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Sustainability transition in the agrifood system: a systematic review focused on food loss and waste

Transição para a sustentabilidade no sistema agroalimentar: uma revisão sistemática com foco nas perdas e desperdício de alimentos

Transición a la sostenibilidad en el sistema agroalimentario: una revisión sistemática centrada en las pérdidas y el desperdicio de alimentos

Marli Kuasoski
Midwestern State University
R. Professora Maria Roza Zanon de Almeida - CEP 84505-677 - Irati - PR
https://orcid.org/0000-0002-5996-8556
marlikuasoski@hotmail.com

Sérgio Luis Dias Doliveira
Midwestern State University
R. Professora Maria Roza Zanon de Almeida - CEP 84505-677 - Irati - PR
https://orcid.org/0000-0001-9957-225X
sldd@uol.com.br

KEYWORDS
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Abstract: The transition of socio-technical systems has received growing attention in the literature on sustainability. Specifically, a more sustainable way to produce and consume is being discussed in the context of agrifood systems. This transition is relevant because society faces a paradox: on the one hand, the amount of food loss and waste (FLW) is significant; on the other hand, a sizeable portion of the world's population goes hungry. There is, therefore, an urgent need for a transition to a more sustainable production and consumption model. Considering the studies on sustainability transition and the FLW issue, this study intends to analyze scientific productions about the subject. The literature search comprised the databases Emerald, Sage, Science Direct, Scopus, Web of Science, and Wiley Online Library. The results indicate that studies on sustainability transition in agrifood systems are scarce in terms of observing FLW. Thus, it is possible to expand knowledge in the field of transitions and FLW, involving different social actors than those already investigated in the literature selected, and seek mechanisms to face this urgent problem. The existing scientific works reveal an opportunity to advance knowledge in this field and contribute to the literature on transitions.

PALAVRAS-CHAVE
Transição para a sustentabilidade. Perdas e desperdício de alimentos. Sistema Agroalimentar.

Resumo: *A transição dos sistemas sociotécnicos vem ganhando espaço na literatura sobre sustentabilidade. Especificamente no âmbito do sistema agroalimentar, está sendo discutida uma forma mais sustentável na produção e consumo. Isso porque a sociedade enfrenta um paradoxo: de um lado, a quantidade de perdas e de desperdício de alimentos (PDA) é significativa e, de outro lado, uma parcela significativa da população mundial passa fome, apontando a urgência de uma transição para um modelo de produção e de consumo que se tornem mais sustentáveis. Considerando os estudos sobre transição para a sustentabilidade e o problema de PDA, o presente estudo pretende analisar a produção científica que versa sobre essa temática. A pesquisa bibliográfica compreendeu as bases de dados Emerald, Sage, Science Direct, Scopus, Web of Science e Wiley Online Library. Os resultados indicam que os estudos relativos à transição para a sustentabilidade em sistemas agroalimentares são escassos, ponderando-se que se trata de observar a PDA. Nesse sentido, existem possibilidades de ampliar o conhecimento no campo de transições e PDA, envolvendo atores sociais diversos daqueles investigados na literatura selecionada, na busca de mecanismos para enfrentar esse problema que demonstra-se urgente. No que tange às pesquisas científicas, constatou-se que há oportunidade para avançar o conhecimento neste campo e contribuir para a literatura acerca das transições.*

PALABRAS CLAVE
Transición a la sostenibilidad. Pérdidas y desperdicio de alimentos. Sistema Agroalimentario.

Resumen: *La transición de los sistemas sociotécnicos ha ido ganando terreno en la literatura sobre sostenibilidad. Específicamente en el contexto del sistema agroalimentario, se está discutiendo una forma más sostenible de producción y consumo. Esto se debe a que la sociedad se enfrenta a una paradoja: por un lado, la cantidad de pérdidas y desperdicio de alimentos (PDA) es significativa y, por otro lado, una parte importante de la población mundial sufre hambre, lo que apunta a la urgencia de una transición. a un modelo de producción y consumo cada vez más sostenible. Considerando los estudios sobre la transición a la sustentabilidad y el problema del PDA, este estudio pretende analizar la producción científica que trata este tema. La búsqueda bibliográfica incluyó las bases de datos Emerald, Sage, Science Direct, Scopus, Web of Science y Wiley Online Library. Los resultados indican que los estudios sobre la transición a la sostenibilidad en los sistemas agroalimentarios son escasos, considerando que se trata de observar el PDA. En este sentido, existen posibilidades de ampliar el conocimiento en el campo de las transiciones y PDA, involucrando a actores sociales diferentes a los investigados en la literatura seleccionada, en la búsqueda de mecanismos para enfrentar esta urgente problemática. Con respecto a la investigación científica, se encontró que existe la oportunidad de avanzar en el conocimiento en este campo y contribuir a la literatura sobre transiciones.*

Introduction

Hunger is a problem on a global scale, yet it coexists with another paradoxical issue: food loss and waste (FLW). According to the Food and Agriculture Organization of the United Nations (FAO, 2021), 17% of all food available for consumption is wasted. This corresponds to about 931 million tons of food that went to waste, equivalent to 23 million fully loaded 40-ton trucks.

