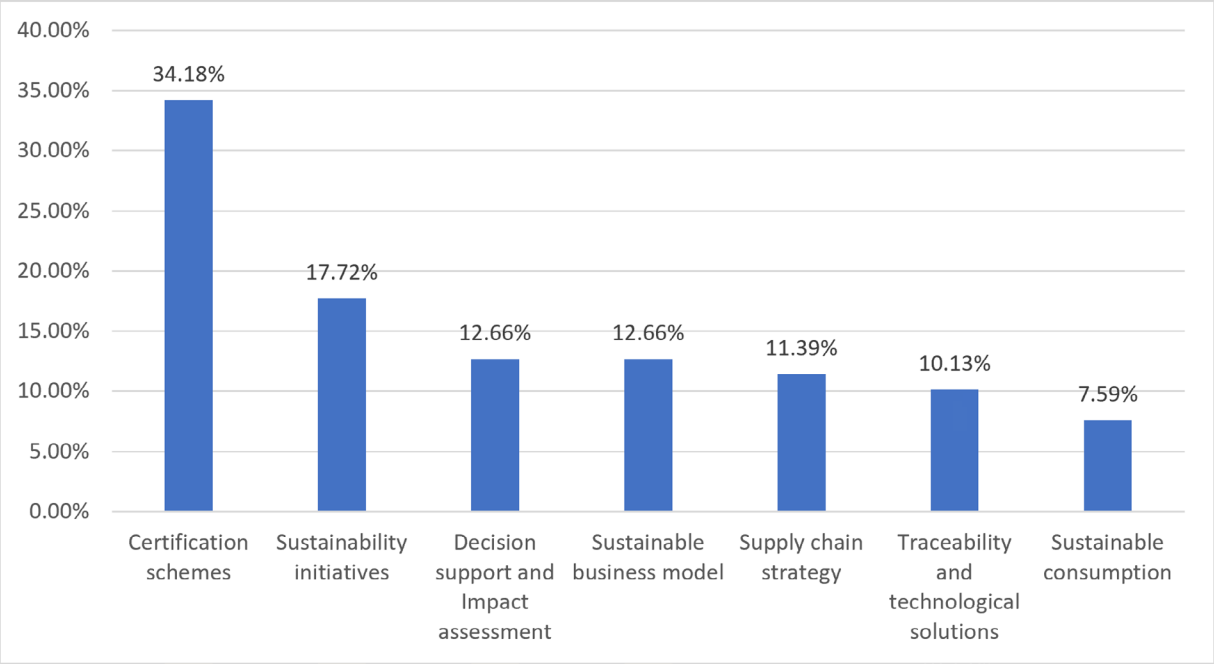


Figure 5. Number of articles in each theme ($N = 79$)

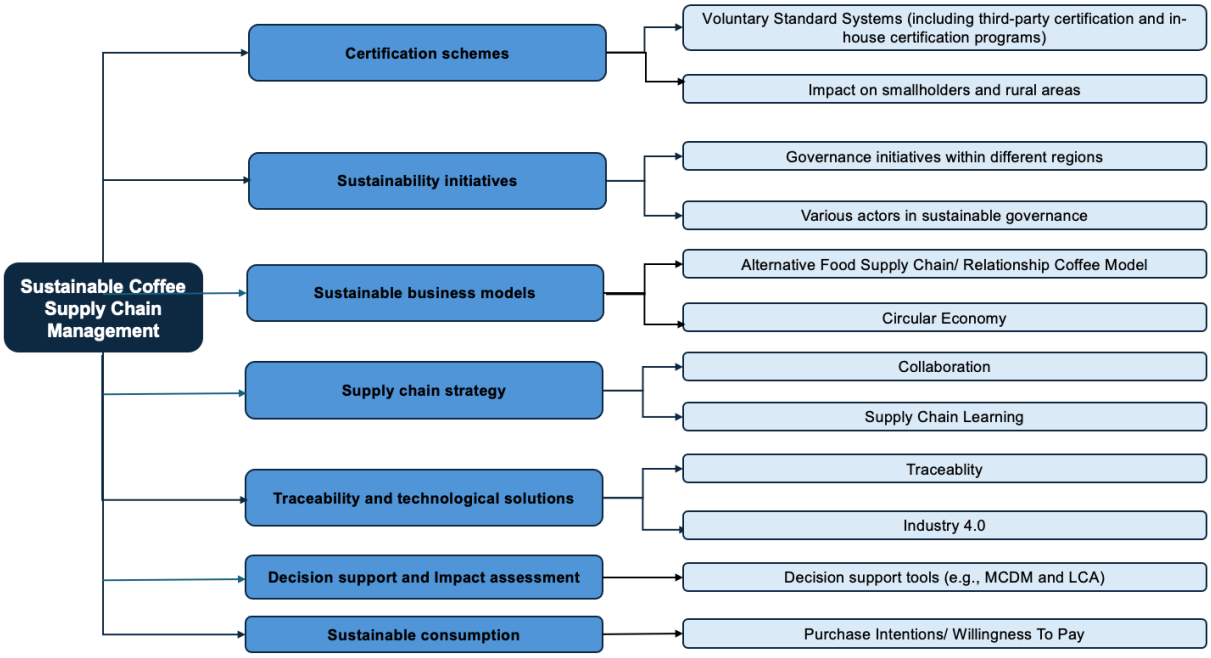


Figure 6. Main themes in sustainable coffee supply chain management

(VSS), which aim to address social and environmental issues while improving quality and profits for farmers.[47] VSS consists of third-party certification programs led by NGOs, and in-house sustainability standards developed by large corporations. In the 2019/20 coffee year, the total volume of certified or verified coffee was equivalent to approximately 55% of global coffee production, although this figure was not adjusted for double or triple certification[48]. The most common third-party certifications are Fairtrade (FT), Organic, Rainforest Alliance (RA), and UTZ. In addition to third-party certifications, firms also use company-led sourcing programs (*e.g.*, Starbucks C.A.F.E. Practices; Nespresso AAA) and baseline verification schemes such as 4C for high volume mainstream sourcing. To clarify the landscape of certification and sustainability standards in the coffee sector, Table 4 provides a comparative overview of the major sustainability standards and sourcing schemes identified in the reviewed literature.

