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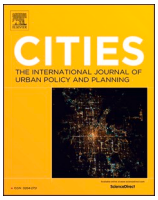

The role of short food supply chains in advancing the global agenda for sustainable food systems transitions

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ABSTRACT

Food systems are experiencing a unique momentum of transformation guided by the Sustainable Development Goals (SDGs) and the Milan Urban Food Policy Pact (MUFPP). The potential of short food supply chains to contribute to this transition both in urban and rural environments has been broadly acknowledged by policymakers and scientists. Yet no exhaustive evidence exists on their capacity to meet the goals declared. This paper categorises the benefits these chains are reported to have in 69 publications selected via a PRISMA review. It develops an exhaustive inventory of which benefit is connected with which SDG target and recommended action of the Milan Pact. Multidimensional infographics illustrate the associations between these benefits and both sets of global sustainability goals. The 348 benefits collected show disparities in current research on the topic across benefit categories, chain structures and continents. Benefits have been reported for ten SDG targets and nine MUFPP recommended actions. Quantifying externalities of short food supply chains and establishing causal effects for their targeted usage worldwide are aspects barely addressed by scientific inquiry. The insights gained help urban policymakers to understand to what extent the promotion of short food chains can help cities to meet SDG and MUFPP goals.

1. Introduction

Given that the share of the urban population is predicted to rise worldwide from 39 % in 2010 to approximately 60 % in 2050 (Kii, 2021) an increasing number of cities around the globe are investing greater efforts into the design of sustainable urban food strategies (Filippini et al., 2019; Sonnino, 2023). Food and its multifaceted societal dimensions are considered essential to achieve the seventeen Sustainable Development Goals (SDGs) agreed by the international community (Sachs et al., 2019; Wilkinson et al., 2016). As a consequence a joint declaration of the largest cities and metropolitan areas, named the Milan Urban Food Policy Pact (MUFPP), has been agreed upon in 2015 to strengthen the implementation of SDGs in urban food systems (MUFPP, 2015). This alliance calls institutions to recognise the vital role of food systems in urban planning (Cohen, 2022) through six categories of interventions articulated in 37 recommended actions (RAs). These commitments represent today the backbone of the food policy agendas of more than 200 major urban conglomerations worldwide and drive food distribution and consumption patterns of their 400 million inhabitants (FAO, 2019).

Within the global policy discourse about the required sustainability transition of food systems, the potential of short food supply chains (SFSCs) has been widely acknowledged (Augère-Granier, 2016; Belletti & Marescotti, 2020; USDA, 2022). The understanding of the comprehensive positive implications of SFSCs has been repeatedly advanced (Table 1, Forssell & Lankoski, 2018). SFSCs are promoted due to their potential to boost resilient urban-rural food economies (European Commission (EIP-Agri), 2015), facilitate local cohesion (Kneafsey et al., 2013), and improve social relationships among food system stakeholders (Chiffoleau, 2009). They have been shown to territorialize food (Venn et al., 2006) and to provide increased access to fresh and healthy food products (Galli & Brunori, 2013). The evidence about their environmental impact is divergent (Kulak et al., 2015; Loiseau et al., 2020). However, major findings refer to their environmentally sound practices (Jarzebowski et al., 2020).

Various reviews about research on SFSCs have been published (see

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Table 1). They focus on their theoretical conceptualisation (Bazzani & Canavari, 2013; Fabbrizzi et al., 2014; Thomé et al., 2021), on their logistics (Liverpool-Tasie et al., 2020; Paciarotti & Torregiani, 2021), on their implementation (Bayir et al., 2022), or on the bibliometric impact of SFSC research (Luo et al., 2021). Although Liverpool-Tasie et al. (2020) link their analysis to SDGs, they do not explicitly consider them in their analysis. The investigation is restricted to the impact of market transactions without formal contracts on the welfare of small-scale producers in developing countries. Reviews specifically tackling the sustainability of SFSCs are either focused on a single continent (Evola et al., 2022), a single SFSC type (Michel-Villarreal et al., 2019) or the consumer perspective only (Feldmann & Hamm, 2015). This comprehensive, though scattered, literature does not allow researchers to obtain a global overview of which SFSC types specific beneficial effects have been found for and which benefits have received more or less attention so far. The most comprehensive study of Chiffoleau and Dourian (2020) does not quantitatively analyse review results and does not decompose them by geographical scope or specific chain types. None of the existing analyses elaborates on the potential of SFSCs for achieving the policy goals of the SDGs and MUFPP.

Our analysis extends the existing literature by structuring and categorizing research findings and by quantitatively analysing their links to the most prominent global sustainability goals. It creates the first exhaustive database of SFSC benefits reported globally in the literature, in which benefits are catalogued by continent and by SFSC organisational structure. The search of the documents reviewed is designed to capture SFSC diversity across organisational structures and geographical scopes by considering a broad set of keywords referred to SFSCs. This analysis complements the predominantly narrative accounts on the merits of SFSCs and unifies them into a single structured framework that can be decomposed based on categories relevant to policymakers or scientists. Building on this database, this paper establishes the first inventory of the links between SFSC benefits reported and the most prominent policy goals for achieving the global sustainability transition as declared in the SDGs and MUFPP. Multidimensional infographics visually summarise these links. Last, we examine publication patterns in the bibliometric characteristics of the identified documents. This analysis provides thus timely science-based evidence suitable to establish coherent policy design (Collste et al., 2017) for aligning urban transformations with the agreed-upon sustainability goals (Grainger-Brown et al., 2022).

Our analysis does not consider costs or negative effects these chains might potentially cause (Forssell & Lankoski, 2015). We focus on inventorying and synthesising their positive effects as these are the aspects which are referred to in policy discourses (European Commission (EIP-Agri), 2015). Quantitative cost–benefit analyses of SFSCs, causal analyses of their effects on sustainability via randomised controlled trials or similar approaches or quantifications of their effectiveness, costs and disadvantages (Aubry & Kebir, 2013) are beyond the scope of this paper and, thus, left for future research.

This article is organized as follows. Section 1.1 details the methodology used for the search strategy, the data analysis, and the visualisations. Section 2 summarizes SFSC benefits and maps them to specific SDGs and MUFPP recommended actions. Section 3 discusses the results and limitations of the analysis and concludes by pointing out future research options and policy implications.

1.1. Conceptual background

SFSCs are very heterogeneously defined throughout the literature. First categorised by Marsden et al. (2000) into face-to-face, spatially proximate and spatially extended channels, these chains are understood as local or regional food production and distribution networks characterised by the closeness of producers and consumers (Goodman et al., 2011). Hence, important dimensions for their definition are geographic distance (Aubry & Kebir, 2013), the number of intermediaries (Poças Ribeiro et al., 2021) and economic relationships between participants (Sellitto et al., 2018). Connections among actors are particularly essential for the success of SFSCs (Galli & Brunori, 2013) and are mostly built on trust and reciprocity (Taylor, 2005; Torquati et al., 2016).