In another report, FAO (2020) estimated that 820 million people go hungry, a number rising due to the problems intensified by the Covid-19 pandemic, such as social inequality and income reduction caused by the restriction policies adopted to contain the virus.

Thus, FLW is a social, environmental, and economic problem. It is a social issue because, even though food production is enough to feed everyone on the planet, food does not reach everyone's table due to waste. Therefore, food loss and waste impact the environment because of the food residues generated and the resource consumption inherent to production (energy, water, soil, among others). It is also an economic problem because financial resources are wasted, either in the production and transportation stages, where most of the losses occur, in commercial establishments, or in how the food is consumed by families (Dou, Toth & Westendorf, 2017; Notarnicola et al., 2017; Morone, Falcone & Lopolito, 2019).

Therefore, FLW is a sustainability issue and deserves priority in policy agendas (Foden, Browne, Evans, Sharp & Watson, 2017). It demands a transition in how food is produced and consumed throughout the agrifood system. Thus, it is possible to migrate from the current conventional system to a more balanced one (Notarnicola et al., 2017).

Geels (2002) defines sustainability transitions as the change from a dominant system to a more sustainable one. In the studies on the subject, moving from the conventional agrifood system to a more sustainable one is a substantial challenge, especially in terms of food waste and loss throughout the production, supply, and consumption chain. According to El Bilali (2019), the field of research on sustainability transition has developed and gained prominence in the last two decades. However, the author argues that it has ignored agrifood systems.

Thus, this study seeks to analyze the scientific production on sustainability transitions in the agrifood system focusing on the FLW problem, an area that is still lacking in the literature. This systematic review contributes to identifying the advances of scientific production quantitatively by surveying bibliometric aspects and qualitatively by observing the author's approaches in the papers selected. Thus, this study identifies possible advances in the literature on sustainability transitions in the agrifood system focusing on the FLW problem.

It should be noted that there is speculation with food (futures market) and expectations of production and crop failures due to climate problems around the world and currency conversion. In certain currency situations, exports are more interesting than domestic market sales. These are all questions that affect the food market.

The paper is organized as follows: first, the introduction presents the general concept of FLW as a sustainability issue, the research goal, and a brief justification. The second section contains the theoretical framework based on the literature on sustainability transitions in the agrifood system focusing on FLW. The third section approaches the methodological aspects of the study: the databases used for surveying papers, the keywords employed, the inclusion and exclusion criteria, and the material selected at the end. The fourth section presents the results and discussions, containing quantitative, bibliometric, and qualitative data, as well as the analysis of the scientific production reviewed and its results. Finally, the final considerations reflect on the study's limitations and suggest future avenues for research about the subject.

Theoretical framework

This section contains a literature review on the subject at hand, that is, sustainability transitions in the agrifood systems observing the FLW issue.

Sustainability transition in the agrifood system

Geels (2002) defines transition as an innovation from one sociotechnical system to another, which encompasses the coevolution of processes, technological changes, and modifications in other elements of the system. The author also points out that the transitions are coevolutionary processes that occur at the niche, regime, and landscape levels, which are interconnected elements.

Geels (2002) defines niches as spaces where innovations that can drive changes in the established regime occur, destabilizing it in a way that can entail a transition. The author describes regimes as existing sociotechnical systems (energy, mobility, transportation, among others) that encompass a set of rules, laws, and behaviors that govern the actions of their social actors. The sociotechnical landscape, according to the author, consists of the external environment (globalization, environmental issues, cultural changes, wars, natural disasters, and economic crises), which influences regimes and creates opportunities for niches to grow.

In the agrifood system, niches are innovative spaces that tend to follow a line that diverges from the dominant system. Examples include agroecology, urban gardens, and farms, among others, which seek to establish a new way of production and consumption (Rut & Davies, 2018).

