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Exploring Novel Sustainability Metrics for the Agri-Food Supply Chain

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Abstract

The need for the agri-food supply chain (AFSC) to adopt sustainable practices is driven by rising environmental consciousness and an expanding world population. As a result, composite indicators—which include several measurements to assess effects on the environment, society, and economy—have been continuously emerging. This paper finds new trends in sustainability indicators inside the AFSC through a bibliometric review utilizing Google Scholar and Scopus. A comprehensive analysis was conducted on 257 English-language papers which span from 2000 to 2024 and were chosen for their focus on various sustainability measures relevant to different actors in the AFSC. Through a methodical examination of key bibliometric metrics, the most prominent trends focus on resource efficiency (such as water reuse), product quality (such as food freshness and organic food), social responsibility (like educational attainment and food insecurity), and technological innovation. These results improve knowledge of widely used sustainability indicators/indexes and their applicability in encouraging sustainable behaviors. The development of composite indicators highlights the move away from narrow metrics and toward more thorough evaluations. When the AFSC tackles difficult issues like social justice and climate change, a comprehensive approach is crucial.

Keywords: Agri-food supply chain, sustainability assessment, metrics, trend

1. Introduction

In the agri-food supply chain (AFSC), achieving sustainability has emerged as a key goal. The AFSC encompasses a complex web of activities, including production, harvesting, processing, distribution, and consumption. It plays a crucial role in shaping the global food landscape, impacting the environment, society, and economy simultaneously (Cimino et al. ,2024). From farmers to consumers, every link in this intricate chain influences the sustainability footprint (Yadav et al., 2022), making it a pressing issue.

Sustainability within the AFSC is of paramount concern due to several compelling reasons. The industry's burgeoning growth (Joshi et al., 2023), necessary to meet the escalating food demand worldwide, has resulted in severe environmental degradation, resource constraints, and exacerbated social inequalities (Frona et al., 2019). This underscores the urgency of transitioning towards more sustainable practices to safeguard the planet and ensure equitable access to resources and food security (Dammak et al.,2023).

Moreover, the AFSC operates in a dynamic environment subject to rapid changes driven by various factors. These include technological advancements, evolving consumer preferences, and global trends. Technologies like precision agriculture IoT, and blockchain are revolutionizing farming practices and supply chain management, offering opportunities to enhance efficiency and sustainability (Kumar et al., 2023). Simultaneously, consumers are increasingly demanding healthier, ethically sourced,

and sustainable food products, reshaping market demands (Mesías et al., 2021).

The changing preferences of consumers, influenced by concerns about sustainability, ethics, and health, require ongoing monitoring to maintain a balance between supply and demand. Additionally, fluctuating market conditions influenced by meteorological and geopolitical events necessitate trend analysis for informed decision-making. There is also a growing emphasis on environmental sustainability, driving the need to develop metrics for measuring impacts such as carbon footprint and water consumption. Similarly, monitoring contamination risks using indicators and ensuring compliance with standards are essential for ensuring food safety and quality assurance.

Despite the challenges posed by rapid change, there are significant opportunities for innovation and collaboration within the AFSC (Bhakta et al. ,2019). Addressing research gaps, developing new metrics can help navigate this dynamic environment while promoting a more sustainable and resilient future. These metrics, which are made up of multiple indicators, collectively provide measures or sets of measures. These indicators provide concrete depictions of the qualities, traits, or features of a setting, often expressed through quantitative or qualitative variables, enabling the efficient evaluation of sustainability standards and performance metrics. It's evident that sophisticated measures are necessary to fully reflect the complex dynamics at play. These measures can be classified into two main categories: leading indicators and lagging indicators (Szekely et al., 2005). Leading indicators often pertain to early signals of potential changes in market demand, production trends, or environmental factors that could impact crop yields or livestock health. These indicators might include weather forecasts, consumer preferences surveys, or emerging technologies for precision agriculture. By monitoring leading indicators, stakeholders can anticipate shifts in demand, optimize production processes, and proactively address potential challenges such as supply shortages or quality issues.