The term SFSCs refers currently to a wide range of organisational structures, for example, to alternative food networks (AFNs), community-supported agriculture (CSA), farmers markets (FM), box schemes (BS), home delivery or pick-your-own approaches (Bazzani &

Table 1
Existing review articles on short food supply chains (SFSCs) research.

Article	Geographical scope	No. of articles	Content scope	Temporal scope	Number of SFSC synonyms used for search	Focus on SDGs or other policy goals	Quantitative analysis
Bazzani and Canavari (2013)	Global	64	Evolution and description of SFSCs	Not specified	4	No	No
Fabbrizzi et al. (2014)	Not specified	Not specified	Classification and description of SFSCs	Not specified	Not specified	No	No
Thomé et al. (2021)	Global	51	Conceptual framework of the food supply chains and SFSCs	2015–2020	3	No	No
Liverpool-Tasie et al. (2020)	Developing countries	202	Market relationships of small-scale producers	2000–2019	7	No	Yes
Paciarotti and Torregiani (2021)	Global	66	Role of logistics in improving sustainability of SFSCs	2006–2019	3	No	No
Bayir et al. (2022)	Not specified	44	Understanding of challenges of SFSCs	2000–2020	2	No	Yes
Luo et al. (2021)	Global	684	Bibliometric mapping of research topics and future directions for SFSC research	2000–2020	4	No	Yes
Evola et al. (2022)	Europe	108	Overview of the SFSCs in Europe	2012–2021	2	No	No
Michel-Villarreal et al. (2019)	Global	61	Investigation of how sustainability has been studied in alternative food networks	2006–2017	1	No	Yes
Feldmann and Hamm (2015)	Global	73	Consumer perceptions and preferences for local food	2000–2014	2	No	No
Chiffoleau and Dourian (2020)	Global	157	Definition and characterisation of SFSCs and their sustainability	2000–2018	5	No	No
This paper	Global	69	Database of SFSC benefits and links to global sustainability goals	2000–2021	10	Yes	Yes

Source: Authors.

Canavari, 2013; Bertazzoli et al., 2010). Martinez et al. (2010) considers them as local networks where food is sold less than 400 miles away from its production origins. In contrast, the European Union (2013) in Article 2 regulation 1305/2013 defines an SFSC as a "*chain involving a limited number of economic operators, committed to cooperation, local economic development, and close geographical and social relations between producers, processors and consumers*".

To distil the commonalities among SFSCs terminologies and to embrace a global perspective, this analysis adopts the SFSCs categorisation of the UN industrial development organisation (Belletti & Marescotti, 2020).[1] We, therefore, consider short supply chains (SSCs), local food systems (LFSs), AFNs, on-farm selling, FMs, farmers' shops, CSA, BSs, solidarity purchasing groups (SPGs) and consumer managed shops as SFSCs.

2. Methods

2.1. Data collection

To identify the relevant publications reporting SFSC benefits in a transparent and reproducible way, we conducted a systematic literature review implementing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page, McKenzie, et al., 2021). Our review follows this rigorous protocol that guarantees objectivity and replicability in document selection and summary of results (Moher et al., 2015). Supplementary Fig. A shows the structure of the search strategy designed according to the PRISMA flow diagram (Page, McKenzie, et al., 2021). The review considers English-language documents from 2000[2] until the end of 2021. Our analysis takes the global perspective of the SDGs and MUFPP.

Scientific publications were searched for in Scopus.[3] The Scopus search query was deduced from the above-mentioned UN categorisation of SFSCs (Belletti & Marescotti, 2020) in combination with the keyword *benefit* and its synonyms. The search query documented in Supplementary Table A yielded 327 results. We manually eliminated duplicates and ineligible documents. Then the titles, abstracts, and keywords of the remaining 323 articles were read by the authors and the ones not focusing on SFSC benefits were manually excluded from the database if not compatible with the research objective (see Supplementary Fig. A).

We follow Garousi et al. (2019) and Paez (2017) by complementing scientific journal publications with grey literature to improve the comprehensiveness of the review. As in Bazzani and Canavari (2013) and Wood et al. (2021), we opt for targeted websites which are relevant for our research objective because there is no universal consensus on the databases to be used for identifying grey literature. Hence, we conducted a targeted search on the websites of the most relevant intergovernmental and non-governmental organisations which are working with an international scope and have a key role in the food system debate: the FAO, the MUFPP, the International Panel of Experts on Sustainable Food Systems, Slow Food, and the International Food Policy Research Institute. The website search was conducted in January 2022 for collecting documents reporting the benefits of SFSCs in line with the research objective. The websites were screened and the identified documents double-checked to guarantee validity of the search (Page, Moher, et al., 2021). This resulted in twenty-eight English-language organisation reports published between 2000 and 2021.

We accessed and read the full texts of both scientific articles and grey literature reports and only documents meeting the inclusion criteria (see Supplementary Fig. A) were manually selected. Hence, we included documents which (a) had their full text available, (b) explicitly focused on the assessment of SFSC benefits, (c) presented novel evidence which did not summarise or review previous studies, and (d) produced quantitative or qualitative results. After this rigorous and structured selection process was completed in February 2022, 64 scientific and 5 documents published by organisations were included (see Supplementary Table B).

2.2. Data analysis

Based on the final set of 69 publications, the database of reported benefits of SFSCs was established and connected to the global sustainability goals. The analysis followed the four steps outlined in Fig. 1.[4]

2.2.1. Step 1. Benefit extraction

Following Neuendorf (2002), each document was examined through content analysis. Given the heterogeneity of studies, this analysis was conducted manually to guarantee an adequate critical perspective and continuous reflection throughout the process (Anastasiei & Georgescu, 2020).[5] The identified benefits were extracted as individual text lines. The methodology used, the geographical scope and the organisational structure of the SFSCs assessed were recorded in the terminology used in the document. Additionally, to assess the claim that SFSCs are more often qualitatively analysed (Kneafsey et al., 2013), the analysis used in the document for the evaluation of the SFSC benefits was categorised into qualitative or quantitative. The data were organized in an Excel file that served as a basis for the following steps.

2.2.2. Step 2. Benefit coding

To make benefits suitable and comparable for further analysis, a set of keywords was extracted from each benefit contained in the database. The extraction was performed using the RAKE algorithm (Rose et al., 2010) which guarantees reproducibility. The algorithm results were interpreted by the authors to define a final set of essential keywords describing each benefit.[6]

2.2.3. Step 3. Benefit categorisation

Once the benefits had been coded, each benefit was categorised through deductive reasoning to systematise and unify the database. A major advantage of this process is that categories are defined prior to the analysis (Moretti et al., 2011) which increased the objectivity of the approach. To overcome the often used three-pillar sustainability construct (Luo et al., 2021), we adapted the conceptual framework of Hoang (2021) and created six thematic categories that refer to the sustainability dimensions and the related subcategories. The final categories and subcategories adopted in the analysis are summarised in Table 2 and described in detail in Supplementary Table D. For each category, a subcategory named "Others" was considered to include benefits whose characterisation did not fall in any other subcategory. The coded benefits were uniquely assigned to one category and subcategory.