The dominant regime of the agrifood system is the existing pattern of production and consumption, based on increased food production and involving national and regional changes in solid waste policies, social activism, technologies, business policies, food regulation, and food cultural policies (Tartiu & Morone, 2017).

The sociotechnical landscape of the agrifood system is formed by external factors, like environmental changes, population growth, economic changes, among others. They constantly interfere with the regime and niches (Mardsen, 2013).

The way food is produced and consumed is shifting to a FLW perspective when it comes to sustainable development. Scientific studies are being developed in several areas, which shows the interdisciplinary nature of the subject studied and recent research. According to Notarnicola et al. (2017), the search for changes in how food is produced and consumed is urgent, seeing that the world population tends to increase considerably, which entails a growing demand for food and other resources. The authors also point out that food waste and loss go far beyond the attempt to reduce social impacts because it involves understanding a widespread social and environmental problem, especially considering that part of the world's population does not have basic food conditions.

When it comes to FLW, it is critical to understand how this process occurs. Food waste happens, essentially, at all stages of food supply in the production chain, from the initial processes to the final consumer (Morone et al., 2019).

Morone et al. (2019) argue that the amount of food waste produced at a global level generates environmental and economic impacts while having a significant social repercussion. It also creates problems like greenhouse gas emissions, soil degradation, waste generation, consumption of natural resources, economic losses, inequality, and poverty.

Regarding transitions in the agrifood system, Mardsen (2013) explains that pressures at the landscape level refer to global factors, such as climate change, population growth, the shift to biofuels and biomass, and the nutritional transition. These factors trigger pressures at the regime level and drive niches forward, which, in turn, destabilize the existing regime.

Regarding the food sociotechnical regime, Galli et al. (2020) criticize the regulatory effort made to establish a single market for agriculture of cultural commodities and policy measures, which led the paradigm of agricultural modernization to focus only on productivity.

The FLW problem

Society became more acutely aware of food waste and its social, environmental, and economic repercussions after World War II (1939-1945). During this period, technological changes in food production, agriculture, food policies, and global

trade were critical to the food transition. In the 2000s, climate factors, financial crises, deforestation, and world food crises, among other factors, made the food waste issue more visible on political agendas and social and environmental debates (Tartiu & Morone, 2017).

Food waste is caused by factors like climate, human control, biological elements, and the behavior of those involved in the food chain (Cicatiello, Franco, Pancini & Blasi, 2016). It affects the entire chain, from the choice of crop to domestic consumption (Goossens, Wegner & Schmidt, 2019; Morone et al., 2019).

Food waste is a matter of resources and sustainability since its production consumes resources like land, water, energy, and inputs. It also triggers environmental impacts, like biodiversity loss, degradation, atmospheric emissions, and other inherent problems. Food waste squanders all these resources as well (Dou et al., 2017). The amount of food wasted globally affects the environment and has economic and social impacts, such as economic losses, inequality, and poverty (Morone et al., 2019). In this sense, seeking alternatives to reduce waste is minimizing the use of resources and promoting sustainability because if the food is enough to feed the population properly, there is no reason to produce greater quantities.

According to Belik, Cunha, and Costa (2012, p. 112), food waste occurs at three levels "[...] in the field, at the wholesale, and retail levels - considering every form of commercialization, and at the household level - differentiating what could be processed from other foods that simply have not been consumed". All these levels of waste require strategies that seek its reduction or eradication, which would translate into environmental, social, and economic advantages, as shown in Chart 1.

Corroborating the authors of Chart 1, Foden et al. (2017) explain that water, energy, and food are interconnected, and how one is used affects the others. Recognizing this interdependence between resources allows us to take more effective actions to promote food safety and draw attention to it in policy agendas.

The main food waste factors in low-income countries are linked to financial problems, business culture, technical limitations in the harvesting and storage phases, lack of packaging infrastructure, and modern commercialization systems (Aguilar Gutiérrez, 2019).

Chart 1
Advantages in reducing food losses

	Advantages
1.	Increasing food supply significantly without increasing crop areas;
2.	Saving the energy invested to produce and market the food lost;
3.	Reducing pollution due to decreasing decomposing organic matter and better meeting consumer needs;
4.	Better nutrition using the same amount of energy, land, water, and work.

Source: Adapted from Aguilar Gutiérrez (2019, p. 175)

Therefore, food waste is an unsustainable practice in production because it generates food and nutritional insecurity at every step of this process (Nascimento, 2018).

Based on the literature, Goossens et al. (2019) categorize possible food waste prevention measures, as shown in Chart 2.