On the other hand, lagging indicators in the AFSC typically revolve around retrospective measures of performance or outcomes. These may include metrics such as crop yields, livestock mortality rates, or post-harvest losses. Lagging indicators offer insights into past performance, allowing stakeholders to assess the effectiveness of their strategies, identify areas for improvement, and implement corrective measures to enhance productivity, reduce waste, or mitigate risks in subsequent production cycles. The dynamic nature of food and agriculture supply chains necessitates a continual search for novel index to ensure effectiveness, durability, and adaptability to changing circumstances. Regulatory changes emphasizing responsibility and compliance are driving the development of new indicators. Therefore, by incorporating both leading and lagging indicators, stakeholders can navigate regulatory changes effectively while also gaining insights into past performance and prospects. This comprehensive approach enables stakeholders to make informed decisions, identify areas for improvement, and implement corrective measures to enhance productivity, reduce waste, and mitigate risks in subsequent production cycles. Thus, the utilization of both leading and lagging indicators offers a holistic understanding of the business's present condition and its future potential, fostering resilience and sustainability in the AFSC.

This conference paper aims to address existing research gaps and contribute to the assessment of sustainability at the AFSC level. It seeks to fill the void by conducting a comprehensive bibliometric analysis to identify emerging sustainability metrics and provide insights into the evolving landscape. Beyond mere identification, the analysis will lay the foundation for future empirical investigations and discussions, potentially impacting various stakeholders, including researchers, policymakers, and smallholders.

In terms of organization, this paper will begin by reviewing the existing methodology, followed by the results and discussions.

2. Materials and Methods

The methodology employed involves a bibliometric analysis to be conducted to identify and analyze new indicators of sustainability in the AFSC. Given the sector's multifaceted challenges, the need for robust indicators to gauge sustainability is highlighted. This approach has been adopted by various studies, such as (Ababou et al., 2023), which aims to contribute by examining current trends and developments in the resilience of food industry supply chains, pinpointing potential areas for enhancement.

Our main objectives are to identify new and compelling sustainability indicators within the AFSC, analyze their significance, and ascertain their relevance to various stakeholders. This involves synthesizing crucial insights from existing literature to understand emerging trends, discerning which indicators are gaining importance, and determining their impact on different actors within the supply chain. Utilizing the Scopus database as our primary data source, a comprehensive search is conducted to access the latest research publications. Specific keywords, including: (sustainability OR sustainable OR durability OR resilience) AND indicator AND (new OR trend OR tendance OR modern OR innovative OR recent) AND (food AND chain) are used to refine our search and ensure relevance.

Initially, the database search was conducted without specifying a particular period, resulting in the identification of 271 papers. Among these, 257 were in English, and they will be the focus of our analysis.

Following this, the papers by year of publication are classified and include a graphical representation to provide visual insight into the trends identified. This histogram visualizes both the annual count of papers and their citation frequency (refer to Figure 1). The average citation per year serves as a commonly utilized indicator for assessing the impact of research articles. Integrating the yearly publication count enhances our understanding of the changing publication landscape within our field over time and its potential implications for citation metrics.

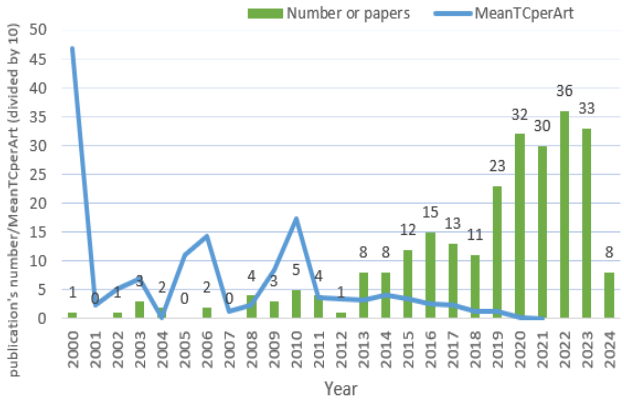

Figure 1. Time distribution of publications and citations.