4.2.1.1. Third-party certification programs

Historically, Fairtrade and Organic were the most adopted VSSs, but UTZ and RA have grown faster due to their compatibility with mainstream businesses.[49] Research in RA includes comparing benefits between group and individual certification,[50] and assessing environmental and economic outcomes of farmers.[51] Findings suggest RA promotes environmentally friendly practices but does not significantly affect incomes.[51]

Fairtrade (FT) is the most studied scheme in the literature. It aims to enhance conditions for marginalized farmers by setting minimum prices.[52] Studies examine premium distribution, environmental and social outcomes, scheme stringency, and buyer types.[52-55] Reported producer shares vary substantially: approximately 14–17% of the retail price in the United States, 24–31% of the Fairtrade premium reaching the producing country in Sweden, and around 50% of the premium reaching farmers in Germany.[52,53] These figures should not be treated as directly comparable estimates because they use different denominators, geographic markets, chain structures, and measurement approaches. The more consistent cross study finding is that downstream actors, particularly roasters, retain substantial value and that consumers have limited visibility over how the premium is allocated. This shifts the analytical question from identifying a universal producer share to explaining how market structure, contracting arrangements, certification costs, and transparency shape distributional outcomes. Environmental effects are also limited in some settings,[56] while mainstreaming appears more responsive to lower certification costs than to weaker standards.[55]

4.2.1.2. In-house certification programs

Among all certification types, 4C Association compliant coffee is the most prevalent. The 4C was initially proposed in 2003 with multi-stakeholder involvement and is

Table 4. Comparison of major sustainability standards and sourcing schemes in the coffee sector

Scheme	Governance/scheme structure	Core focus	Key features
Fairtrade (FT)	Third-party certification, governed by Fairtrade International and certified by FLOCERT	Fair trade, producer livelihoods, and economic, social, and environmental sustainability	Fairtrade Minimum Price and Fairtrade Premium
Organic	Third-party / regulation-based certification, national/regional organic authorities + accredited certifiers	Restricts the use of synthetic inputs and emphasizes ecological production practices	Emphasizes production processes and input controls
Rainforest Alliance (RA)	Third-party certification system governed by Rainforest Alliance, with audits conducted by authorized certification bodies	Integrated biodiversity/forest protection, labor & human rights, climate resilience, and farm management	2020 standard strengthened human-rights, livelihood and deforestation requirements
UTZ (now within RA system)	Former third-party certification program, with UTZ and Rainforest Alliance merging in 2018	Good agricultural practices, farm management, traceability, working conditions, and environmental protection	Gradually phased into the Rainforest Alliance 2020 Certification Program following the 2018 merger
Starbucks C.A.F.E. Practices	Company-led verification scheme, led by Starbucks	Quality plus economic/social/environmental indicators, transparency and continuous improvement in sourcing	Over 200 indicators, third-party verification, Starbucks-developed sourcing program
Nespresso AAA Sustainable Quality™ Program	Company-led sourcing scheme, led by Nespresso (Nestlé)	High-quality coffee sourcing, farmer livelihoods, productivity, and environmental protection	Co-developed with RA (2003), integrates quality and sustainability
4C Code of Conduct	Baseline industry third-party certification, with multi-stakeholder governance managed by 4C Services	Entry-level / baseline TBL standard for mainstream coffee, aiming for broad diffusion	Fast diffusion and high market share, debated for relatively low stringency, and widely used for mainstream coffee sourcing by major brands (*e.g.*, Nescafé)

positioned as a "baseline" sustainability standard for the coffee industry, aiming to promote sustainability in the mainstream bulk coffee market. And it underwent a major organizational and system transition around 2016–2018.[55] Its standards cover economic, social, and environmental dimensions, and producer groups (4C Units) are verified through third-party audits. Compared to higher threshold certifications like Fairtrade and RA, 4C is widely regarded as a "baseline" approach: it spreads quickly and has broad coverage, but its effectiveness in improving farmers' incomes and generating sustainable additionality is debated. As a result, there is frequent academic discussion about the tension between its "mainstreaming" and "weak standards". Although 4C is not strictly an in-house program, it is used by companies such as Nestlé to verify their in-house processes. For producers adopting 4C, the area with the most improvement is environmental sustainability. However, participating in 4C does not give competitive advantages in terms of better price, quality, or productivity.[57] Another dimension studied is decoupling, which is the difference between the certification standards and their implementation on farms by producers.[58] Renard[59] shows that some companies adopt 4C standards merely to satisfy lead firms, not to advance sustainability goals.

Compared to third-party schemes, in-house standards are less studied. Alvarez *et al.*[60] conducted empirical longitudinal research on the multi-stakeholder Nespresso AAA program over five years to examine how the governance mechanisms evolve within the context of uncertainty. Giuliani *et al.*[58] found that in-house certifications tend to improve environmental but not social practices, largely because environmental practices yield faster benefits and are easier to implement.

Few studies have studied both third-party and in-house certifications. Dietz *et al.*[61] developed the "Voluntary Coffee Standards Index" (VOCSI) to compare the strength of different VSSs in four main criteria: social, environmental, economic sustainability, and compliance enforcement. According to VOCSI, UTZ is the strongest certification, Fairtrade USA ranking second, and RA ranking third. For mainstreaming, 4C is the most popular, accounting for 47% of certified coffee, the second is UTZ at 15% and Fairtrade International at 10%. The study observes that in-house certifications are usually weaker than third-party schemes, but about 60% of certified coffee is governed by these weaker schemes like 4C, AAA, and C.A.F.E. Manning *et al.*[62] found that though standards are often initiated by consuming countries, standard transmission and selection

are determined by the producing country's institutional and economic structures.