To objectively quantify the uniformity of the existing knowledge, i.e., the attention of the literature on SFSC benefits across and within benefits categories, we follow Gomez et al. (2021) - who measure the diversity of a city's food inflow supply chains - and calculate the normalised Shannon entropy index S (Shannon, 1948). It has been applied to measure the concentration of bibliometric parameters (Merediz-Solá

[1] Public procurement or HoReCa are not considered since Belletti and Marescotti (2020) explicitly treat them as opportunities of supporting SFSCs.

[2] In this year, the term SFSC was firstly used by Marsden et al. (2000) and the scientific debate took off (Luo et al., 2021).

[3] Visser et al. (2021) as well as Singh et al. (2021) emphasize that Scopus is one of the largest databases globally of peer-reviewed publications in social sciences. It includes more than three times the journal entries and covers 99 % of the journals indexed in Web of Science (Singh et al., 2021).

[4] Supplementary Table C shows examples of the data analysis process.

[5] The first author led the process which was supervised and double-checked by co-authors.

[6] As for step 1, the first author led the process which was double-checked by co-authors to obtain the final set of keywords.

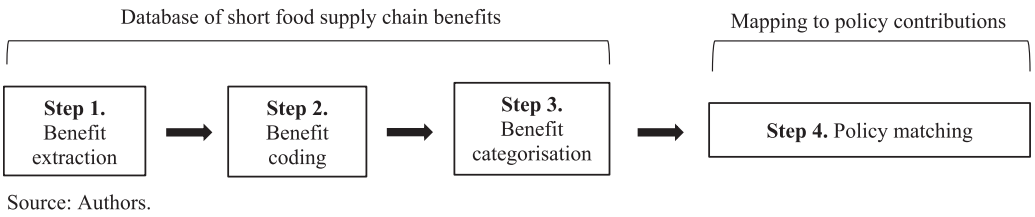


Fig. 1. Data analysis process.

Table 2
Thematic categories and subcategories of SFSC benefits.

Categories	Product quality	Space and Time	Information	Economy	Environment	Society
Subcategories	• Freshness • Safety • Taste • Certification • Speciality • Nutritional profile • Appearance • Others	• Short distance and time • No preservation • Others	• Label • Traceability and transparency • Communication • Others	• Price • Profitability • Job • Income • Local development • Others	• Production pollution • Water usage • Energy usage • Food waste • Biodiversity • Animal welfare • Others	• Health • Relationship • Fairness • Trust • Culture • Others

Source: Authors.

& Bariviera, 2019; Polyakov et al., 2017). Given that p_i denotes the frequency of observing each item $i = 1, \ldots, N$ within the set of interest, the entropy S is defined as:

$$S = \frac{-\sum_{i=1}^{N} p_i ln(p_i)}{lnN}$$

The closer the index is to zero, the higher the concentration of attention for a few benefits within a category and, hence, the more uneven the distribution of benefits across and within categories.

2.2.4. Step 4. Policy matching

Based on the coding, we connected each benefit to the SDGs and MUFPP policy objectives it contributes to. For both the MUFPP and SDGs, we considered the match to the highest level of detail possible. Hence, we link each benefit to one of the 37 RAs rather than to the six outcome areas of MUFPP and to one of the 169 targets of the SDGs. We did not consider SDG indicators since they provide quantitative goal attainment measurements that are not informative for our analysis. RA and SDG target went through manual concept extraction to have each of them identified with a univocal scope. Then, based on the benefit coding, we qualitatively matched each coded benefit based on deductive reasoning with the single RA and the single SDG target it appeared to be associated with most strongly.

2.3. Data visualisation

For facilitating the intuitive understanding of the results, various multidimensional infographics were created following the data visualisation design suggested by Chen et al. (2008). Such data visualisations are helpful for translating scientific knowledge into intuitive visual summaries, rendering quantitative information more communicable to non-academic audiences such as stakeholders of policy-making processes (Khoury et al., 2019; Masud et al., 2010). The most informative design was selected based on the relevant levels of information to be communicated (Schwabish, 2021). The graphical draft of the infographics was created using Flourish (2022) and finalized with vector graphics application Adobe Illustrator CC 2021 (Adobe, 2007).

3. Results

3.1. Bibliometric analysis

Fig. 2 indicates the annual distribution of documents on SFSC benefits published as well as the annual growth rates of scientific output and of the impact of that specific literature on general research. Until 2013, no more than two documents were published per year. Eighty percent of the scientific publications were published after 2013 and all publications by organisations after 2011. The growth of the cumulated number of scientific documents (citations) represents a measure of the increase (of the impact) of knowledge on the benefits of SFSCs (on the scientific debate). The growth rates of the impact tend to exceed the growth rates of knowledge generation. Until 2006, the scientific output on SFSC benefits doubled in two years and showed a stable growth of approximately 20 % per year after 2006. Citations show high annual growth rates of more than 50 % from 2005 to 2010. Since 2011, annual citation growth has smoothly declined from approximately 40 % to also about 20 %.

The methodologies adopted in the studies assessing the SFSC benefits vary greatly – often several approaches are used in combination (Supplementary Table E). Qualitative approaches appear to dominate the publications on SFSC benefits. Most methods collect primary data from various SFSC stakeholders through surveys, interviews or focus group discussions. Participant observations, mathematical modelling and other quantitative approaches have rarely been applied. Sample sizes vary between more than 2000 (Maestripieri, 2017) and 5 (Pato, 2020). Most of the documents using SFSCs as the unit of analysis consider fewer than five chains, and the remaining nine studies consider up to 24 chains. Four documents use country data and five do not explicitly specify their sample size (Supplementary Table E).