Between 2000 and 2018, the literature appears relatively scarce, with fewer than four papers published per year. However, starting in 2019, there is a notable increase in the number of publications, reaching 23 papers that year. This upward trend continues in the following years, peaking in 2022 with 36 papers published. In 2023, the number of publications remains high, with 33 publications. This significant increase in the number of publications, particularly from 2019 onwards, likely reflects a growing interest in the sustainability of AFSC, possibly influenced by global events such as the COVID-19 pandemic. Despite this increase in the number of publications, the average total citations per article (MeanTCperArt) show significant variability over the years, with a notable peak in 2013 and a subsequent decline which might be due to recent articles from 2022 and 2024 not yet having had enough time to accumulate citations. This pattern suggests fluctuating levels of impact and attention within the field of study over time. Most of these publications are esteemed academic journals renowned for their contributions to research on sustainability and related topics (Figure 2). Among them, "Sustainability" stands out as a premier publication in the field, with 14 articles providing valuable insights into sustainable practices and their implications. Following closely behind is the "Journal of Cleaner Production," which has published 12 impactful articles focusing on environmentally responsible practices. The "International Journal of Life Cycle Assessment" is another notable source, with 8 articles offering rigorous research on the environmental impacts of products and systems.

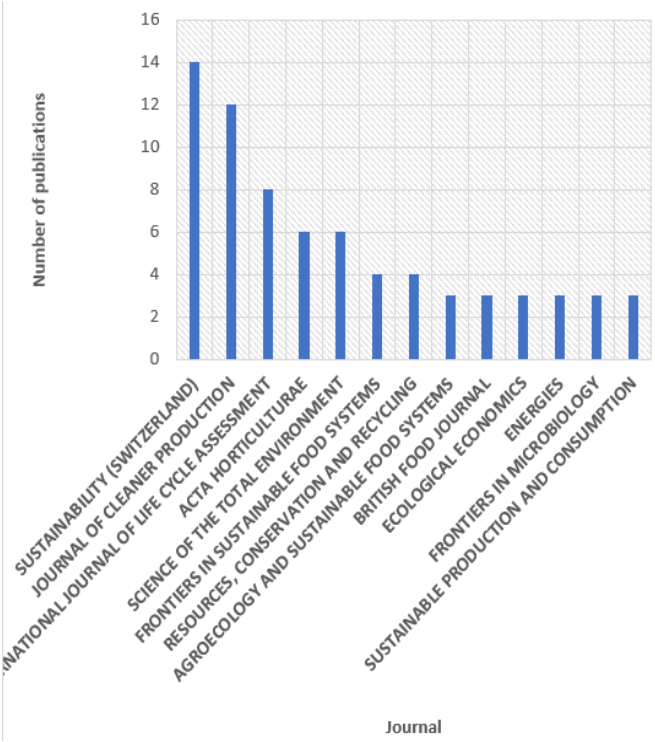

Figure 2.Most relevant sources.

To delve deeper into the global trend concerning the indicators of sustainability, an analysis was undertaken to evaluate the interest levels across different countries. Assigning each paper to a specific country or continent proves challenging due to the prevalence of international collaborations among authors from various nations. However, an examination of the distribution of papers based on the nationality of the corresponding author reveals a predominant contribution from authors in developed countries.

The presented data in Figure 3 depicts the geographic dispersion of publications.

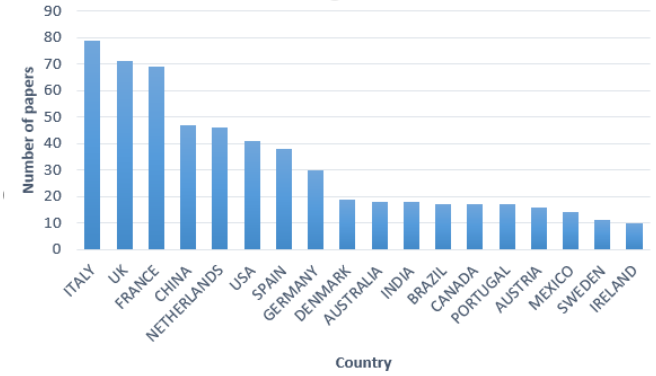

Figure 3. Geographical dispersion of publications

Among the countries listed, Italy, the UK, and

France stand out as key players in the AFSC, collectively representing the highest percentages of production at 13.8%, 12.4%, and 12.0% respectively. Following closely behind, China holds a significant share at 8.4%, indicative of its growing presence in agri-food production. Notably, the Netherlands and the USA also contribute significantly, accounting for 8.3% and 7.4% of the total, showcasing their pivotal roles in the global agri-food market.