Chart 2
Measures to reduce food waste

Categories	**Description**
Category 1	Prevention measures aimed at reducing surplus food at the source; avoiding food overproduction and buying more than necessary
Category 2	Redistribution or donation measures, like redirecting surplus food to people in need.
Category 3	Food appreciation and conversion, and removing inedible food parts from the food supply chain, such as redirecting food wasted to the bio-based industry or animal feed.
Category 4	Recycling, through anaerobic digestion or composting, and recovery of energy, food, and inedible parts removed from the food supply chain to avoid landfill dumping.

Source: Adapted from Goossens et al. (2019, p. 3).

Preventing food loss is an invitation to rethink the function of food in nutritional life and consider the natural resources consumed in food production and their environmental impacts, which encourages the search for a more efficient and sustainable food system, innovatively using food leftovers (FAO & ODEPA, 2019).

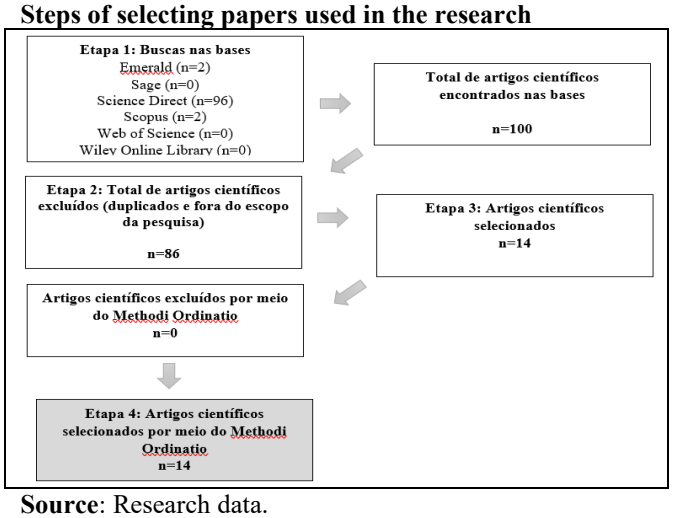
Methodological Elements of the Research

The literature search on sustainability transition and food waste was conducted in the databases Emerald, Sage, Science Direct, Scopus, Web of Science, and Wiley Online Library.

The keywords and Boolean operators used were "transition towards sustainability" AND "food waste" AND NOT "nutrition." The word "nutrition" was excluded due to the large number of scientific papers related to the specific area of Nutritional Health, which escapes the scope of this study. The filters selected were title, abstract, and keywords. The field of sustainability transition is relatively recent in the literature, and therefore, there were no publication date restrictions for selecting the scientific studies. The selected works were peer-reviewed scientific papers, excluding other types.

Figure 1 presents a flowchart showing the research steps.

Figure 1
Steps of selecting papers used in the research



Source: Research data.

As seen in the flowchart, after the search in databases, the inclusion and exclusion criteria for the papers were:

1) Inclusion criteria: papers that presented a relationship between the search terms (sustainability transitions and food waste).

2) Exclusion criteria: b1) duplicate papers; b2) publications that were not peer-reviewed (papers published in conferences, books, book chapters, among others.); b3) papers with no title, abstract, or keywords aligned with the scope of this study; b4) papers that address the subjects of sustainability transition and food waste separately.

The final result was the selection of fourteen scientific papers for the application of the *Methodi Ordinatio*. This method is a multicriteria decision-making tool to select scientific papers used to create a bibliographic research portfolio. It selects papers according to the journal's impact factor, the year of publication, and the number of citations. Then, it calculates an index for each paper and ranks them (Pagani, Kovaleski & Resende, 2015) according to the following equation:

$$InOdinatio = (Fi/1000) + a^* [10 - (AnoPesq - AnoPub)] + (\Sigma Ci)$$

In which:

InOrdinatio: index achieved by the paper;

Fi: the impact factor of the journal that published the paper;

a: coefficient from 1 to 10 assigned by the researcher to the relevance of the year of publication;

AnoPesq: the year in which the review was conducted;

AnoPub: the year of publication of the paper;

Ci: the number of citations of the paper.

This review assigned 10 to the coefficient *a*, considering there were no time restrictions for the years of publication.

In the *Methodi Ordinatio*, the first paper achieved a 386.00 index, while the last achieved 83.00. No study was irrelevant, with a negative index (<0). Considering their relevance, revealed by their indexes, all of the fourteen papers were kept in the research portfolio.