4.2.1.3. Impact on smallholders and rural areas

Twenty-five million smallholders, with farms smaller than 5 hectares, account for 70–80% of total coffee production,[4,63] hence this type of player receives great attention in the literature. The studies on smallholders' adoption of VSS include barriers,[64] economic benefits,[64,65] change in supply chain relationships,[66] decoupling, and mainstreaming.[67,68]

The barriers for smallholders to adopt certification are limited knowledge and financial resources and difficulties in forming cooperatives as required by some schemes.[64] Moreover, a high level of decoupling from both VSS requirements and consumers' expectations is observed, even with mandatory requirements.[68] In terms of economic benefits, coffee with both Fairtrade and Organic certification receives the highest price premium, followed by Fairtrade-certified coffee. RA has the highest price, followed by UTZ and 4C.[68] If smallholders have already participated in third-party certifications, adopting an extra company-led certification will not improve their economic performance.[68] However, the decision to participate in certification schemes is not always voluntarily made by farmers. Multinational corporations in the North can choose to only source their coffee from certified farms, and farmers have no option but to comply if they want to sell to big players.[65] Moreover, higher premiums and prices do not translate to higher profits compared to non-certified farmers.[64] And VSS requirements are often delivered as bundled packages and include labor-intensive practices, compliance can shift intra-household labor burdens: potentially increasing women's workloads and constraining their time agency, which complicates equity claims associated with certification.[69] At the same time, certifications with lower requirements and premiums like 4C usually disseminate better, despite limited additionality to current sustainable practices of farmers. This is concerning because 4C coffee is the most common among certified coffee, shaping how consumers view sustainable coffee while barely improving sustainable practices.

Few studies examine the social implications of adopting VSSs for rural livelihoods. Akoyi *et al.*[70] examine the child schooling effect of private sustainability standards (FT, Org, 4C, Utz, and RA) in Africa. The study found that only Fairtrade has a positive effect on children's education. This result is not explained by either higher income or prohibition of child labor, but rather by raising awareness. Moreover, Ruben[71] finds that while market-based schemes ensure minimum prices for farmers, they also distribute value unequally within the supply chain, and only a small portion of certified coffee is sold under the label. Hence, these initiatives mostly benefit a group of mid-size farmers rather than smallholders.

4.2.3. Sustainability initiatives

This theme discusses other sustainability initiatives and governance mechanisms that do not focus on VSS. According to Vermeulen and Kok[72], sustainable supply chain governance is defined as "forms of cooperation of market actors in (international) supply chains, possibly together with non-market actors, in improving the environmental and social conditions of production operations." These mechanisms can be initiated within a region, by a company, or by other actors in supply chains.

Regional initiatives reveal that similar upgrading strategies can generate different outcomes. In Rwanda, the SPREAD program and coffee washing stations improved quality coordination and farmers' economic conditions.[73] In Uganda, however, smallholders' attempts to undertake post-harvest processing reduced value because buyers could not reliably verify bean quality and responded with lower prices.[74] The contrast suggests that on-farm or local processing is not inherently upgrading. Its effects depend on complementary conditions, including quality-control infrastructure, buyer trust, collective organization, market reputation, access to technical knowledge, and the ability to transmit credible information. In this sense, value chain upgrading is a contingent governance problem rather than a transferable technical prescription. Other regional studies similarly show that farm size and incentives shape the feasibility of sustainability practices,[75] while national institutional capacity influences whether countries rely on private certification or domestic differentiation systems.[13]

The study of Grabs[13] in Costa Rica and Colombia addresses a different paradox: whether to opt for private schemes or use their existing national system. The result shows that while Costa Rica, having a high reputation for sustainability, replaces third-party certifications with Geographical Indication, Colombia adopts these certifications. The choice of these nations is different because of their state capacity for integration of international standards and country-wide differentiation. In Nicaragua, many farmers practicing certification-worthy practices remain uncertified due to the high cost of adoption. As an alternative, Starobin[76] investigates GPAE, a "farmer to farmer" arrangement to solve this problem. GPAE focuses on local consumption and other niche markets. The study argues that transnational schemes are to serve consumers' demand, so in essence, it cannot be as fair as it claims and farmers can experiment with setting up initiatives such as GPAE, which puts their basic needs

before entertaining distant consumers.

Beyond regional approaches, the literature also examines how various actors can govern sustainable supply chains. Studies focus on how governments facilitate sustainability,[72,77] traders promote sustainability knowledge,[78] retailers occupy a critical leverage point for sustainability transformation,[15] and intermediaries can lead in sustainability transition.[14] Nevertheless, roasting companies are actors that receive the most attention, with studies on how they select sustainability governance schemes,[10,79-81] and encourage environmentally friendly practices.[80,82,83] It is worth noting that, as sustainability governance shifts from voluntary schemes to mandatory due-diligence requirements, compliance is no longer a purely technical exercise; instead, it is becoming a contested, negotiated process of governance co-produced by multiple actors.[84]

Rueda *et al.*[10] identify seven common instruments for promoting sustainability in supply chains: (1) direct investment at origin, (2) geographic indication, (3) NGO-led certification, (4) multi-stakeholder commodity roundtables, (5) Internal code of conduct, (6) Retailer-imposed standard, (7) Bans and moratoria. Which instrument to adopt is dependent on pressures in the producing country, power over suppliers, and characteristics of the consuming country.[10] Bager and Lambin[79] later add that company size matters. Large companies prefer 'hands-on' governance, where they develop internal practices and code of conduct when small companies prefer 'hands-off' governance through VSS adoption. The studies of big players like Starbucks,[10] Sara Lee,[81] and Tim Hortons[80] show that these companies prefer developing codes of conduct tailored to their needs. However, their sustainability approaches can still be challenged by consuming country regulations[81] or criticized for not being strict and specific enough.[80]

4.2.4. Sustainable business models

The coffee supply chain is often long and involves several intermediaries, leaving producers in the Global South with limited information about consumer markets in the Global North.[74] Moreover, the bargaining power within the supply chain is concentrated in a few major roasting multinational companies.[8] They have the power to define "sustainability" in the terms that provide them the most benefits,[59] while farmers are heavily affected by coffee price fluctuations.[85] For example, retail specialty prices can rise steadily while producer-country shares remain relatively low and volatile, indicating a persistent misalignment between value creation and value capture.[2] Researchers have studied alternative supply chains to overcome these problems, with relationship coffee model[8,9,85,86] and circular economy[87-90] being the most common sub-themes.