Moreover, these leading countries often implement robust agricultural policies and support programs aimed at fostering the growth and sustainability of their agri-food sectors. By offering subsidies and tax incentives to farmers and agri-food businesses, they promote the adoption of sustainable practices and the modernization of infrastructure. For example, Italy, known for its agricultural heritage, surprisingly lacks specific regulations or dedicated measures concerning agricultural land taxation. This absence of specific policies or incentives for agricultural lands may pose challenges to sustainability efforts within the country's food supply chain (Sainteny et al., 2022). These proactive governmental initiatives not only enhance the competitiveness of these nations in the global market but also advocate for environmentally conscious and socially responsible agricultural practices. Leveraging their historical prowess and favorable geographical conditions, Italy, the UK, and France continue to anchor the global AFSC, reinforcing their central role in shaping its dynamics.

Following this analysis, the next step involves creating a word cloud to visually represent the frequency of these terms (Figure 4). The word cloud will offer a graphical depiction of the most common terms, with larger font sizes indicating higher frequencies. The keywords of the articles were used to generate the word cloud, and the data was processed using R Studio.

Figure 4. WordCloud

A frequency analysis of common terms reveals key themes prevalent in the literature on sustainability and food supply chains. Terms like "sustainable development," "food supply," "supply chains," and "sustainability" underscore the overarching focus on sustainable practices within the AFSC. Additionally, concepts such as "climate change," "environmental impact," and "waste" highlight the growing concern for environmental conservation and resilience. Discussions on "food security", and "food safety" reflect the emphasis on ensuring access to nutritious food while maintaining ethical standards. The prominence of terms like "practices" and "supply chain management" suggests a strategic approach to addressing sustainability challenges throughout the supply chain. Overall, these frequently occurring terms provide insights into the core themes and priorities shaping discussions on sustainability in the agri-food sector.
In the subsequent section, all these terms will be analyzed to identify the indicators resulting from this assessment.

3. Results and Discussion

Based on the reference Word Cloud highlighting trends, researchers focus on classifying these trends into three main categories. These categories can be determined by analyzing a set of indicators. They include:

- Environmental Indicators: This category consists of measures related to the environmental impacts of food production, including "carbon footprint", "land use," "carbon emission," and "greenhouse gases."
- Economic Indicators: These measure the economic aspects of food production, encompassing "economics," "income", "commerce," and "sales."
- Social Indicators: These evaluate the social and human aspects of food production, covering "humans," "health," "nutrition," "public health," and "social aspect ".

This classification provides a comprehensive framework for assessing the sustainability and impact of food production across various dimensions. Furthermore, this classification can be further detailed through additional subcategories under each dimension, providing a more nuanced understanding of the complexities involved (Amamou et aL., 2023).

A variety of well-established sustainability indicators, including energy consumption, water usage, waste generation, revenues, value-added, and social welfare indices, have long been utilized to assess environmental economic and social impacts (Bellahirich et al.,2024). Nowadays, some causes are driving the development of new sustainability indicators and index, which in turn affect how

consumers and businesses priorities and understand environmental, economic and social responsibilities. Growing consumer and corporate knowledge of these critical issues forces them to look for more thorough criteria to assess sustainability.