3.2. Taxonomy of short food supply chain benefits

The 69 documents considered report 348 SFSC benefits in total, of which 250 are from scientific papers and 98 are from organisational reports. Fig. 3 provides a packed circle chart of the collected benefits, classified into the six predefined categories and their subcategories. Each line and color indicate a separate benefit category. The size of each circle is proportional to the frequency count of the benefits in each (sub-) category. Fig. 3 reveals the disparities in the attention of scientific

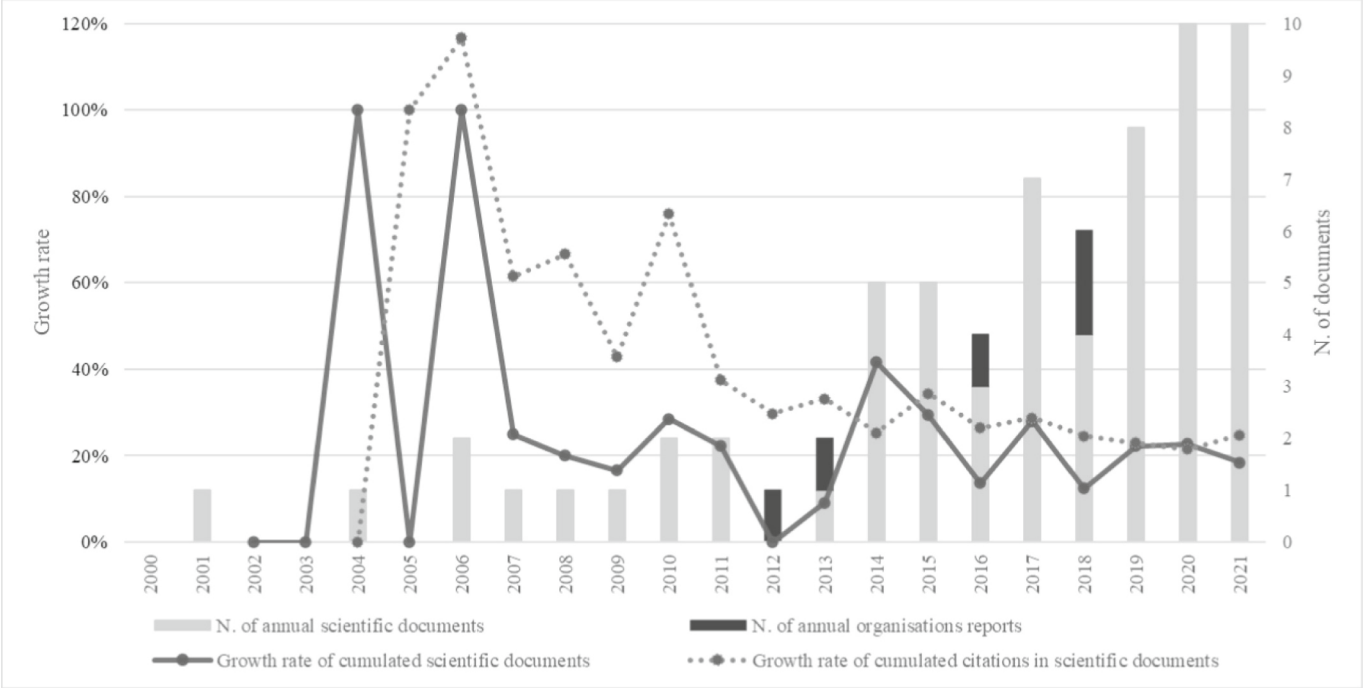


Fig. 2. Annual publications and growth rates of documents on short food supply chain benefits and their citations.

analysis to certain benefits subcategories. The Shannon entropies in Supplementary Table F show that benefits are quite evenly distributed across the six categories. Within categories, benefits relating to society, space and time and information have been addressed until 2021 most unevenly by this literature each having only one predominant subcategory.

Fig. 4 links each benefit category with the most prominent organisational structures of SFSCs[7] and the continent for which the benefits have been reported. On the left-hand side, benefits are presented based on the different categories and related organisational structure to which they belong (see Supplementary Table H). The widths of the connections are proportional to the number of benefits they represent. The heights of the bars in the middle of the graph are proportional to the numbers of benefits reported for each organisational structure. On the right-hand side of Fig. 4, the benefits reported per organisational structure are disaggregated by continent (see Supplementary Table I). Only very few benefits (6 out of 348) have been assessed by quantitative methods while the overwhelming majority has been reported based on qualitative research.

Each fourth benefit has been reported by scholars for CSA, which is the most extensively investigated organisational SFSC structure globally. Approximately every tenth benefit has been reported for FM and AFN. Less than every twentieth benefit has been found for LFS, BS and SPG. Fig. 4 is complemented by Supplementary Table F containing the Shannon entropies which suggests that benefits related to economy, product quality and society have been evaluated most uniformly across all organisational structures. The three organisational structures for which the highest numbers of benefits have been reported (CSA, others and SSC) are also the ones whose six benefit categories have received the most balanced attention in the literature.

Fig. 4 shows pronounced differences in the distribution of the number of benefits reported per continent. Forty-four percent of the benefits have been reported for Europe and 24 % for North America, which highlights the geographical disparities in SFSC research. CSA and FM have primarily been assessed for North America and Europe. SSC forms are predominant in Europe and Asia, with no records in North America. The SFSC benefits reported for the remaining five organisational structures have been reported for only one or two continents. BS is the only category whose majority of records come from the African continent. SPG has reported benefits in Europe only.

3.3. Contributions of short food supply chains to SDGs

The radial tree diagram in Fig. 5 categorises the SFSC benefits collected in the database and links each of them to the specific SDG target it contributes to reach. The diagram consists of three circles. The innermost circle consists of two sub-circles and shows the reported SFSC benefits for each of the six benefit categories which are marked with the same color scheme as in the two preceding graphs. A taller bar indicates that more benefits to that SDG target have been reported for that category. The two sub-circles denote whether rich[8] or poor evidence has been reported for the benefits which contribute to a certain SDG target and belong to a certain benefit category.

The middle circle - containing the numbered targets - connects these benefit categories to the SDG target which they contribute to. A thicker

[7] We thank an anonymous referee for pointing out that these categories are not on the same level. Creating a unifying framework of the internationally very diverse forms of SFSCs clarifying these hierarchies would be a core task of future research. As the aim of our review is to reflect terminology diversity and avoid misinterpretation of data, the organisational structure to which the benefits are attached to, is the one referred to in the document of origin (i.e., benefits classified as AFN are extracted from documents that reported to analyse AFN). A short explanation of each organisational structure is provided in Supplementary Table G.

[8] Rich evidence refers to those targets for which 90 % of the total benefits have been reported as outlined in Supplementary Table J. For the SDG targets for which the benefit numbers are mentioned in the outer innermost circle, rich evidence of the contribution of SFSCs to reaching the SDG targets has been reported in the literature. For the SDG targets for which the number of benefits is mentioned inside the inner circle, poor evidence of the contribution of SFSCs to reaching the SDG targets has been reported in the literature. Supplementary Table K briefly describes each SDG target.