Alternative food network (AFN) is defined by specific qualities of products and a closer relationship between producers and consumers.[8] In the third wave coffee revolution, coffee is differentiated not only by quality but also by availability, variety, origin, craftsmanship, and sustainability attributes.[86,91] In this "specialty coffee" sector, some roasters form direct trade relationships with cooperatives to gain exclusive access to unique coffee profiles and shorten the supply chain by excluding most intermediaries.[8,9,92] This type of direct trade is called the relationship coffee model (RCM), with the same foundations as other spatially extended AFN.[93]

The early studies investigate the alternative arrangements of cross border supply chains through building long-term business-to-business relationships.[85] Then, during the third wave, the research looked at how specialty coffee has evolved,[86] the proximity dimensions of RCM,[8] and outcomes from participating in RCM.[9] While some AFNs focus only on geographical proximity between farmers and buyers, proximity scholars look into additional aspects such as organizational, institutional, cognitive, and social.[8] Mixed results regarding specialty coffee prices are recorded. While Boaventura *et al.*[86] believed that the increase of value-in-use in the specialty coffee value chain can lead to higher prices, Hernandez-Aguilera *et al.*[9] argue that there is no discernible difference in farm-gate prices between RCM and non-participants. Although RCM has improved farmers' knowledge of the downstream segment,[9] the high quality coffee requirement can lead to farmers' dependence on roasters.

SCM mostly entails the creation and delivery of goods or services in the forward direction towards consumers.[87] The circular economy (CE), which advocates a closed-loop of material flow, offers an alternative to this paradigm.[90] Circular business models aim to slow, narrow, and close resource loops, reducing resource intake and waste, while minimizing emissions.[94] The studies in this sub-theme consist of drivers and barriers to CE implementation,[90] and a framework to promote CE considering consumers' viewpoint.[87] Additionally, a closed-loop supply chain consists of the original forward supply chain and a reverse supply chain.[95] Research on reverse logistics consists of reducing or recycling packaging waste[87,88] and using coffee residues for biofuel production.[89]

4.2.5. Supply chain strategy

A major shift in recent years has been the move from a supply chain with clearly defined roles to one that is more fluid, with cross-cutting responsibilities and

increased collaboration among actors.[4] Strategies, such as collaboration[11,96-98] and supply chain learning,[12,28,99,100] involve multiple stakeholders and have a significant impact on the supply chain sustainability.[101] Compliance-based model is not always effective when lead firms want to implement sustainability practices across the value chain, since producers may find shortcuts to adhere to these codes of conduct superficially.[96]

Greater cooperation is believed to change the power dynamics within the supply chain.[96] Pereira *et al.*[97] use the relational view concept[102] to conclude that collaborative initiatives yield relational rents that cannot be obtained if operated independently and provide suppliers with a better understanding of global demand. Moreover, the literature investigates several forms of collaboration, from farmers-NGOs[11] to producers-lead firms,[96] and through social brokerage.[98] All studies on this theme have pointed out that building trust is an important prospect in collaboration, and can be achieved through engaging closer with farmers at the community level,[11] or involving researchers.[98] Furthermore, improved knowledge sharing as a result of collaboration can be a tool to deal with the imbalanced power dynamics.[98] Relatedly, drawing on Transaction Cost Economics (TCE) and collective action theories, Abdullah *et al.*[103] found that cooperative governance reduces transaction costs and enhances financial inclusion, whereas middleman-dominated chains involve higher transaction costs and greater power asymmetries.

Supply chain learning (SCL) is becoming more prevalent in SCM literature on collaboration.[28] Sustainable SCL can be understood as "sustainability-related knowledge, behaviors, and values resulting from the experiences of SC actors in implementing sustainability initiatives",[12] and occurs in four steps: acquiring, distributing, interpreting, and storing.[104] Studies on SCL have taken on an inter-firm perspective, with the focal actor being the supplier[12,100] or the buyer.[28,99] Suppliers can drive learning by strategically selecting buyers.[100] From the buyer end, Biotto *et al.*[28] illustrate how the diffusion of knowledge and culture of quality from the focal company illycaffè can lead to economically sustainable SCL. Moreover, buyers also play a bridging role in sustainability diffusion to upstream and downstream actors.[99] Retailers can act as pivotal change roles by coordinating initiatives upstream with farmers and downstream with consumers, effectively linking sustainability action across both ends of the chain.[2] While most SCL studies focus on stakeholder roles, Pereira *et al.*[12] explore how the learning process occurs during an unprecedented event like COVID-19. The literature on SCL has acknowledged the importance of a two-way learning loop.[11,99,100] It is common for the focal firm to diffuse sustainability practices upstream, but a knowledge feedback loop from the suppliers is also necessary for effective dissemination.