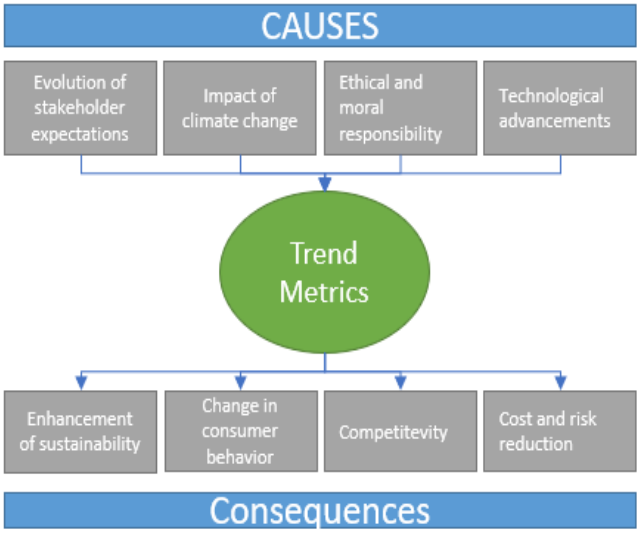

Figure 5. Causes & Consequences of New Sustainability Indicators

New Metrics that offer in-depth information about a product's ecological and social footprint are being developed and used as a result of consumer demands for increased transparency regarding the effects of products on the environment and society. Additionally, stricter legal requirements also encourage businesses to include sustainability indicators into their operations to guarantee adherence to rules and regulations. Additionally, the emergence of innovative technologies plays a significant role in driving the development and adoption of these sustainability metrics. Technologies such as blockchain, artificial intelligence, and sensor-based monitoring systems are appearing as effective tools for tracking and analyzing sustainability metrics throughout the supply chain giving the example of sensors designed to detect and measure various environmental parameters in complex environments. They enable real-time data collection on food quality throughout their journey, from production to distribution (Pal et al., 2020). In addition to these sensors, other innovative technologies such as blockchain and the Internet of Things (IoT) are also playing pivotal roles in enhancing sustainability indicators (Longo et al, 2023). Blockchain technology ensures transparent and immutable record-keeping, enabling reliable traceability throughout the supply chain. This traceability is crucial for tracking the origins of products and ensuring compliance with sustainability standards. Furthermore, IoT applications provide real-time information about product conditions and contamination levels during production and distribution. These technologies collectively contribute to a more transparent and accountable supply chain, empowering businesses to track and analyze sustainability metrics effectively (Casino et al., 2020).

Because of this, the use of these new metrics encourages companies to change to more sustainable operations, enhancing their social and environmental performance to satisfy customers and comply with regulations. This change not only affects what consumers buy, but it also spurs innovation and market competition as businesses try to set themselves apart by providing more environmentally friendly goods and procedures. Furthermore, by reducing resource consumption, incorporating sustainability into corporate operations lowers risks related to reputation and regulatory compliance as well as results in long-term cost savings. New sustainability indicators are essentially a result of a collective effort to better comprehend, manage, and address the social and environmental repercussions of enterprises and goods, with the goal of building a more sustainable future. In the following table, a set of new sustainability indicators are selected via this review.

Table 1. Collection of New Sustainability Metrics

Dimension	Category	reference
Environmental	Food freshness indicators	(Ndwandwe et al., 2024)
	Waste water discharge	(Shabir et al., 2023) (Paliwoda et al., 2024)
	Water reuse	(Shabir et al., 2023) (Helmecke et al., 2020)
	Animal welfare indicators	(Lanzoni et al., 2023)
	Material Circularity Indicator (MCI)	(Sazdovski et al., 2024)
	Product circularity indicator (PCI)	(Sazdovski et al., 2024)
	Solid waste performance	(Shabir et al., 2023)
Economic	Local food	(Addai et al., 2023)
	Coordination and information transfer	(Zoric et al., 2023)
	Increased customer awareness	(Borsotto et al., 2023) (Chabouh et al., 2023)
	Coopetition index	(Borsotto et al., 2023)
	Organic product	(Addai et al., 2023)
	Digitalization	(Zoric et al., 2023)
	Cleaner technology investments indicator	(Paliwoda et al., 2024) (Negraa et al., 2020)
Social	resilience of employment	(Borsotto et al., 2023)
	Stakeholder involvement	(Borsotto et al., 2023)
	Educational attainment	(Borsotto et al., 2023) (Thom et al., 2024)
	food insecurity	(Bartelmeß et al., 2022) (Li et al., 2024)

In environmental dimension a lot of new composite indicators emerged. The Material Circularity indicator (MCI) and the Product Circularity Indicator (PCI) are key metrics in promoting circularity. The MCI, developed by the Ellen MacArthur Foundation,