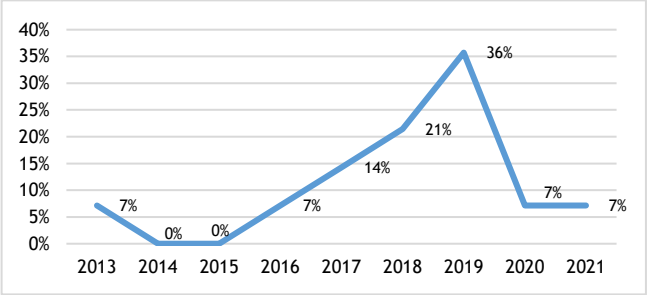
Research results

This section presents the research results and the data collected arranged in figures and charts. The graphs contain the quantitative data, while the chart is qualitative, presenting information collected by reading and analyzing the selected bibliographic portfolio.

Figure 1 shows the number of papers published from 2013 to 2021. The sample has a higher concentration of studies connecting sustainability transition and FLW in 2019, which

shows that few sustainability transition studies are directed at FLW. In percentage terms, the scientific production increased 36% between 2013 and 2019.

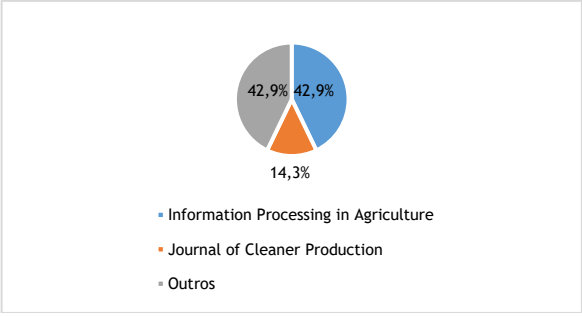
Figure 1
Percentage of publications on the subject between 2013 and 2021



Source: research data.

A relevant point in systematic literature reviews is to indicate the journals publishing papers on the subject, which enables researchers to find material more efficiently. Figure 2 shows that 42.9% of the studies were published in the *Journal of Cleaner Production*, and 14.3% were published in *Technological Forecasting and Social Change*. Journals with only one publication were listed under "Others." Jointly, they represent 42.9% of the papers analyzed.

Figure 2
Percentage of publications per journal

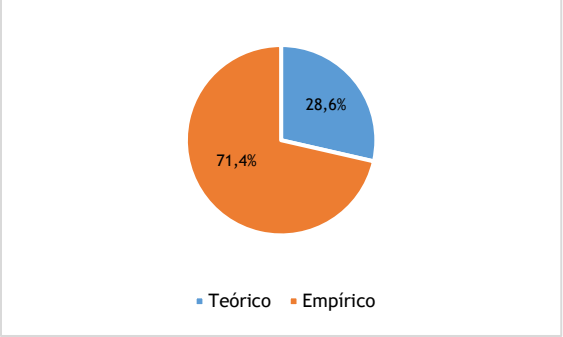


Source: research data.

Figure 3 shows the types of studies conducted in the papers analyzed. Empirical papers were more expressive, with 71.4%. Literature reviews corresponded to 28.6% of the sample. It is possible to observe that more works in the sample focused on testing the theory in empirical cases.

The empirical studies were conducted in Belgium, Norway, Finland, Ireland, France, the United Kingdom, and Italy. Specifically, they were conducted in industries related to the agrifood system, such as the subcontracting, agricultural, food, and retail industries. Other papers focus on consumers, the government, NGOs, research institutions, public and private innovations, financial institutions, families, universities, and other civil society actors, all connected to the agrifood system.

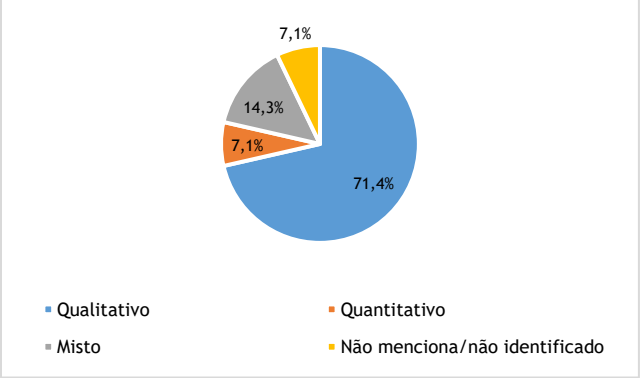
Figure 3
Type of study conducted



Source: research data.