4.2.6. Traceability and technological solutions

Research on this topic aims to reduce information asymmetry, which can have a positive effect on sustainable consumption decisions. Traceability can be defined as "the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution."[105] The benefits of a traceability system are improved handling of food quality crises, better inventory management, and enhanced marketability of goods that are verifiable.[106] In the literature, León-Bravo *et al.*[107] explore the link between traceability and sustainable supply chains, finding that moral legitimacy fosters a synergistic relationship, while pragmatic motives do not. Before this study, Raynolds[54] explained how "market-driven" companies can transform the relationship between producers to buyers from partnership to traceability. From these studies, it is safe to conclude that whether the uptake of traceability can contribute to a sustainable supply chain is dependent on the objective of the company.

Studies on Industry 4.0 (I4.0) in the agricultural supply chain mainly focus on two aspects: digitalization integration and agricultural production technology.[20] Digitalization enhances information flow across supply chain actors,[108] while production tech aims to reduce environmental impacts. Tseng *et al.*[20] found that digitalization integration, social responsibility, labor conditions, and supplier management are attributes of SSCM. Furthermore, they identified the interrelationships among these attributes and pinpointed the critical attributes. Within digitalization, research covers blockchain technology (BCT),[18,24] and data architecture to reduce information asymmetry.[16,17] Balzarova *et al.*[18] interviewed blockchain technology and Fairtrade experts to measure their readiness to adopt BCT for Fairtrade products. While the blockchain representatives have a positive attitude towards implementing BCT, Fairtrade representatives are much more skeptical and less ready to adopt it. Additionally, Sayogo *et al.*[16,17] analyze the I-Choose platform, designed to reduce information gaps in traceability. Their research identifies key challenges: ensuring high data quality and designing systems that balance commercial needs with consumer transparency. Petrillo *et al.*[19] developed a mobile application that combines blockchain with RFID and barcodes to capture and record data from farm inspections to shipment and processing, thereby improving transparency and traceability across stakeholders.

Across the coffee-specific literature, digital technologies are examined primarily in terms of their potential to improve transparency, data sharing, and traceability, while evidence of their actual economic, social, and environmental outcomes remains limited. Blockchain experts may be optimistic while certification organizations remain cautious, and platform studies repeatedly identify data quality, interoperability, commercial confidentiality, and user participation as implementation constraints.[16-18] The mobile application developed by Petrillo *et al.*[19] illustrates movement toward integrated farm-to-processing data capture, but the literature does not yet establish whether such systems redistribute value, reduce environmental impacts, or improve smallholder inclusion. Digitalization should therefore be understood as a governance infrastructure whose effects depend on who controls data, who bears implementation costs, and how information is converted into decisions.

4.2.7. Decision support and Impact assessment

The sustainable food supply chain requires support for multiple decisions.[101] Therefore, having decision support tools to decide what to prioritize,[20,61,109] or assessing the environmental impact of the supply chain[110-115] is of great importance.

The use of multi-criteria decision-making (MCDM) tools has been prevalent to support those decisions, as well as analyze drivers and barriers.[101] Do *et al.*[109] adopted the Technique for Order of Preference by Similarity to the Ideal Solution (TOPSIS) to rank parameters that help the Vietnamese coffee industry to grow sustainably. In Indonesia, Tseng *et al.*[20] used the cause-effect model to determine the aspects to be prioritized to improve SSCM, and integrated fuzzy Delphi to validate SSCM practice indicators with fuzzy DEMATEL and ANP to map interdependencies and prioritize practices, offering a structured decision-support scheme for managers. On the company level, decision-makers can get overwhelmed when choosing sustainable governance practices, especially with third-party certifications. Dietz *et al.*[61] introduced VOCSI, the index that compares certification schemes by social, environmental, economic, and compliance metrics, to help firms easily choose the scheme that align with their goals.

Life cycle assessment (LCA) is the most comprehensive environmental impact method represented in the coffee corpus. Studies assess roasting, compare coffee preparation systems, support carbon-neutral certification, and examine water footprints.[110,111,113,114] Their findings show that the location of environmental hotspots varies with product system boundaries and consumer-use assumptions, for example, water heating and dishwashing can dominate some preparation scenarios.[111] This makes methodological choices and regional consumption data central to interpretation. LCA can also be costly and data-intensive, which explains interest in screening approaches such as Hot Spot Analysis and Material Input Per unit of Service.[112,115] The literature therefore presents a tiered decision problem: managers need methods that balance comprehensiveness, timeliness, data availability, and the ability to integrate environmental results with social and economic consequences.

4.2.8. Sustainable consumption

With easy access to information and various channels to express their concerns, consumers are more powerful than ever.[4] Sustainable consumption means consuming in ways that minimize harm to future generations and others.[116] Understanding consumer demand and behavior is essential to designing market-based sustainability schemes,[116] as producers are unlikely to adopt such schemes without sufficient demand from consumers.

The aspects of consumers explored in the literature are purchasing intention,[22-24] purchasing behavior,[55,87] and willingness to pay.[21] Topics linked to purchase intention include sustainability labeling,[21,23,24] traceability using blockchain,[24] and green claims.[22] Moreover, purchasing intention is found to indicate actual purchasing behavior.[117] Previous studies explored the purchasing behavior of certified coffee for customers with different involvement levels[55] and factors that promote consumers' participation in the circular economy.[87] For willingness to pay (WTP), the literature found that customers are willing to pay a premium for sustainable labeled coffee, specifically carbon-neutral labeling and blockchain-traceable coffee.[21,24]

5. Discussion

5.1. Key emerging themes

Taken together, certification schemes, sustainability initiatives, sustainable business models, supply chain strategy, traceability and technological solutions, and sustainable consumption may each contribute to sustainability, but their effects are not uniform across firms, countries, or stakeholder groups.

Evidence on certification illustrates this contextual variation. Reported producer shares of Fairtrade premiums differ across studies because the studies use different denominators, geographic markets, chain structures, and measurement approaches. Likewise, broad adoption of a standard does not necessarily imply equivalent economic or social gains, particularly when compliance costs, implementation capacity, and buyer power differ.