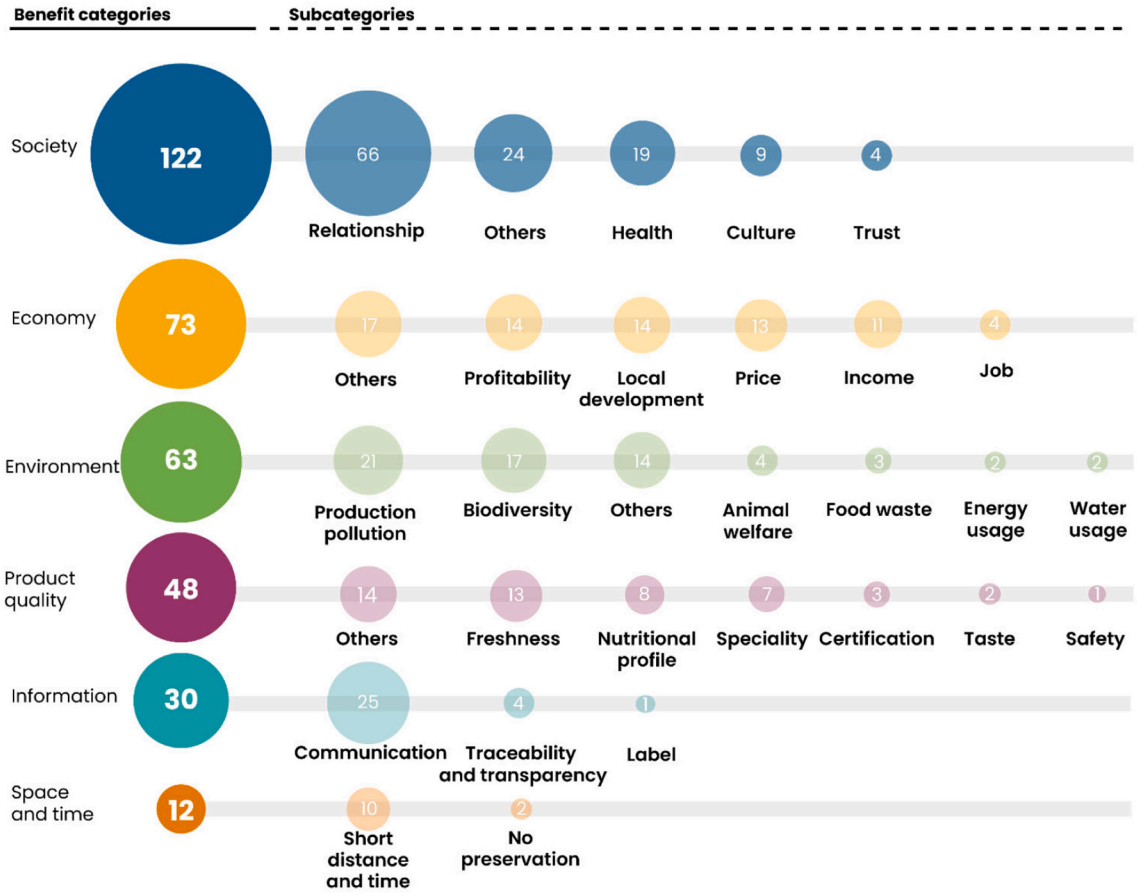


Fig. 3. Frequencies of categorised benefits (color should be used for this figure in print).

(longer) circle segment indicates that a higher number of SFSC benefits (distinct benefit categories) has been reported for that target. The outermost circle names the SDGs which the targets shown in the middle circle belong to. A longer outermost circle segment indicates that more benefit categories relating to more targets have been reported for this SDG, i.e., the knowledge on SFSC benefits per benefit category and target of this SDG is more encompassing and more diverse.

The outermost circle shows that the richest evidence exists for SFSC benefits relevant for SDG 2 "zero hunger" (50 % of all); 174 benefits are relevant for five targets of this SDG. SDG 11 "sustainable cities and communities" is the sustainability goal for which the second most diverse evidence (82 benefits) has been reported. SDG 12 "responsible consumption and production", generally linked to food systems through food losses and waste (Munir, 2022), is connected to 29 benefits mostly through SDG 12.8, which aims to create awareness for sustainable development. SDG 10 "reduced inequalities" appears to be linked to 23 positive effects of SFSCs, particularly via target 10.2 (promoting social, economic and political inclusion).

The middle and innermost circles of Fig. 5 show that SFSCs have been reported to help achieve 26 SDG targets, for 10 of which rich evidence exists.[9] Most benefits have been reported for the potential of SFSCs to facilitate links between urban, peri-urban and rural areas (SDG 11.a), to provide nutritious, seasonal, and sustainable food that is accessible to consumers and that can improve the provision of adequate food to all (SDG 2.1) and to foster environmentally and socially related sustainable agricultural practices to improve the sustainability of food production systems (SDG 2.4). Rich evidence on the role of SFSCs has also been reported for topics that play important roles in national agricultural and food system policymaking, such as farm income (SDG 2.3), awareness of food sustainability (SDG 12.8), safeguarding cultural and natural heritage (SDG 11.4) and the proper functioning of food supply chains (SDG 2.c). For most of these 26 targets, only one or two benefit categories have been reported in the literature. For ten targets, only scattered evidence has been reported in the literature thus far. More than 3 different categories are associated with targets 2.1, 2.4 and 11.4.

3.4. *Contributions of short food supply chains to MUFPP goals*

The radial tree diagram in Fig. 6 categorises - in a similar way as Fig. 5 does - the SFSC benefits reported and links each of them with the specific MUFPP RAs it contributes to reach. The figure has the same structure as Fig. 5. The outermost circle shows that the richest evidence exists for SFSC benefits contribute to MUFPP category "food production" (30 % of the total), as 105 benefits are associated with 5 RAs of this category. "Social and economic equity" is the MUFPP category for which the second most comprehensive evidence (104 benefits) has been reported. "Sustainable diets and nutrition" relates to 101 benefits across four RAs, mostly via RA 7 on "sustainable diets". For these three categories, the benefits associated with them are also most diverse. Benefits linked with the "food supply and distribution", "governance" and "food waste" categories appear to be less connected to SFSCs.

The middle and innermost circles of Fig. 6 reveal that SFSCs have been reported to help achieve 18 of the 37 RAs, for 9 of which rich

[9] Supplementary Table I gives a complete inventory of which SDG target each benefit is associated with.

