

Sustainability-based Multi-capital Approach for the Agri-Food Supply Chain: Research Trends Based on Bibliometric Review

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Abstract— The purpose of this paper is to depict a landscape of the bibliometric literature review on the sustainability-based multi-capital approach in the agri-food supply chain. The potential for a multi-capital framework to assess sustainability in the agri-food supply chain is holistically limited to three capitals thus defining the sustainability dimensions: economic, social, and natural. However, other forms of capital such as relational, intellectual, image, and ethical are also so important to evaluate sustainability in this context. So, by using two databases, Scopus and Web of Science, over a period of 10 years, 643 relevant papers on this topic are identified. The results of this study not only highlight the different sustainability capitals in the literature but also provide insights into the necessary research questions that should be addressed in future review papers. This study reflects the importance of multidimensional sustainability in the agri-food sector and serves as a valuable resource for researchers in this field.

Keywords—sustainability, agri-food supply chain, multi-capital approach.

I. INTRODUCTION

In recent years, there has been increasing recognition of the importance of sustainability in various sectors, including agri-food supply chains (AFSC). Such topic is attracting more and more attention from researchers due to especially importance given to the agriculture and food sectors. These ones are major sources of environmental degradation, social inequality, and economic instability, [1]. In fact, the sustainability of the AFSC is crucial for ensuring access to quality food and mitigating environmental impact with helping the different actors to insure a sustainable activity. For that, a multi-capital approach is well-used in the literature, [2, 3, 4, 5, 6]. Such approach can be defined as a measurement and appraisal tool for the current sustainability state where the aim is to identify the management issues from the economic, social, and environmental points of view to better manage resources in the future. In addition, it provides significant insights to improve the strategy for integrating sustainability into AFSC. According to [3], the sustainability-based multi-capital approach is defined as a useful tool for comprehending corporate contributions to sustainability. In this paper, the authors applied multi-capital framework based on six capitals (financial, human, social, natural, built, and cultural) to evaluate the local impacts and benefits of resource extraction within rural Australia. Additionally, the authors in [4] explain

that the multi-capital approach is an analytical framework that aims to conceptualize, measure, and balance various forms of capital. Therefore, such an approach is recognized as a way of managing the change process in terms of the promotion of sustainable development, [5]. And, it helps acknowledge the interconnection and interdependence level of different capital sources and the need for a balanced use of each one. This includes recognizing the trade-offs and synergies between different forms of capital to adopt a good decision-making approach. Another study [7] assessed the sustainability of territorial short-food supply chains (TSFSCs) vs. large-scale food distribution (LSFD) based on economic, social, and environmental pillars. The study found that TSFSCs were the most sustainable alternative globally, prioritizing the social dimension. TSFSCs contribute to ecosystem services, equity, territorial cohesion, and economic revitalization. Furthermore, it is important to note that the various actors within the agri-food chain, such as farmers, policymakers, distributors, retailers, and consumers, all have a role to play in the management and optimization of these different forms of capital. In [8], a study analysed the factors that contribute to the vulnerability of wheat farmers in Iran from a multi-capital perspective. The study identified a range of social, environmental, and economic factors that affect the farmers' natural, social, and financial capital. These factors include farm management practices, government policies, and support, the impact of Sun pests on crop yield and natural capital, weather conditions, and equipment and maintenance costs, which can have significant implications for farmers' economic and financial capital. In [9], the authors study the relationship between social capital and consumer behaviour in promoting food security. On the other hand, informed consumer behaviour can influence food availability and accessibility, support local food systems, and advocate for policies that promote sustainable and equitable food production and distribution.

To better understand the new research orientations on this topic, a bibliometric analysis to gain insight into previous studies conducted in this area will be presented in this paper. Indeed, this paper aims to analyse the keywords of the papers included in the research to find the current trends and make a difference between previous and current research.