The contrasting findings from Rwanda and Uganda further suggest that the effects of processing upgrading depend on complementary infrastructure, quality-control capabilities, buyer coordination, and market positioning. Similarly, traceability technologies can improve information availability, but their sustainability effects depend on data quality, access, cost, and how information is used in commercial and governance decisions.

These comparisons indicate that future research should pay greater attention to the conditions under which particular practices generate economic, social, and environmental benefits, as well as to how benefits and costs are distributed among supply chain actors. Overall, the effectiveness of a sustainability practice should be assessed in relation to implementation conditions, stakeholder capabilities, and observed outcomes rather than inferred from adoption alone.

5.2. Gaps and future research direction

5.2.1. Certification schemes

Regarding farm size, more than 80% of farms worldwide are smaller than two hectares, yet they operate only about 10% of global farmland.[118] Despite the literature paying more attention to smallholders, Meemken[118] found that certification is more common among large farms, with 20% of large farms participating in VSS schemes, while that of small farms is 1%. Therefore, focusing only on smallholders may underestimate the effect of certifications. Further research is needed to investigate the motivations and barriers, as well as the sustainability outcomes of large farms from the adoption of VSSs.

The consensus that the cost of certification is a significant barrier to adopting it has been established in the literature. Studies have shown that certifications do help farmers obtain higher prices for beans and improved revenue. However, implementation and compliance costs can substantially reduce these economic benefits, and certification does not necessarily translate into higher profits for farmers.[65] More research is needed in ways to reduce the cost of certifications for producers, without sacrificing its stringency.

The non-monetary social benefits of adopting certification schemes can be further studied. Existing studies have examined social sustainability outcomes such as child schooling and rural poverty alleviation.[70,71] More dimensions of social sustainability outcomes such as food security, gender equality, and job generation can be explored.

Building on the view that the impacts of VSS are inherently multi-dimensional, future research should explicitly examine trade-offs and synergies across economic, environmental, and social outcomes rather than evaluating certification effectiveness through a single metric.[69]

5.2.2. Sustainability initiatives

Ruben[71] identified the barriers of VSS schemes to alleviate rural poverty. Ruben[71]also proposes strategies to overcome these barriers, including profit-sharing arrangements to protect farmers from price shocks, shorter and more circular supply chains, and increased local processing. Future studies can assess the efficacy of these proposals in alleviating poverty.

One of the instruments to promote sustainability within supply chains is direct investment at origin.[10] How does direct investment benefit the sustainability practices of farmers? Whether donations through NGOs or cooperatives is the most cost-effective? What are the drawbacks of this instrument compared with VSS? Those are questions that need further research in the literature.

The role of other actors in promoting sustainability initiatives is also a topic to be further investigated. Previous studies have shown that consultants can have a bridging role when forming a new governance scheme,[60] or social brokerage can facilitate producers' selection.[98] NGOs have comprehensive knowledge of sustainability practices across multiple industries, but they lack the closeness to businesses. Future studies could investigate the incentives for these actors to promote sustainable practices. Moreover, an emerging theme is the politicization of sustainable coffee SCM. This perspective implies that future research into sustainable coffee SCM should theorize not only governance instruments (such as standards, contracts, and traceability), but also political responsibilities to be undertaken by companies for sustainability-related issues in their supply chain and beyond.[119]

5.2.3. Sustainable business models

Relationship coffee model (RCM) is characterized by a close relationship between suppliers and buyers. However, power asymmetry still exists in this business model. Specifically, farmers depend on roasters for higher quality coffee, while roasters are mainly concerned about profits.[8,86] Future studies can investigate the effective ways to reduce this asymmetry in power.

Given the mixed results of economic benefits from participating in RCM, more research is needed on the topic. Meemken[6] has outlined several outcome variables to measure economic benefits, such as price, yields, revenue, and household income. Future research can use these variables to assess whether RCM farmers achieve better

economic conditions compared to non-participants.

Regarding circular economy, current research in the management field mainly focuses on recycling practices. Other research on reverse logistics, the use of coffee residues, or protecting natural resources are few or often lack business insights. Future studies should address more of these CE principles and develop tools, such as a hierarchy of circularity actions, to guide businesses toward impactful practices.

Circular business models of companies that incorporate actions from production to consumer should be further studied to gain management insights. Nestlé[120] invested $30 million in the Closed Loop Leadership Fund to support the collection of packaging materials. The company also signed the European Plastic Pacts, which aims to make 100% of its packaging reusable or recyclable by 2025.[121] Future research can investigate the effectiveness and progress of this commitment via a longitudinal case study.

5.2.4. Supply chain strategy

The reviewed articles in this theme have primarily examined collaboration within traditional forward supply chains, with limited attention to collaborative practices in circular or closed-loop supply chains. Future research can investigate collaborative practices in a circular business model. Future research could therefore investigate collaboration in circular business models, which extend beyond traditional forward flows by incorporating reverse flows and interactions across production and consumption stages.[90,94] Such research could examine collaboration with actors involved in reverse and circular flows, such as recycling partners and coffee shops.

More research on supply chain collaboration in the local supply chain is also needed. Much research centers on the roasting companies in the Global North.[11] Silva *et al.*[100] stress that understanding how sustainability knowledge is distributed in the domestic supply chain is as important as that in international supply chains. This could also assist in overcoming some of the obstacles that are commonly encountered when interacting with international markets, such as cultural differences and disparate business methods.[11]

Assessment of outcomes from collaborative practices is necessary. Existing studies have focused more on how collaborative practices are implemented than on assessing their effectiveness. As research has fairly reached the consensus that collaboration has an impact on achieving sustainability,[101] future studies can use the triple bottom line to quantify the effects of collaboration in different aspects. Comparing the triple-bottom-line performance of multiple focal stakeholders (*e.g.*, farmers/cooperatives, intermediaries, roasters/brands, and retailers) before and after incorporating cooperative practices can produce useful managerial implications.