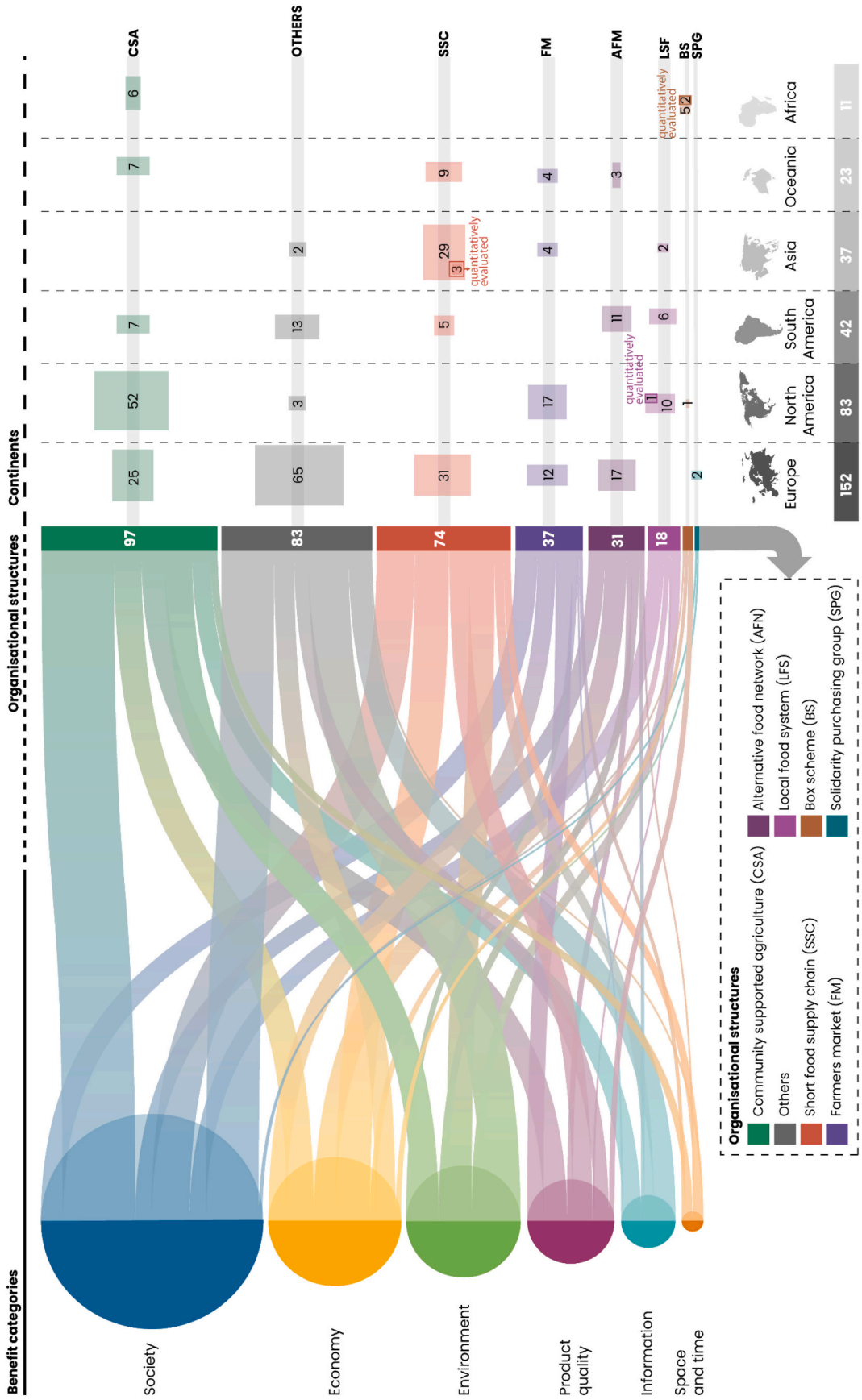
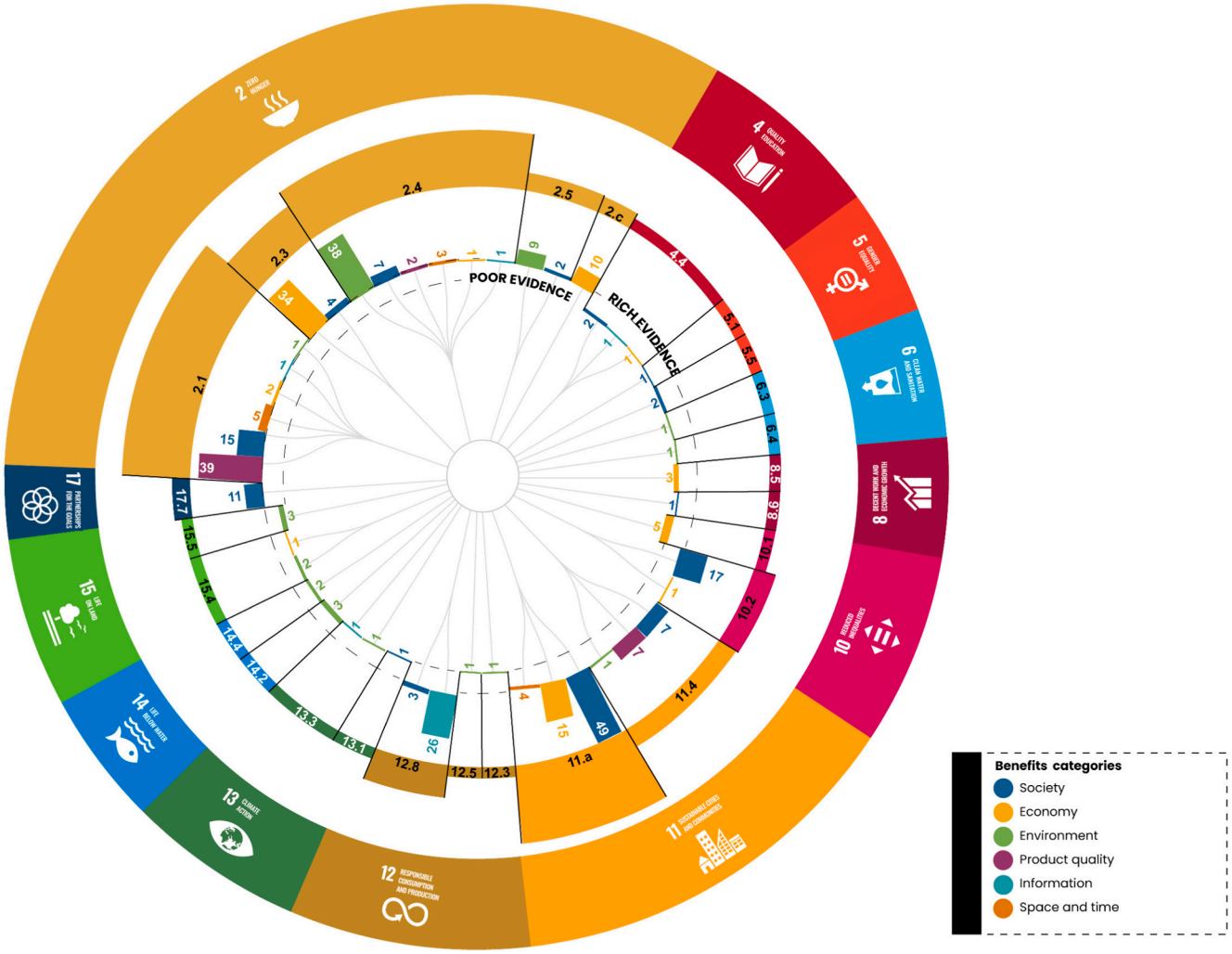


Fig. 4. Short food supply chains benefits per category, chain structure and continent (color should be used for this figure in print).