The rest of this paper is arranged as follows. Section 2 provides the review methodology employed in our study

where a step-by-step explanation of the research process is involved including details on data collection and analysis. Section 3 is dedicated to the results and discussions. Finally, concluding remarks are drawn in section 4.

II. METHODOLOGY

Bibliometric review is a powerful method for exploring and analysing large volumes of scholarly data in various fields. It provides detailed instructions for conducting rigorous analyses and identifying emerging areas of research, [10]. Several studies have employed this approach to investigate sustainability and supply chain management. For instance, article [11] analyses AI and sustainability research trends, revealing insights into future developments. Similarly, article [12] provides a comprehensive overview of Supply Chain Management (SCM) and its significance in today's business world.

To provide an analysis on the research progress and development and future orientations related to the sustainability-based multi-capital approach for the AFSC, a PRISMA methodology is employed. With PRISMA, a systematic and transparent literature review process is ensured, enhancing the credibility and reproducibility of our analysis. The maximum number of relevant documents in our sample selection is considered based on pre-defined criteria. Our review includes books, reports, conference proceedings, and scholarly articles, if available in the referenced databases.

A. Search Strategy

A research study is planned to be conducted with a focus on exploring the factors that contribute to the multi-capital sustainability of the AFSC. To do so, the first crucial step is the identification of the different combinations of keywords. For this, a couple of synonym terms are used as an example "agri" and "agro", "environmental" and "natural". For multi-capital sustainability, different terms are often used in scientific papers such as "capital", and other ones just use the capital name (e.g.: natural) while other papers mentioned the combined terms "natural capital" or the "indicator" term to evaluate the capital. That's why; the used specific keywords are as follows: " (agri or agro) food supply chain AND (sustainability OR sustainable) AND (capital OR indicator OR natural OR environmental OR economic OR intellectual OR ethic OR relational OR image OR social OR stakeholder OR shareholder OR human OR material OR financial)". For the 2nd-step, the data were obtained from two mostly used databases: Web of Science (WOS) and Scopus. These two ones are complementary for bibliometric analysis since they do not hold the same data and their search algorithms are different, [13] which can therefore give more comprehensive results.

B. Database Extraction

Each database's file was taken out and combined into a single file using the *R Studio* program. Nevertheless, it's crucial to look for and thoroughly remove any duplicate paper. In addition, it can assist with managing references and locating duplication, but manual checking is required not only to avoid removing significant or pertinent articles but also to eliminate off-topic articles from the bibliometric review. By using this method, the database is made accurate and comprehensive, increasing its usefulness. Initially, the

WOS database yielded 500 documents, whereas Scopus presented 497 documents. However, upon a meticulous examination and comparison of the outcomes from both databases, it was discovered that 208 entries were duplicated in the combined list. Consequently, a comprehensive list of results was compiled after the elimination of these duplicates and other papers, resulting in a total of 643 English language results. This approach allowed for a more rigorous and reliable analysis of the data, thereby enhancing the academic rigor of the study.

III. RESULTS AND DISCUSSION

Data is gathered from our database over a ten-year period, from 2013 to April 2023. To gain insight into trends and changes in the impact of research articles in our field of interest, the number of papers per year and citation frequency are plotted on the same histogram, see Fig. 1. The average citation per year is a commonly used indicator to assess the impact of a research article, [14]. By incorporating the number of articles per year, a better understanding can be gained of how the number of publications in our field has changed over time and how it may have impacted the impact metrics.