Regarding the approach to the problem, Figure 4 shows that most papers employed qualitative data analysis methods (71.4%). The mixed approach corresponded to 14.3% of the sample, and only 7.1% used quantitative methods to analyze data. Thus, in sustainability transition studies related to the FLW issue, researchers choose the qualitative approach, predominantly with data collection through semistructured interviews, literature analysis, and documents.

Figure 4
Approaches to the problem



Source: research data.

The research tools employed by each study, which proved to be quite varied, were also mapped. Techniques like Life Cycle

Analysis, Household-level Sustainability Transition, Fuzzy Methodology, Social Network Analysis, Multilevel Perspective, and the Morphological Approach to Participatory Scenario Development Analysis were employed in the studies. The Fuzzy methodology and the Multilevel Perspective stood out.

Every paper analyzed addressed concepts related to the transition of regimes and FLW aspects and, by this criterion, were selected to compose the portfolio. Besides these basic concepts, Chart 3 presents the more specific theoretical approach of the papers.

Chart 3
Theoretical approaches used

Authors	Theoretical approach used	Authors	Theoretical approach used
Marsden (2013)	Transitions towards sustainability.	Coteur, Marchand, Debruyne and Lauwers (2019)	Agrifood system; Sustainable development.
Laakso and Lettenmeier (2016)	Sustainability transitions in domestic material flows.	Galli *et al.* (2020)	The development of a European Food Policy in the transition process; Integration of transition policies.
Sandberg (2021)	A typology of consumption changes; sufficiency practices; sufficiency transition.	Morone et al. (2019)	Food waste.
Notarnicola *et al.* (2017)	Agrifood Life Cycle Analysis in response to sustainability and food security.	Kuokkanen *et al.* (2018)	Transition in the Finnish food system.
Devaney and Davies (2017)	HomeLabs: concepts, interventions, impacts	Azzurra, Massimiliano and Angela	Consumer behavior for sustainable consumptio
	and projection.	(2019)	n.
Bilali and Allahyari (2018)	ICT in the food chain.	Hoolohan, McLachlan and Larkin (2019)	Multiple methods for scenario development.
Egelyn *et al.* (2018)	Bioeconomic transition.	Capasso, Hansen, Heiberg, Klitkou and Steen (2019)	Drivers and barriers of green growth.

Source: research data.

The variety of specific subjects addressed by the papers is evident, showing that the researchers used diverse theories and methodologies to approach sustainability transitions focused on FLW.

Figure 6
Word cloud

Source: survey data (elaborated using: https://wordart.com/).

Figure 6 presents the word cloud, designed based on the theory addressed in the analyzed papers. The words "sustainability" and "transition" stand out as the central thematic axes addressed by the authors, followed by the more specific terms adopted in the studies.

Analysis and discussion of results

This section reflects on the elements in the literature on landscape, regime, and niche in the agrifood system sphere, as well as the relationship between sustainability transitions and the FLW problem. Finally, it presents thoughts on the literature analyzed.

Landscape, regime, and niche in the agrifood system sphere

To analyze studies on sustainability in the agrifood system, it is worth explaining what the researchers understand as landscape, regime, and niche in this system. After all, these concepts are intrinsically related, as Geels (2002) points out. Looking at these three levels, it is possible to understand the current scenario of the agrifood system and what changes are occurring.

Some authors addressed concepts related to landscape, regime, and niche to explain how these three levels are interrelated in the context of the agrifood system. As Marsden (2013) explains, on the one hand, there is the food crisis; on the other, there is a new age, entailing landscape changes and potential alterations in niche production systems, up to whatever extent they can be integrated.

At the landscape level of the agrifood system, Kuokkanen et al. (2018) mention examples like climate change, global food security, and loss of biodiversity. Marsden (2013) also brings up, besides environmental factors, social factors like population growth, the shift to biofuel and biomass, and the nutritional transition.

More specifically, they are global problems related to the scope of food production and consumption. The landscape level features global influences related to politics, culture, and economics (GDP, climate change), as well as influences related to food production (technologies, crops, animal protein) and consumption (diets, mealtimes, shopping) (Hoolohan et al., 2019).

The landscape constantly influences the regime, which drives the system due to its coercive norms, such as how food is produced and consumed (Kuokkanen et al., 2018). Within the current existing regime, that is, the conventional agrifood system (Bui et al., 2016), this creates new forms of production and consumption, like agroecology, which would be an alternative for the transition to a new regime (El Bilali, 2019; Galli et al., 2020).

Niches are innovative alternatives that emerge within regimes in an attempt to reconfigure the dominant regime (Geels, 2002). As examples of niches, El Bilali (2019) points to community food buying and care farming. Other examples include alternative food movements, biotechnological innovations, and new products such as artificial meat (Kuokkanen et al., 2018).