Pascucci[122] further identifies collaborative practices as a key governance mechanism through which sustainability knowledge and learning are mobilized along the chain, particularly in support of producers in developing countries. At the same time, collaboration can itself create tensions and trade-offs that may hinder progress toward sustainability.[122] Therefore, instead of assuming collaboration is always beneficial, future research should investigate when and why collaboration works, who benefits (or loses), and what trade-offs it creates across economic, social, and environmental goals.

5.2.5. Traceability and technological solutions

Geographical indications (GI) refers to goods with qualities associated with their geographic origin. Protected GI helps local farmers gain economic benefits by upholding the reputation and uniqueness of GI products.[123] Most of the studies on GI currently look at it from the policy perspective.[123,124] It would be interesting to explore the relationship between GI and sustainable supply chain. The causal model, similar to Tseng *et al.*,[20] can be utilized.

Literature on Industry 4.0 in the coffee supply chain lacks studies on agricultural production technology. Examples of agricultural technology include water-saving irrigation, plastic film recovery, multidimensional subsoiling, and green fertilizer technology.[20] Future research can be based on the TBL to assess whether this development in I4.0 improves the sustainable farming practices of farmers.

Research on traceability should move from technology adoption to governance and outcome evaluation. Comparative studies could examine when blockchain, mobile applications, QR-based systems, and digital product passport architectures improve data credibility, smallholder inclusion, regulatory compliance, and consumer trust. Particular attention is needed to data ownership, interoperability, cyber risk, verification, and the distribution of implementation costs. Artificial intelligence (AI) represents a genuine gap because no coffee-specific study was identified in the analytical corpus. Future research could test AI-enabled risk sensing, anomaly detection, quality prediction, and premium distribution monitoring, while also examining explainability, bias, human oversight, and whether algorithmic systems reinforce or reduce existing power asymmetries. Digital technologies should be evaluated against measurable triple-bottom-line outcomes rather than novelty or adoption alone.

5.2.6. Decision support and Impact assessment

Future research on decision support should move beyond proposing established methods such as ISM or DEMATEL as novel directions and instead examine integrated, adaptive, and decision-oriented systems. AI-enabled decision support could combine farm, climate, price, certification, logistics, and consumer data to forecast risks and recommend interventions. Explainable AI is especially important because managers and supply chain partners must understand, contest, and trust model recommendations under uncertainty.[125] Research should compare predictive accuracy with interpretability, fairness, accountability, and the quality of human-AI judgment.

Digital twins and simulation-based optimization provide a second direction. A coffee supply chain digital twin could support what-if analysis of sourcing regions, processing configurations, transport modes, inventory policies, packaging systems, and circular flows before decisions are implemented. Recent supply chain research demonstrates how digital twins can integrate simulation with sustainability and resilience objectives, and how they can be combined with multi-criteria methods for dynamic risk assessment.[126,127] Coffee research should test whether such models remain usable when data are fragmented across smallholders and intermediaries and should compare model recommendations with actual organizational decisions and outcomes.

A third direction is hybrid AI-MCDM and life cycle sustainability assessment. Machine learning can update forecasts, identify nonlinear patterns, or generate scenarios, while MCDM can make stakeholder preferences and triple-bottom-line trade-offs explicit. These hybrid systems should be benchmarked against static models and subjected to sensitivity, robustness, and equity analysis. Impact assessment should also progress from environmental LCA alone toward life cycle sustainability assessment that integrates environmental LCA, social LCA, and life cycle costing. Dynamic data from traceability platforms and digital twins could make assessment timelier, but research must establish data quality standards, appropriate system boundaries, and decision rules for reconciling conflicting economic, social, and environmental results.

5.2.7. Sustainable consumption

Most of the research on sustainable consumption is carried out in developed nations, except for Brazil in the study of Abuabara *et al.*[87] The national context has been found to affect the variations in sustainability standards.[62] Therefore, future research should extend sustainable consumption research to underrepresented emerging producing countries.

Beyond expanding the geographical coverage of existing research, future studies should also move beyond cross-country comparisons of willingness to pay and purchasing intention. One priority is digital consumer engagement: field experiments and longitudinal transaction data could test whether personalized recommendations, digital nudges, loyalty incentives, and interactive provenance information produce durable changes in actual behavior rather than stated intentions. AI-enabled personalization also raises questions about manipulation, privacy, unequal access, and the risk that sustainability claims are optimized for marketing rather than impact. A second priority concerns the design and credibility of sustainability information. Research can compare blockchain transparency, digital product passports, carbon footprint labels, and broader ESG (Environmental, Social, and Governance) claims in terms of trust, comprehension, information overload, and greenwashing risk. Existing evidence on carbon neutral labels and blockchain-traceable coffee provides a foundation, but future studies should connect communication design with verified supply chain performance.[21,24] A third priority is consumer participation in circular systems, including reusable packaging, take-back and refill schemes, coffee-ground recovery, repair or reuse of brewing equipment, and community-based initiatives. Studies should evaluate which combinations of convenience, incentives, social norms, and retailer infrastructure close the intention behavior gap and whether benefits are shared across producing and consuming regions. Table 5 summarizes the future research agenda.

6. Managerial implications

The findings provide several practical implications for firms involved in the coffee supply chain. First, managers should select sustainability governance mechanisms according to firm size, sourcing capabilities, market position, and supply chain conditions. Large firms may have the resources to develop company-led sourcing standards, whereas smaller firms may depend more on established third-party certifications. However, internal schemes should include clear criteria, credible verification, and transparent reporting to avoid weak implementation.

Second, managers should assess certification schemes according to their actual outcomes rather than the quantity of certified coffee purchased. The reviewed studies show that certification premiums are distributed unevenly,[52,53] and that higher premiums and prices do not necessarily translate into higher profits for producers.[64] Firms should therefore monitor the share of value reaching farmers, the costs imposed on producers and cooperatives, and changes in economic, social, and environmental performance.