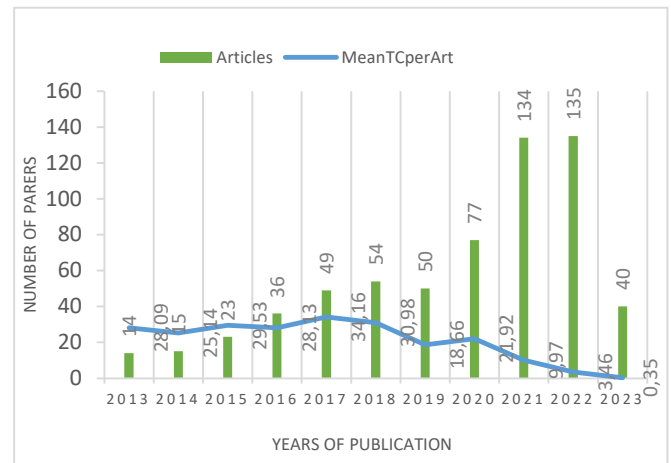


Fig. 1 Number of publications and frequency citations per year (MeanTCperArt = average total citations per article)

Fig. 1 shows that the number of publications in this field has increased continuously from 2013 to 2022. Notably, as of April 2023, there are already 40 additional publications, indicating a continued upward trend in the production of research in this field. Moreover, it is evident from the figure above that the most cited publications are those from 2017, highlighting their significant contributions to the field and their impacts on subsequent studies. Research related to sustainability in AFSC has shown a clear upward trend over time, indicating a growing interest and investment. A number of factors may be contributing to the growing trend of AFSC sustainability publications. Firstly, there is growing recognition of the importance of sustainability in the agri-food sector, particularly in response to growing concerns about climate change and the environmental impact of food production, [15]. Secondly, the COVID-19 pandemic has highlighted the fragility of global food supply chains and the need for more resilient and sustainable systems [16].

After evaluating the number of articles published and the citation frequency, it is observed that the analysis highlighted the most cited authors and the top journals related to the multi-capital sustainability in AFSC. In the Fig. 2, the analysis reveals that the Journal of Sustainability emerged as the top

journal in this field, with over 100 publications. The Journal of Cleaner Production followed closely with more than 40 publications. The identification of these top journals provides important insights into the most impactful outlets for research in this area, and can guide researchers in publishing their work to reach a wider audience.

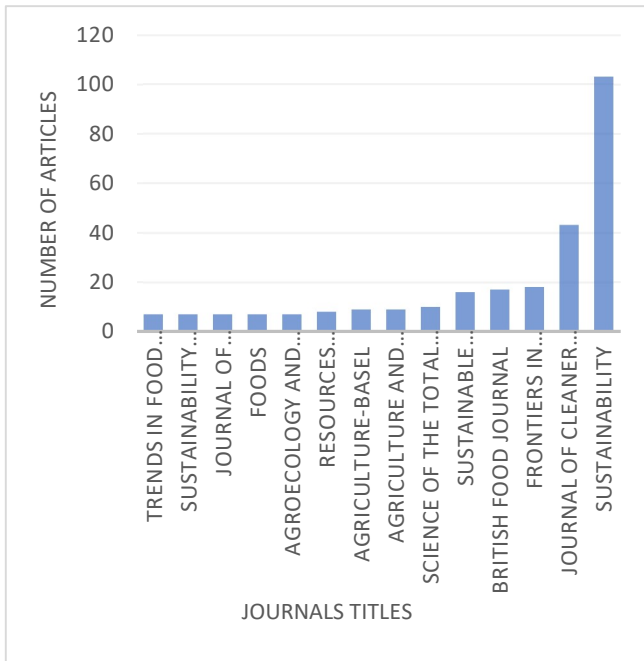


Fig. 2 Number of publications per journal

After the quality of journals in the sustainability field that applied the multi-capital framework to the AFSC was evaluated, the productivity of authors is assessed (Fig.3). It is found that several of the most productive authors in this area are affiliated with top journals. To gain a deeper understanding of the relationship between journal affiliation and author productivity, the analysis was limited to authors who have at least five articles. By doing so, a comprehensive assessment of their contributions to the field is ensured, and insights are gained into the factors that contributed to productivity in sustainability research using the multi-capital framework applied to the AFSC.