In the current agrifood system, some niches may also appear in supply chains and in practices of access to land and agriculture to drive sociotechnical changes (Bui, Cardona, Lamine & Cerf, 2016). Authors also highlight other niches, like organic agriculture (Marsden, 2013; Galli et al., 2020) and fair trade (Galli et al., 2020).

The literature notes that the landscape influences the existing agrifood system, which may lead to new forms of production and consumption, considering factors like the food crisis, potential environmental problems, and nutritional transition (Marsden, 2013; Kuokkanen et al., 2018; Hoolohan et al., 2019), for instance, affect food production and consumption.

Thus, the landscape puts pressure on the existing agrifood regime and opens opportunities for innovative niches to develop, as Geels (2002) points out. The research reviewed points to innovative niches that go against the current large-scale food production model, creating new ways to produce and consume food more sustainably, like agroecology, and organic agriculture, among others (Bui et al., 2016; El Bilali, 2019; Galli et al., 2020). In this context, these niches may generate sustainability shifts over time as the spaces and society change.

Relationship between sustainability transition and the FLW problem

Notarnicola et al. (2017) apply a life cycle analysis to the transition toward sustainable production and consumption. They discuss the challenges in assessing the life cycle of complex food systems and recommend that studies prioritize scientific development and improvements in practical implementation. The interconnection with the food waste problem relates to the obscurity in the results of the assessment of food waste impacts in different stages of the life cycle and in supply chains, which are dysfunctional in this issue. The authors

recommend a real solution for the food waste problem with management-oriented tools and technological solutions.

Marsden (2013) assesses the most turbulent period in the agrifood sector since 2007 and 2008, applying the perspective of a series of empirical data collected from key public and private interested parties in the UK over the timeframe, testing the exogenous factors. The author comments that shifts to a new regime begin with facing several problems related to the agrifood sector, including food waste. That will push niches toward a more sustainable food system alternative.

The study of El Bilali and Allahyari (2018) explores the contribution of information and communication technologies (ICTs) to sustainability transitions in the food chain (production, processing, distribution, consumption). The paper briefly discusses the impact of ICTs on food waste, commenting that they can create networks that provide solutions to deal with production surpluses to prevent food waste.

Azurra et al. (2019) conducted a study to further analyze the determinants that affect the behavior of organic food consumers. The authors argue that consumers can be the core of sustainable development, playing a central role in the transition to sustainable food systems. Briefly, the paper points out that consumers are the protagonists of sustainable consumption, with more balance and less waste.

Morone et al. (2017) examined which policy drivers and particular initiatives can modify current unsustainable food conditions to reduce food waste. In general, the results point to the complexity of the food residue system, clearly showing that policy drivers and private initiatives have potential side effects and negative impacts that must be considered in a suitable, balanced policy intervention for the food waste system.

Devaney and Davies (2017) studied the implications of conceptualizing, designing, and implementing experimental sites that seek to support more sustainable home-based eating practices. The authors found that the consumers reinforce calls to connect, combine, and align product support and aspects of regulation, information, and motivation in the interdependent food practices (acquisition, storage, preparation, and waste minimization) to optimize sustainability transitions.

The literature review conducted by Capasso et al. (2019) aimed to synthesize perceptions on green growth, explicitly explaining innovation drivers and hindrances in the geographical context of green growth. In the food waste context, the study found that the aspects related to policy coordination include the need to align development policies and implementation of green technologies with other types of policy.

Galli et al. (2020) researched the policy processes that contribute to sustainable food systems in Europe. Assessing the gaps in current food policy instruments, the authors state that food waste has drawn the attention of public and volunteer initiatives, especially in high-income countries.

Sandberg (2021) analyzed the growing literature on sufficiency, which consists of substantial changes in consumption patterns so as to minimize it. From a consumption perspective, food waste can be minimized with good practices ranging from the acquisition to leftover management.

Hoolohan et al. (2019) presented a new morphological method for the development and transdisciplinary analysis of scenarios related to water, energy, and food. In the authors' approach, food waste is a challenge because innovations use food leftovers as a product in their processes, which entails depending on this resource, seeing that, if there are no leftovers, it is impossible to maintain the organizations that depend on them.

Laakso and Lettenmeier (2016) presented a new methodology for sustainability transition at the family level. The results showed that achieving a significant reduction in the material consumption footprint is possible with few changes in the consumption practices of families, and one of the resources analyzed by the authors is food waste.