assesses material circularity by minimizing linear flows and integrating biological cycles. Meanwhile, the PCI, introduced by (Bracquené et al., 2020) focuses on product circularity by evaluating reuse, recycled content, and production efficiencies. Both metrics drive sustainability efforts by guiding material practices and product design. Additionally, freshness indicators ensure food quality and safety, reducing waste and supporting sustainable food practices. Collectively, these indicators lead to the development of smart packaging solutions that integrate innovative technologies and functionalities to optimize food preservation while minimizing environmental impact and promoting material and product circularity. Moreover, these composite indicators align with the broader goal of solid waste performance which is the degree to which an organization successfully reduces the production of solid waste, optimizes recycling and reuse opportunities, and manages and disposes of residual garbage in a way that minimizes environmental impact is measured. Implementing strategies like waste reduction initiatives, raising recycling rates, starting composting programs, encouraging sustainable packaging, implementing effective waste disposal techniques, and abiding by pertinent regulations and standards are frequently necessary to improve solid waste performance. In addition to existing indicators, recent trends emphasize the importance of addressing water reuse, wastewater discharge, and animal welfare. Water scarcity and pollution drive the adoption of water reuse strategies to conserve resources and minimize environmental impact. Managing wastewater discharge is crucial for safeguarding water quality and ecosystems. Additionally, prioritizing animal welfare aligns enhances product quality and brand reputation. For example, in the poultry industry. Ensuring animal welfare is crucial across all stages, including rearing, slaughtering, transporting, and processing (Yogeswari et al., 2024). Defect detection in poultry products, as highlighted in the article on "Detection of Defects in Poultry Products with Relation to Animal Welfare," is vital. Traditional methods often lack comprehensive information, especially concerning poultry welfare. Hyperspectral imaging offers advancements in detecting bacterial contamination, physical defects, and ensuring product quality while prioritizing animal well-being. This commitment to animal welfare is further exemplified by research on computer vision technology, demonstrating the industry's dedication to quality and animal welfare.

Among the various categories examined in the economic dimension, coordination and information transfer emerge as pivotal factors influencing the sustainability and functionality of AFSC, particularly within the wholesale and retail segments. Especially, for these last ones, it is evident that coordination and timely information transfer among stakeholders in the AFSC are regarded as paramount. This emphasis reflects the understanding that deficiencies in these areas can profoundly hinder the AFSC's ability to operate effectively and adapt to changing market dynamics. In practical terms, ineffective coordination can lead to delayed decision-making, inefficient inventory management, increased waste, and erosion of trust between supply chain participants. Addressing these challenges requires concerted efforts to enhance collaboration and streamline communication processes throughout the AFSC, thereby fostering greater resilience, responsiveness, and sustainability in the face of evolving market pressures and operational demands.

For the social dimension, employment resilience has become a particularly important metric, particularly in the wake of catastrophes like the COVID-19 epidemic and financial crises. Resilience efforts now center on an economy's and an organization's capacity to sustain steady employment levels in the face of external shocks. This includes steps to safeguard employees' livelihoods, make it easier for them to stay in their current jobs, and assist them in switching to new ones in industries less impacted by disruptions. To comprehensively assess this composite indicator, factors such as the labor-to-production ratio, the presence of corporate welfare programs, and the inclusion of disadvantaged individuals need to be considered. In order to effectively address these issues and make sure that a variety of viewpoints and interests are taken into account when making decisions about employment policies and support systems, stakeholder input is still essential. Furthermore, obtaining an education is essential for developing resilience because it gives people the information and abilities, they need to adjust to shifting needs in the job market and support efforts to revive the economy. These metrics become increasingly more important for promoting sustainability, inclusivity, and resilience in a variety of systems and sectors as societies negotiate uncertain times. Adding to this index, early discovery of temporary food insecurity is crucial in order to prevent its progression into chronic insecurity, as demonstrated by the events leading up to and including the COVID-19 epidemic and the Russo-Ukrainian conflict (Bartelmeß et al., 2022). Detection of acute food insecurity allows for the implementation of relevant measures, such as food aid or livelihood support, to address the immediate needs of vulnerable populations. By monitoring indicators like food prices and market access, policymakers and humanitarian organizations can gain insights into emerging food insecurity trends and target interventions where they are most needed. This proactive approach not only helps alleviate immediate suffering but also prevents the exacerbation of food insecurity over the long term.

4. Conclusions

In the context of the development of new metrics in the agricultural and agri-food sector is crucial for effectively assessing sustainability and the value of adopted practices. These important indexes should

focus on key aspects such as economic, social, and environmental impacts, with specific attention given to measuring the influence of the community. Consumers play a significant role in driving industry trends and pushing for the adoption of new environmental metrics, putting pressure on food companies to integrate sustainable practices into their operations. This consumer-driven demand has led to the development of sustainability programs and a premium being placed on environmental performance by businesses.

Furthermore, the development of indicators aimed at classifying the level of influence or conditioning that the community exerts on organizational or consumption choices can be particularly relevant. This would enable a better assessment of how decisions made in the AFSC are shaped by the needs and expectations of the community, and how they contribute to the overall value generated by these enterprises.