Fig. 3 Number of papers per author

According to our latest analysis, Tsoulfas et al. has the most publications in this research field, as supported by Fig. 3. However, other authors have also made significant contributions to the literature. In 2017, Sharma et al. explored green supply chain management indicators [17], and in 2022 they developed a sustainable performance assessment framework using fuzzy analytic hierarchy process analysis, which includes 16 KPIs and prioritizes economic factors over the environment, circular economic practices, and social

dimensions [18]. In their latest publication, Tsoulfas et al. 2023, presented a review paper exploring the emergence of short supply chains and their importance for sustainable development and vulnerable communities. This article is a part of a special issue that addresses the challenges related to environmental, social and economic sustainability in the digital era, highlighting the importance of addressing these issues to ensure supply chain resilience, [19].

After reviewing the works of various authors, it is important to note the articles' origin and the countries that have the highest scientific production in this research field. The statistics shown in Fig. 4 reveal that Italy has a significant presence with a high number of published articles which can then be considered a leading country in this field, along with the United Kingdom and the USA. These can provide valuable insights into the countries that are leading the way in this field and the potential for future research collaborations. Note that the number of articles selected in Fig. 4 is greater than 20. This means that only the most significant connections between countries are represented in the citation network. This may explain why only fifteen countries are included in the analysis.

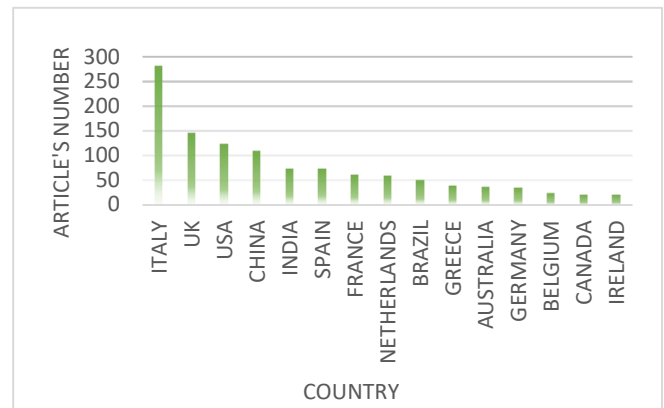


Fig. 4 Countries productions

In the upcoming analysis, keywords will be evaluated. Author Keywords and Keywords Plus are commonly used in the bibliometric analysis for different research purposes. Although Keywords Plus is equally successful as author keywords for analyzing the knowledge structure of scientific areas using bibliometric analysis, it is less thorough in expressing an article's content, [20]. However, for our analysis, it would be advisable to use author keywords because they provide a more accurate and detailed representation of an article's content. Author keywords are specifically chosen by the authors to reflect the main theme of their research, making them a reliable and consistent indicator of the article's content. This level of specificity and intentionality is particularly useful if a detailed understanding of the specific themes and concepts covered in the analyzed articles is desired. In Table 1, relevant keyword groups for our research topic are selected. The author's keywords, which consisted of 2034 terms, were analyzed, and the most important ones were categorized into 11 groups, including supply chain, sustainability, capital, and indicators. Other keyword groups were also identified, focusing on different types of capital, such as environmental, social, economic, human, ethical, relational, and stakeholder, as discussed in the literature.

It is observed that environmental dimension is frequently mentioned in various contexts, accounting for 9% of total author keywords, including terms such as water, biodiversity, and waste, which highlight the importance of environmental factors in the research field. It is furthermore noteworthy that researchers recognize the value of considering environmental factors, particularly in the agri-food sector where research efforts are more focused on waste management. Additionally, our analysis indicates that the literature is moving towards a more nuanced understanding of capital, beyond the traditional three dimensions of environmental, economic, and social. Other capital categories, such as relational and human capital, are increasingly mentioned in the literature. For instance, in [21] that was published in 2020, the authors discuss how difficult economic conditions and the level of human capital influence various forms of collaboration within AFSC. Moreover, it is noteworthy that the human factor is increasingly being considered from a behavioral perspective in the literature. This suggests that the concept of capital is being expanded due to their real implication in sustainable development.