Source: Authors.

Fig. 5. Associations between SFSC benefits and SDGs (color should be used for this figure in print).

evidence exists.[10] Most comprehensive evidence has been reported for promoting sustainable diets (RA 7), developing opportunities for improved land management and ecosystem services (RA 22) and providing food producer services such as safe market and resource access, training, and assistance to create economic solidity (RA 24). The evidence on the merits of SFSCs is most diverse for RA 7, as this action is associated with benefits belonging to all six categories. There is also rather diverse evidence for the central role of SFSCs in encouraging networks for participation and social inclusion in food systems (RA 18), stimulating participatory education, knowledge sharing, awareness building and cultural contamination (RA 19), promoting decent employment (RA 16) and improved infrastructure for food market systems (RA 32). Finally, rich evidence exists on the capacity of SFSCs to address food-related diseases (RA 8) by pushing consumers to have healthier diets and to strengthen solidarity economic activities (RA 17). For the 9 remaining RAs, 5 RAs are linked with a maximum of 3 benefits each, and 4 RAs are linked with between 6 and 10 benefits.

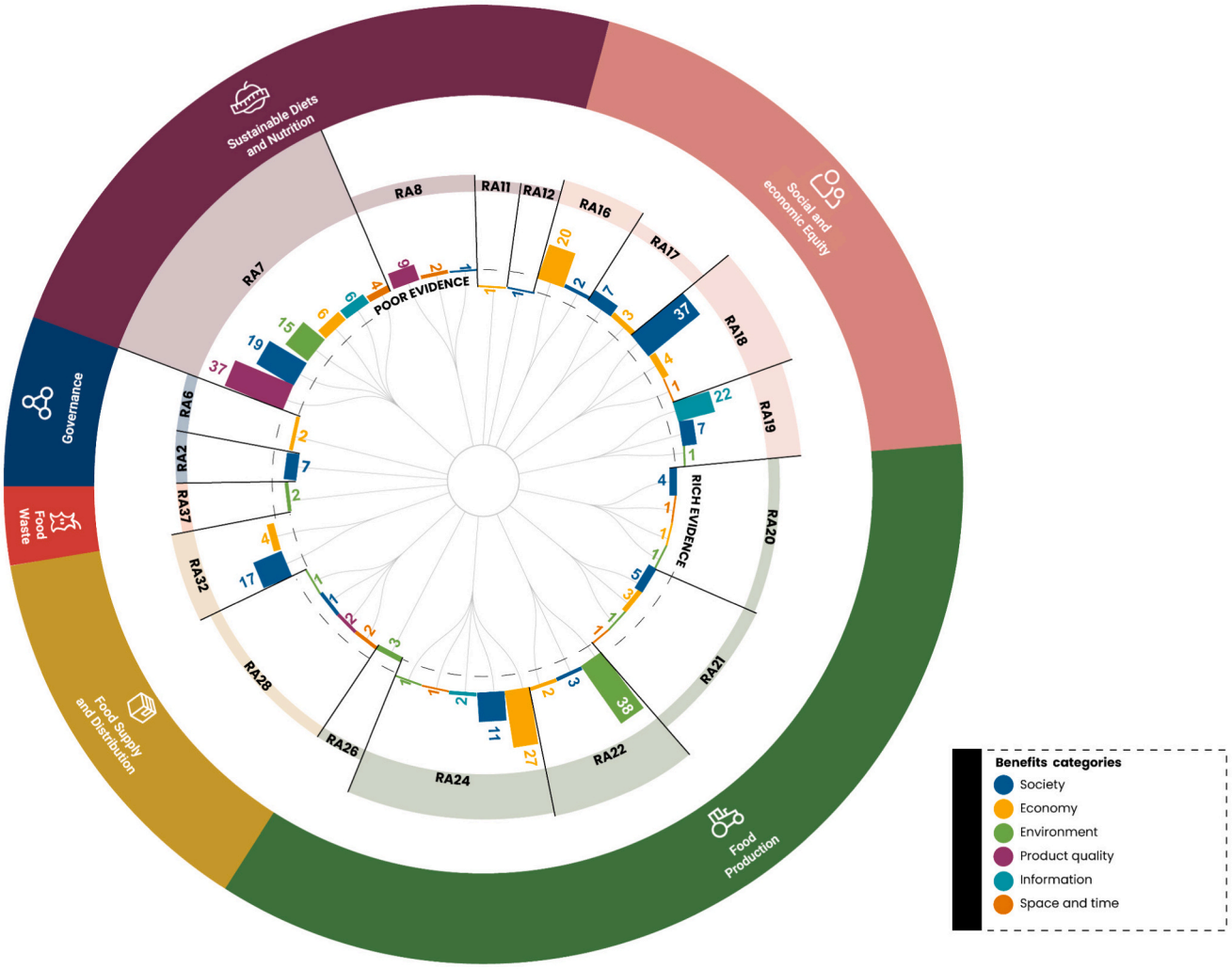
4. Discussion and conclusions

4.1. Summary of the evidence on short food supply chains benefits

The current knowledge on the benefits of SFSCs reported in 69 documents connects to 12 of the 17 SDGs. However, approximately 92 % of these connect to only five SDGs. SDG 2 (zero hunger) dominates, as 50 % of the reported benefits are linked to it. The insights on SFSC benefits gained and reported so far connect to only 15 % of all 169 SDG targets, and for only 6 % of them is the existing evidence comprehensive. For 16 more targets the current evidence on the contributions of SFSCs to them is scattered, while no benefits have been reported for the remaining 143 targets. Although current knowledge on the benefits of SFSCs links to all six categories of MUFPP interventions, 90 % of them connect to "food production", "social and economic equity" and "sustainable diets". The benefits assessed in the literature link to 18 of the 37 RAs. Among these 18, rich evidence exists for only 50 % of them.

Most of the benefits reported focus on the positive effects of SFSCs on

[10] Rich evidence refers to those targets for which 90 % of the total benefits have been reported, as outlined in Supplementary Table L. Supplementary Table M briefly describes each RA. Supplementary Table I gives a complete inventory of which MUFPP RA each benefit is associated with.



Source: Authors.

Fig. 6. Associations between SFSC benefits and MUFPP Recommended Actions (color should be used for this figure in print).

society in general as well as on their beneficial economic implications and reduced environmental impacts. These focuses coincide with the three sustainability dimensions that are most commonly investigated in food systems (de Alves & de Oliveira, 2022; Doernberg et al., 2022). The statistical evaluation via the Shannon index shows that the existing scientific publications have not given equal attention to SFSC benefits across sustainability dimensions. Benefits relating to the society, space and time and information categories have been addressed unevenly.