In conclusion, the development of new metrics in AFSC is crucial for a more accurate assessment of the sustainability and value of adopted practices. By focusing on aspects such as community influence, it becomes possible to better understand how businesses can make meaningful contributions to sustainability while also meeting the needs and expectations of their community. As these metrics are rapidly evolving according to AFSC stakeholders needs. Consequently, the relevance and applicability of current metrics may change over time. This paper provides a snapshot based on current knowledge, which may soon require updating.

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References

Ababou, M., Chelh, S., & Elhiri, M. (2023). A Bibliometric Analysis of the Literature on Food Industry Supply Chain Resilience: Investigating Key Contributors and Global Trends. Sustainability, 15(11), 8812.

Addai, G., Suh, J., & Bardsley, D. (2023). Contributions of urban periodic markets to sustainable rural development in Ghana : A rural web analysis. Social Sciences & Humanities Open, 7(1), 100480.

Amamou, A., Sidhom, L., Zouari, A., and Mami, A. , Sustainability-based Multi-capital Approach for the Agri-Food Supply Chain: Research Trends Based on Bibliometric Review. 17th International Conference on Innovations in Intelligent Systems and Applications (INISTA), September 1-3, 2023, Hammamet, Tunisia

Amitangshu Pal and Krishna Kant. 2020. Smart Sensing, Communication, and Control in Perishable Food Supply Chain. ACM Trans. Sen. Netw. 16, 1, Article 12 (January 2020), 41 pages.

Bartelmeß, T., Jasiok, S., Kühnel, E., & Yildiz, J. (2022). A scoping review of the social dimensions in food insecurity and poverty assessments. Frontiers in Public Health, 10, 994368.

Bellahirich, S.,Amamou, A., Sidhom, L., and Mami, A. ,(2024). Sustainability Indicators for Evaluating the Activities of a Home Delivery Company: a Tunisian Case Study , The 15th IEEE International conference of Logistics and Supply Chain Management (LOGISTIQUA), Sousse – Tunisia, May 2 -4.

Bhakta, I., Phadikar, S., & Majumder, K. (2019). State-of-the-art technologies in precision agriculture: a systematic review. Journal of the Science of Food and Agriculture, 99(11), 4878-4888.

Borsotto, P., Cagliero, R., Giarè, F., Giordani, G., Iacono, R., Manetti, I., & Sardone, R. (2023). Measuring Short Food Supply Chain Sustainability: A Selection of Attributes and Indicators through a Qualitative Approach. Agriculture, 13(3), 646.

Bracquené, E., Dewulf, W., & Duflou, J. R. (2020). Measuring the performance of more circular complex product supply chains. Resources, Conservation and Recycling, 154, 104608.

Casino, F., Kanakaris, V., Dasaklis, T. K., Moschuris, S., Stachtiaris, S., Pagoni, M., & Rachaniotis, N. P. (2021). Blockchain-based food supply chain traceability: a case study in the dairy sector. International journal of production research, 59(19), 5758-5770.

Chabouh, S., Sidhom, Amamou, A, and Mami, A., (2023). Agri-food supply chain sustainability from the consumer perspective: a survey-based study in the Tunisian context, 9th International Food Operations & Processing Simulation Workshop, 18-20 September.

Chabouh, S., Sidhom, L. and Mami, A. Towards baseline sustainability scenario development for the agri-food supply chain in the Mediterranean area. 3rd IEEE Signal Control and Communication, December 1-3, 2023, Hammamet, Tunisia.

Cimino, A., Longo, F., Solina, V., & Verteramo, S. (2024). A multi-actor ICT platform for increasing sustainability and resilience of small-scale farmers after pandemic crisis. British Food Journal, 126(5), 1870-1886.

Dammak K., Zouari A., and Sidhom L., (2024). Overcoming Barriers of Sustainable Agrifood Supply Chain Through Conservation Agriculture

and Multi-Capital Sustainability, The 15th IEEE International conference of Logistics and Supply Chain Management (LOGISTIQUA), Sousse – Tunisia, May 2 -4.

Fróna, D., Szenderák, J., & Harangi-Rákos, M. (2019). The challenge of feeding the world. Sustainability, 11(20), 5816.