Therefore, it is common to come across keywords or concepts that repeat across multiple groups via Table 1. These interconnected keywords are often essential in comprehending how different areas of analysis are related and linked together. In turn, this can help us understand our findings more fully and communicate them to others more effectively. For instance, the term "social indicator" can be placed within the group of indicators, as well as the social group, when discussing social capital. Similarly, terms like "social sustainability" or "economic sustainability" may be kept as the author's keywords to highlight the interconnection between social and economic sustainability points of view. These terms are often retained in their original form to facilitate analysis of the trends and issues discussed by authors.

To provide further evidence, a trend analysis of research topics is conducted. As shown in Fig. 5, there are now six trends in the literature, with a dominant focus on the four capitals of environmental, social, economic, and human. However, there are other relevant capitals that are not always explicitly mentioned in the literature, such as intellectual, ethical, material, and relational capital. While these additional capitals are not always categorized as such, they are still potential contribution for sustainability outcomes. For example, topics like ethics in agri-food governance and relationships between farmers and buyers (table 1) are not explicitly categorized as capitals but are crucial for sustainable practices. Via Fig. 5, the research work also is more focused specifically on two key actors in AFSC: farmers and consumers. This is because farmers represent the primary node of the chain, and the way they conduct their operations can have a significant impact on the rest of the supply chain.

By contrast, the consumer's behavior, responsiveness, and attitude have a direct impact on the sustainability and profitability of the AFSC.

Additionally, in table 1, some indicators (like social indicators or socio-economic indicators...) listed illustrate how these various forms of capital relate to the actors involved. Due to the fact that they offer a way to measure and

Table 1: Authors' keywords co-occurrence evaluate sustainability, these indicators have gained more and more attention in recent years.

Group of keywords	Words	Freq.
Supply chain (298)	supply chain	177
	agri-food supply chain	46
	short food supply chains	25
	food supply chain	24
	supply chain management	17
	sustainable supply chain	9
Sustainability/ Sustainable (282)	Sustainability/sustainable	197
	sustainable development	51
	sustainable supply chains	10
	environmental sustainability	9
	social sustainability	7
	economic sustainability	4
Capital (5)	sustainability assessment	4
	social capital	3
	human capital	1
	net working capital	1
	cultural capital	1
Indicator (20)	indicators	6
	performance indicators	5
	social indicators	3
	agri-environmental indicators	1
	food security indicators	1
	Sustainability indicators	1
	multi-level indicators	1
	new indicators of wealth	1
	socio-economic indicators	1
Environment (181)	waste	64
	environment/envinomental	41
	water	24
	greenhouse-gas emissions	15
	climate change	14
	biodiversity	13
	environmental sustainability	9
	natural resources allocation	1
Social (58)	social	27
	Corporate social responsibility	11
	social sustainability	7
	social innovation	4
	social capital	3
	social impact	3
	social indicators	3
Eco- nomic (35)	economic	19
	cost	12
	economic sustainability	4
Human (16)	behavior	12
	green human resource management	1
	human-animal interactions	1
	human-machine interactive learning	1
	human-nature connectedness	1
Ethic (7)	ethics	2
	bio ethics	1
	ethical analysis	1
	ethical poultry production	1
	ethics and agri-food governance	1
	food ethics	1
Stakeholder (6)	stakeholder	3
	external stakeholders	1
	multi-stakeholder engagements	1
	stakeholder engagement	1
Relational (5)	farmer-buyer relationships	1
	green buyersupplier relationship	1
	processor/retailer relationships	1
	social relationships	1
	vertical relations	1