Table 5. Future research agenda for sustainable coffee supply chain management

Theme	Future direction
Certification schemes	• Motivations and barriers of large farms in adopting VSS • Reducing the cost of certifications for producers without sacrificing its stringency • More dimensions of social sustainability outcomes such as food security, gender equality, and job generation can be explored. • Evaluation of trade-offs and synergies across the economic, environmental and social outcomes of certification.
Sustainability initiatives	• Assess efficacy of rural poverty alleviation proposals • More research about direct investment at origin • Incentives of third-party facilitators (*e.g.*, NGOs, consultants, brokers) in promoting sustainable practices • More comprehensive understanding of the companies with political responsibility for sustainability-related issues in their supply chain and beyond
Sustainable business models	• Reducing power asymmetry in RCM • Assessment of economic outcomes of RCM • Address underexplored CE principles and develop tools. • Longitudinal case study of a large company implementing circular business model
Supply chain strategy	• Collaboration in circular business model • Supply chain collaboration in the local supply chain • Assessment of outcomes from collaborative practices • Investigation of tensions and trade-offs in supply chain collaboration across economic, social, and environmental goals
Traceability and technological solutions	• Relationship between geographical indicator and sustainability • Assess I4.0 applications in improving sustainable farming practices • Outcome-based comparison of blockchain, mobile, QR code, and digital product passport systems data • Ownership, interoperability, cyber risk, and allocation of implementation cost • AI-enabled risk sensing, quality prediction, anomaly detection, and premium-distribution monitoring • Explainability, bias, human oversight, and power asymmetries in AI-enabled systems • Evaluation of AI-enabled and other digital technologies against measurable triple-bottom-line outcomes
Decision support and impact assessment	• Integrated and explainable AI-enabled decision support combining multiple supply chain data sources for risk forecasting, intervention recommendations, and responsible human-AI judgment. • Supply chain digital twins and simulation-based optimization • Hybrid AI-MCDM and life cycle sustainability assessment
Sustainable consumption	• Extension of sustainable consumption research to underrepresented emerging producing countries • Digital consumer engagement and field experimentation • AI-enabled personalization and ethical safeguards • Comparison of sustainability communication approaches in terms of credibility, consumer understanding, information overload, greenwashing risk, and alignment with verified supply chain performance. • Consumer participation in circular systems, including reusable packaging, take-back and refill schemes, coffee-ground recovery, repair or reuse of brewing equipment, and community-based initiatives • Actual purchasing behavior and the intention-behavior gap

Abbreviations: AI: Artificial intelligence; CE: Circular economy; MCDM: Multi-criteria decision-making; RCM: Relationship coffee model.

Third, direct sourcing and RCM can improve coordination and information exchange,[9,85] but they may not automatically reduce power imbalances.[8,86] Managers should support transparent pricing, clearly defined quality assessment procedures, longer-term purchasing relationships, and investment in producer capabilities.

Finally, traceability and digital technologies should be adopted in response to clearly defined sustainability problems. Managers need to consider data quality, implementation costs, supplier accessibility, and the ability of smallholders to participate. Improved transparency alone does not necessarily lead to fairer value distribution.[19]

Overall, sustainable coffee supply chain management requires managers to consider not only whether a certification, business model, or technology is adopted, but also who bears its costs, who controls its implementation, and who receives its benefits.

7. Conclusion

Coffee is a globally significant commodity whose sustainability challenges extend from farm livelihoods and ecological impacts to downstream governance, value capture, traceability, and consumption. This review examined 79 AJG-listed articles to answer two questions concerning the main themes of sustainable coffee supply chain management research and its future directions. The analysis identified seven themes and provided a consolidated overview of the main issues and findings within each theme.

This paper contributes to the literature on sustainable coffee supply chain management. The key findings and contributions are as follows:

(i) The review provides a deliberately bounded business and management synthesis. Its distinctiveness lies in systematically organizing management-oriented research that is otherwise dispersed across certification, sustainability initiatives, business models, supply chain strategy, traceability and technology, decision support and impact assessment, and sustainable consumption.
(ii) The review organizes the reviewed literature on sustainable coffee supply chain management into seven themes.
(iii) The research agenda updates the directions associated with the seven themes by incorporating recent methodological and technological developments, including AI-enabled and explainable decision support, digital twins, hybrid AI-MCDM, life cycle sustainability assessment, digital product passports, carbon communication, and circular consumer participation.
(iv) The review derives practical implications for managers involved in the coffee supply chain. These implications concern the selection and evaluation of certification schemes, the management of direct sourcing relationships, the distribution of costs and benefits, and the adoption of traceability and digital technologies.

While this paper has made several contributions to sustainable coffee supply chain management, there are limitations that can inspire future studies, as follows:

(i) The chosen keywords may not be exhaustive. Although this paper has included multiple keywords regarding the sustainability and supply chain elements, some articles that fit for inclusion may have been excluded because they do not have these keywords in the abstract or title. Future studies can expand the set of keywords to obtain a more exhaustive database.
(ii) The AJG boundary narrows the evidence base and may underrepresent influential research in agricultural economics, development studies, agronomy, food science, and related fields. As a result, the review gives greater analytical prominence to organizational governance, business models, interorganizational relationships, traceability, decision support, and market-facing issues, while it may provide less coverage of farm-level agronomic practices, rural livelihoods, and development-oriented outcomes. The seven-theme structure and future research directions should therefore be interpreted as reflecting the emphases of business and management scholarship rather than as an exhaustive representation of the multidisciplinary coffee sustainability literature. A sensitivity analysis of the 228 non-AJG articles would provide stronger evidence about the consequences of this boundary.

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The authors declare they have no competing interests.

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The data supporting the findings of this study are derived from publicly available published literature cited in this article.

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