Helmecke, M., Fries, E., & Schulte, C. (2020). Regulating water reuse for agricultural irrigation: risks related to organic micro-contaminants. Environmental Sciences Europe, 32(1), 4.

Joshi, S., Singh, R. K., & Sharma, M. (2023). Sustainable agri-food supply chain practices: Few empirical evidences from a developing economy. Global Business Review, 24(3), 451-474.

Kumar, M., & Choubey, V. K. (2023). Sustainable Performance Assessment towards Sustainable Consumption and Production: Evidence from the Indian Dairy Industry. Sustainability, 15(15), 11555.

Lanzoni, L., Whatford, L., Atzori, A. S., Chincarini, M., Giammarco, M., Fusaro, I., & Vignola, G. (2023). The challenge to integrate animal welfare indicators into the Life Cycle Assessment. animal, 17(5), 100794.

Li, J., Xiao, Q., Wu, H., & Li, J. (2024). Unpacking the Global Rice Trade Network: Centrality, Structural Holes, and the Nexus of Food Insecurity. Foods, 13(4), 604.

Longo, F., Mirabelli, G., Solina, V., Belli, L., Abdallah, C. B., Ben-Ammar, O., ... & Zacharewicz, G. (2023), "An overview of approaches and methodologies for supporting smallholders: ICT tools, blockchain, business models, sustainability indicators, simulation models", Procedia Computer Science Journal, 217(3), pp.1930-1939, 2023.

Mesías, F. J., Martín, A., & Hernández, A. (2021). Consumers' growing appetite for natural foods: Perceptions towards the use of natural preservatives in fresh fruit. Food Research International, 150, 110749.

Ndwandwe, B. K., Malinga, S. P., Kayitesi, E., & Dlamini, B. C. (2024). Recent developments in the application of natural pigments as pH-sensitive food freshness indicators in biopolymer-based smart packaging: challenges and opportunities. International Journal of Food Science & Technology.

Negra, C., Remans, R., Attwood, S., Jones, S., Werneck, F., & Smith, A. (2020). Sustainable agri-food investments require multi-sector co-development of decision tools. Ecological Indicators, 110, 105851.

Paliwoda, B., Matuszak-Flejszman, A., & Ankiel, M. (2024). The Impact of Environmental Indicators on Consumer Purchase Decisions for Food Products. Sustainability, 16(5), 1834.

Sainteny, G., Dupuis L. (2022). La taxation des terres agricoles en Europe : approche comparative. Fondation pour la recherche sur la biodiversité (FRB).

Sazdovski, I., Batlle-Bayer, L., Bala, A., Margallo, M., Azarkamand, S., Aldaco, R., & Fullana-i-Palmer, P. (2024). Comparative assessment of two circularity indicators for the case of reusable versus single-use secondary packages for fresh foods in Spain. Heliyon.

Shabir, I., Dash, K. K., Dar, A. H., Pandey, V. K., Fayaz, U., Srivastava, S., & Nisha, R. (2023). Carbon footprints evaluation for sustainable food processing system development : A comprehensive review. Future Foods.

Székely, F., & Knirsch, M. (2005). Responsible leadership and corporate social responsibility: Metrics for sustainable performance. European Management Journal, 23(6), 628-647.

Thom, A. E., Bélières, J. F., Conradie, B., Salgado, P., Vigne, M., & Fangueiro, D. (2024). Exploring social indicators in smallholder food systems: modeling children's educational outcomes on crop-livestock family farms in Madagascar. Frontiers in Sustainable Food Systems, 8, 1356985.

Yadav, V. S., Singh, A. R., Gunasekaran, A., Raut, R. D., & Narkhede, B. E. (2022). A systematic literature review of the agro-food supply chain: Challenges, network design, and performance measurement perspectives. Sustainable Production and Consumption, 29, 685-704.

Yogeswari, M. S., Selamat, J., Jambari, N. N., Khatib, A., Mohd Amin, M. H., & Murugesu, S. (2024). Metabolomics for Quality Assessment of Poultry Meat and Eggs. Food Quality and Safety, fyae004.

Zorić, N., Marić, R., Đurković-Marić, T., & Vukmirović, G. (2023). The importance of digitalization for the sustainability of the food supply chain. Sustainability, 15(4), 3462.