Reproducible evaluations of causal links between SFSCs and their benefits as well as comparisons of positive effects in terms of some generally applicable metrics that quantify benefits' quality and quantity are missing in this literature. Only six of the 348 benefits reported are deduced from quantitative analyses implying a substantial need for quantification. Such quantifications would create transparent evidence for determining which of the six sustainability dimensions and their subcategories provide most benefits to societies. Such insights would also create value added for policy-makers when it comes to taking decisions in favour of or against short food supply chains.

Across almost all organisational types of SFSCs, benefits to society have been assessed most frequently. For alternative food networks and box schemes the economic benefits and product quality benefits are most often assessed, respectively. In line with Chiffoleau and Dourian (2020), we confirm that most benefits have been reported for community-supported agriculture while very few benefits have been reported for box schemes and solidarity purchasing groups.

Geographically, the assessment of the positive effects of SFSCs is concentrated to industrialized countries in Europe and North America (68 % of reported benefits). For four of the six continents, barely any evidence on the positive effects of SFSCs has been reported. Especially for Africa, the topic of SFSCs has barely been assessed so far – at least not using the terminology which is being used for this research in Europe and North America. Most of the focus has been placed on the effects of establishing modern marketing channels which mirror the large-scale food retailing structures of industrialized countries (Maertens et al., 2012; Rao & Qaim, 2011). This lack of evidence contrasts with the supposedly frequent incidence of SFSCs around the globe, many of which are traditional chains in the Global South (FEWS NET, 2022) which are often short, local and informal and dominate food provision (Nickanor et al., 2019). However, literature on comprehensive measurements of the length and structure of supply chains by food category or country, such as King et al. (2010) or Low and Vogel (2011), appears to be scarce.

The systematic review of documents suggests that the overwhelming majority of the benefits of SFSCs have been evaluated by qualitative analyses, of which surveys and interviews have been the most widely adopted methods as found by Michel-Villarreal et al. (2019). The scientific output on the topic has been growing on average by 23 % per year reaching 69 documents at the end of 2021. The impact of this literature

on the scientific debate has been growing each year by 40 % on average reaching 265 citations at the end of 2021. This strong increase in the attention of research as well as in scientific impact developed in parallel with an intensifying societal debate about SFSCs in Europe and North America.

4.2. Limitations and future research

Any analysis of such an heterogenous topic can only be carried out subject to limitations which also bring new research opportunities. Not considering important keywords used might have caused the exclusion of relevant documents. The restriction to English-language documents might have ignored core organisational reports in national languages. Moreover, the quality of each literature review depends on the limitations in the analysis or transparency of communication of the included documents. For example, some of the articles included in our database do not explicitly mention the procedure used for data collection and analysis. Nevertheless, due to the aim of conducting an exhaustive review of the existing documents, they were included despite potential weaknesses in the rigour of their analyses.

As most of the current literature is based on qualitative analyses, the association between benefits and specific policy goals can also only be qualitative. Hence, we stress that methodologically solid research that quantifies effects and clarifies causal linkages, for example, via randomised controlled trials or similar approaches for the assessment of the causal impacts of SFSCs, needs to be added to the current literature to ensure the quantification of effects and to guarantee the comparability of results across commodities and countries.

4.3. Implications for the science-policy research agenda and policymaking

Knowledge on the links between SFSCs, SDGs and the MUFPP supports policymakers in increasing their science-based capacity for making use of SFSCs toward more sustainable food systems as requested by the UN Food Systems Summit (von Braun et al., 2021). Our results have implications both for local and national policymakers. Municipal policy makers willing to develop an urban food policy, can use the results of this analysis to know that investing in SFSCs will help the city in meeting certain SDGs and MUFPP goals. In turn, when they plan to prioritize advancement of some of these sustainability goals, they can use our results to know to which extent SFSCs can be an opportunity to do so.

Furthermore, our findings highlight a set of future research directions to be explored. First, the objective of this study is to exhaustively revise and inventory existing knowledge on the positive impacts of SFSCs, as these benefits dominate the discourse in industrialized countries' societies and policymaking. A complementary analysis addressing the negative effects and costs of SFSCs and how they challenge progress toward reaching sustainability goals is needed to complement the picture. This would allow policy makers and other stakeholders to understand trade-offs and opportunities across countries and SFSCs structures. Such an analysis should ideally be accompanied by creating a unifying framework of the internationally very diverse forms of SFSCs which will ideally be used as the global reference system for analyses and narratives about SFSCs.

Second, for fostering the science-policy research agenda future research should focus on analysing the frequency and scope of the various types of organisational SFSC structures across countries and continents. Such an overview could estimate the size of agricultural land operated under each type or the number of employees involved to obtain measurements of the current scope of each SFSC type. This would allow to assess to what extent the distribution of scientific interest corresponds to the distribution of land or human capital involved in each type. Most importantly, it would also form a basis for estimating the aggregated benefits resulting from each organisational type and thus pave the way for establishing a powerful concrete measurement of the sustainability contribution and future sustainability potential created by each.

Third, targeted policy making would profit from quantifying positive and negative implications of SFSC and a clarification of causal pathways for being able to conduct evidence-based comparisons of their effects with those of global supply chains as the latter are being increasingly innovated to comply with sustainability standards (Meemken et al., 2021). Qualitative analyses do not, for example, allow to precisely evaluate by how much and in which sustainability dimensions SFSCs are superior or inferior to global supply chains. Any objective assessment and ranking of the effects of competing food marketing channels in terms of CO_2 or the water footprint, for example, or the social benefits created must be based on quantification. The development of such measurements would also facilitate the quantification of the contributions of SFSCs to achieving specific policy goals of the SDGs and MUFPP so that their attainment can be more precisely operationalised than currently.

Finally, research on the characteristics of SFSCs should move beyond industrialized countries to analyse the characteristics of this specific food marketing approach - embedded in a country's economic system - in the Global South, where the preservation of traditional knowledge and farming techniques might be lost during the ongoing food retail transition (e.g., Rischke et al., 2015) if not documented. Thus, comparative analyses of SFSCs for similar commodities in dissimilar economic systems and political contexts may constitute a major step ahead for understanding how the characteristics of economic and political systems condition the types and magnitudes of the benefits and costs of SFSCs as, for example, assessed by Schipmann and Qaim (2010) or Short et al. (2021). The above-mentioned inventory of the geographical distribution and size of organisational SFSC types may also lay the foundation for analysis of the facilitating and impeding institutional and socio-cultural factors for the existence of certain organisational types in certain countries. The identification of such general institutional factors would provide substantial value added for policymakers, as it would open practical ways to aid food policy design (González-Azcárate et al., 2023).

CRediT authorship contribution statement

Mara Petruzzelli: Conceptualization, Methodology, Data Curation, Formal analysis, Writing.

Rico Ihle: Conceptualization, Validation, Supervision, Writing.

Simona Colitti: Visualisation.

Matteo Vittuari: Conceptualization, Validation, Supervision, Writing, Resources.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cities.2023.104496.

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