Kuokkanen et al. (2018) recorded the criticisms of a multilevel transition study, contributing to understanding regime destabilization in theory and practice. They briefly

addressed the food waste problem, emphasizing that growing consumer demands have facilitated the emergence of several new startups to combat waste in the location studied.

Coteur et al. (2019) developed a study to understand and structure the myriad of development processes in the agrifood system. One of the problems addressed was food waste. The authors concluded that sustainability assessments through assessment tools are not enough of a guiding principle for developing an agrifood system. Moreover, the interaction between actors in the chain plays an equally important role as drivers of sustainable development processes.

Egelyng et al. (2018) addressed research questions on concrete innovations aiming to create transition options in Norway. They investigated cases in the food industry involving the processing of fish, meat, fruits, and vegetables to capture or increase the value of processing residues. The authors discuss that, through investment in research programs, societies endeavor to expand the options available to food producers and processors, retailers, and consumers to avoid losses and waste in the food system through technical solutions.

Considerations on the literature reviewed

The analysis of the papers selected to compose the portfolio shows that the studies on the transition of agrifood systems are still incipient. There is much to be developed and researched, as the literature on sustainability transitions is still recent, and the papers that connect FLW to sustainability transitions are scarce. The papers reviewed are quite diverse in their thematic axes, considering the social actors investigated and the methodological tools used. Moreover, the studies selected also address issues beyond FLW, which lends an even lower degree of specificity to this issue.

Researching FLW in the sustainability transition literature is a great challenge, considering that, as stated by Geels (2002), transitions occur slowly, sometimes taking decades. Another factor is that the transition involves a considerable diversity of actors with conflicting objectives. There is always a dispute between actors in the transition process, each aiming at their own interests (Geels, 2002). In the agrifood system, a more consensual transition form found in the papers reviewed is the migration from the conventional production and consumption regime to an agroecological one. The studies analyze social practices with that premise and denote the ability of social actors to legitimize these practices and reconfigure the existing regime. On this point, it is worth noting that the proposal to reconfigure the regime needs to address the need for scale, considering that there are seven billion inhabitants on the planet.

El Bilali (2019) pointed out the scarcity of studies that deal with sustainability transitions in the agrifood system focusing on factories and companies, arguing that it is a sector criticized by researchers because they belong to the dominant regime. Therefore, factories and companies need to be addressed by studies on sustainability transitions in the context of FLW. Despite the hindrances linked to the goal of maximum profit, the active participation of these actors is extremely relevant to mitigate this problem.

However, reconfiguring the established agrifood regime is challenging because of the involvement of conflicting interests of various social actors involved, which requires an abrupt posture change of the whole society so that innovations develop to contribute to mitigating FLW in an axis-by-axis process.

Regarding FLW, based on a more profound change in the current agrifood system, it is possible to search for solutions along the entire food chain to reduce its occurrence more and more. The studies reviewed point to technological development, public policies, good practices, and food management as allies in searching for FLW solutions. Therefore, it is possible, by raising the population's awareness about this challenge, to take a more active posture so that the changes begin to reach amplitude.

Final Considerations

This paper aimed to analyze the scientific production on sustainability transition in the agrifood system, focusing on the FLW problem.

The results showed that few studies connect sustainability transition to the FLW problem. Moreover, some of the studies reviewed address other variables that go beyond this question.

As a theoretical contribution, this study can help future investigations about the subject by identifying the theoretical and methodological approaches, data collection and analysis tools, and pointing out possible research gaps. The practical contribution is related to the possibility of using the same research tools as the papers reviewed, as found by this study, or opening up new research perspectives with different proposals from those presented. All these points can favor the dynamics of solutions for the FLW issue, from production to consumption.

Given that, it is possible to propose a research agenda to investigate the sociotechnical transition of the agrifood system and FLW. Thus, a few proposals include measuring and analyzing FLW at various moments of the agrifood chain to suggest solutions, analyzing how existing niches can drive regime shifts by legitimizing innovative practices, understanding how factories and companies can stimulate innovative practices to reduce FLW, and contributing to a more sustainable agrifood regime.

It should be noted that this paper has limitations. One of them is that the papers reviewed were restricted only to the databases investigated and up to the date of collection.

As a suggestion, other studies should be developed applying the analysis instruments identified in this systematic review, which will allow comparisons between the situations. Another possibility is the use of new analysis tools in other contexts and realities. Moreover, this study can be complemented in the future by possible publications on the subject in the coming years.

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