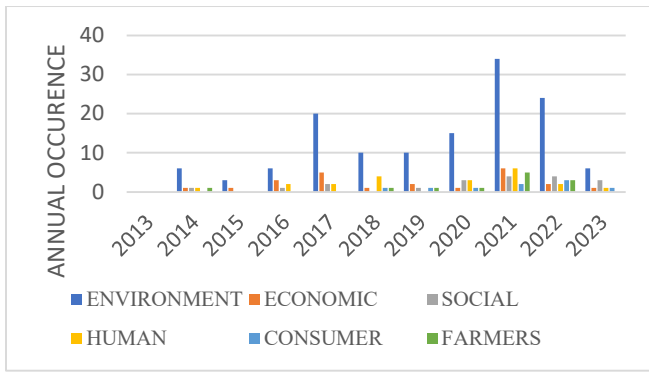


Fig. 5 Trend topics

In addition to the previously observed statistics, a co-occurrence analysis is performed by compiling the number of times the keywords from the publications appear using VOSviewer. The network built in this manner reflects accumulated domain knowledge and aids in the discovery of important knowledge components and insights based on the patterns and strength of relationships between keywords found in the literature, [22]. Fig. 6 illustrates that the identified words are distributed across various clusters, but the red and green clusters appear to be the most dominant. Specifically, the red cluster is primarily associated with sustainability within the supply chain context, economic and social impacts, and sustainable performance. In contrast, the green cluster of keywords in the analyzed literature reflects a growing recognition of the critical role that farmers play in ensuring the sustainability of the AFSC. Farmers, as primary nodes in the chain, have a significant impact on the environmental, social, and economic dimensions of the supply chain. Thus, they are increasingly being viewed as key stakeholders in promoting sustainable practices. The emergence of keywords such as "social networks" and "social media" in the green group highlights the importance of communication channels in promoting sustainable practices within the agri-food sector. These channels are

powerful tools for sharing knowledge and best practices, as well as for building networks and collaborations among stakeholders. Collaboration is a critical factor in promoting sustainability in the AFSC. The connection between collaboration and many of the keywords in the green cluster highlights the importance of coordination among different actors, such as farmers, transporters, stakeholders, policymakers, and consumers. These actors can contribute to the different types of capital, including environmental, social, economic, and human, through their collaborative efforts.

In addition, food safety is an essential element of sustainability in this field. The term "stakeholders" is closely linked to "food safety" because all entities involved in ensuring the safety and quality of food products are stakeholders. Effective collaboration among stakeholders is essential in identifying and managing risks, establishing standards and guidelines, monitoring compliance, and responding to incidents of foodborne illness or contamination. By ensuring food safety, the AFSC can deliver safe, high-quality food products to consumers while also protecting public health and promoting sustainable food systems.

Overall, the analysis of the green cluster of keywords suggests a growing understanding of the multidimensional nature of sustainability in the agri-food supply chain.

In general, this keyword analysis suggests that there are multiple dimensions of sustainability that are relevant to the topic being studied. By examining the relationships between the different clusters and the words associated with each cluster, one may be able to identify potential strategies for addressing these different dimensions of sustainability in a more comprehensive and integrated way. Examination of the data gathered over the years will demonstrate that the sustainability evaluation is no longer defined in a holistic way but new key factors are to be considered which has introduced other capital such as human one. This suggests that current trends in sustainability assessment are oriented toward framework approaches based on multiple capitals. Indeed, a

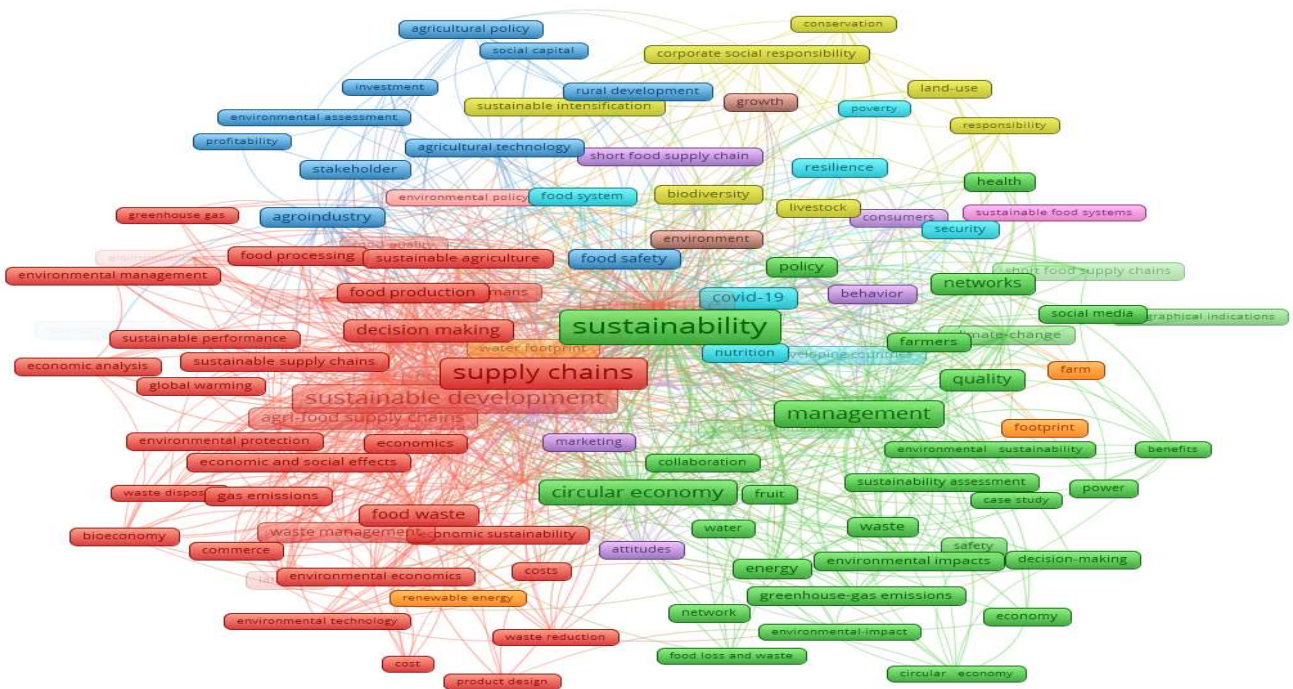


Fig. 6 Keywords' map (VOSviewer)

sustainable AFSC requires not only minimizing environmental impacts but also ensuring fair labor practices and economic viability for all stakeholders involved. By adopting a multi-capital approach, it is possible to create a more sustainable and resilient AFSC that benefits the environment, society, and the economy. While taking into account all actors and dimensions, this study's technique may have some inherent drawbacks. As a result of its all-encompassing approach, it might not pay close attention to some details when analysing particular actors or certain capitals.

IV. CONCLUSION

This paper aims to bibliometric review related to the sustainability for the AFSC based multi-capital approach framework. Most studies focus on one or a limited number of capitals, with varying indicators. Consequently, there is a lack of consensus on which indicators are most relevant for assessing sustainability in the AFSC. Overall, to improve this research topic, it is essential to conduct a more comprehensive literature review and explore a wider range of indicators and capitals for assessing sustainability in the AFSC. Therefore, further research is needed to address the following questions:

RQ1: How sustainability framework approaches multi-capital frameworks are integrated?

RQ2: What types of sustainable capital and indicators are considered in the literature to evaluate sustainability for each actor in the AFSC?

RQ3: What are the case studies on sustainability in the AFSC been conducted?

From this study, several future works can be considered such as a systematic review in order to answer these research questions for a more comprehensive understanding of multi-capital sustainability approach in the AFSC.

ACKNOWLEDGMENT

This work is part of the research project entitled "Smart Models for Agri-food Local value chain based on Digital technologies for Enabling covid-19 Resilience and Sustainability" (SMALLDERS), funded by the PRIMA Program - Section 2 Call multi-topics 2021, through the following National Authorities: Ministry of Universities and Research (MUR, Italy), State Research Agency (AEI, Spain), Agence Nationale de la Recherche (ANR, France), Ministry of Higher Education and Scientific Research (Tunisia).

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