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Agri-food systems in sustainability transition: a systematic literature review on recent developments on the use of the multi-level perspective

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A sustainability transition (ST) of the agri-food system (AFS) is necessary due to manifold environmental and social exigencies. Scholars widely refer to the multi-level perspective (MLP) in the analysis of those transitions. The fast pace of articles covering AFS transitions, the evolving research on spaces between the three levels, and the consisting unclear conceptualization of MLP levels call for a systematic update on literature utilizing MLP in AFS articles covering ST. As a basis for reporting, this systematic literature review uses the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The search was conducted on the database Scopus encompassing the period from 2018 to 2022. After the selection procedure, 58 articles were included in the review. We extracted data based on a combination of a concept-driven and data-driven coding scheme. Qualitative research approaches outweigh and interrelated activities within the AFS are being analyzed, predominantly in the agricultural sectors. The focus lays on ongoing transitions. The concept of sustainability and its direction is considered as given (e.g., through the case lens), without further elaborations. The niche constitutes the most prominent object of study and scholars refer to rather socially innovative activities than technological innovations, providing distinct views on radicality and strategies to breakthrough. A space between niche and regime is being presented, with slightly distinct conceptualisations. Actors from both levels collaborate and exert transformative power. The regime is presented as static but also more vividly evolving views on the regime are demonstrated. The landscape receives the least attention and the focus lays on immaterial characteristics. Combinations of MLP with other frameworks have proven useful, for instance, regarding elaborations on the agency on the landscape level. Generally, an unclear conceptualization of regime and landscape persists, lacking a theoretical elaboration. Further research applying MLP should aim for a deeper examination of its theoretical construct, especially in terms of regime and landscape. More quantitative or mixed-methods research could supplement the current dominating qualitative approaches by testing and validating qualitatively constructed theories and phenomena.

KEYWORDS

multi-level perspective (MLP), food system, agriculture, sustainability, transition, transformation

1. Introduction

Agri-food systems (AFS) are pressured by current environmental degradation and climate change. Weather extremes, soil degradation, loss of biodiversity, food availability, and scarcity represent only some of those manifold effects (IPCC, 2019). Efforts toward sustainable development of AFS are thus inevitable (FAO, 2018a; IPCC, 2019). Agri-food systems are complex and diverse socio-ecological systems (Ericksen, 2008; Leeuwis et al., 2021). They incorporate the whole range of actors, activities, and outcomes, as well as multiple environmental, social, political, and economic determinants, including external elements influencing this system (Ericksen, 2008; Ericksen et al., 2010; FAO, 2018a; Stefanovic et al., 2020). A sustainable AFS should balance food systems outcomes: food security, environmental security, and social welfare, for current and future generations (Ericksen, 2008; Eakin et al., 2017; FAO, 2018a). To achieve this, a transition toward the sustainable development of AFS is necessary.

The multi-level perspective (MLP) represents a framework widely used in the literature to analyse transitions from one socio-technical system to another (Geels, 2004, 2010). Originally developed for the elaboration of historical, concluded transitions, and technological innovations, the MLP is increasingly used to study ongoing socio-technical transitions (Köhler et al., 2019). Socio-technical systems comprise societal elements next to technological elements (Geels, 2004). The MLP is a so-called "middle-range theory" that contributes to the understanding of long-term and complex socio-technical changes, especially their dynamics. The originators perceive it as "middle-range" in the sense that the MLP combines elements from distinct theories with similar ontological assumptions and does not claim to be a theory of everything (Grin et al., 2010). The MLP is informed by science and technology studies, evolutionary economics, structuration theory, and neo-institutional theory that, according to the founders, complement each other by compensating the shortcomings of one with the strengths of the other (Rip and Kemp, 1998; Geels, 2002, 2004, 2011; Grin et al., 2010). By doing so, these theories offer assumptions that are reconciled within and account for the MLP. The main premises of these theories can be found in the cited literature.

The MLP argues that transitions evolve through interaction processes between three levels: niche (1), socio-technical regime (2), and socio-technical landscape (3). In short, niches develop their own dynamics, diverging from the regime. Changes at the landscape-level pressure regimes that may destabilize and thus create a window of opportunity for niches to breakthrough. The framework implies the existence of co-evolutionary processes between these levels at multiple dimensions simultaneously. During transitions, these processes couple and reinforce each other (Grin et al., 2010). Niches (1) comprise the space for experimentation and radical novelty generation where protection is offered by, for instance, subsidies, public authorities, or company investments (Geels, 2004). Niches provide learning spaces and possibilities to deviate from incumbent regime rules (Geels, 2004; Smith et al., 2010). Three niche-internal processes are described in transition literature: network building, heterogeneous learning processes, and vision articulation (Grin et al., 2010; Geels, 2020). Niches compete with the dominant regimes to scale out their radical innovations and bring about "revolutionary" change. Innovations can remain within the niche for a longer period as they encounter discrepancies with the dominant regime (e.g., unsuitable infrastructures and policies) or face headwinds from regime actors. For wider scale influence, regime actors need to be persuaded and become involved in niche activities (Grin et al., 2010).

Socio-technical regimes (2) comprise the semi-coherent prevailing rule-set that coordinates and structures social groups. It encompasses the aligned rules of distinct sub-regimes (e.g., user and market regime, socio-cultural regime, policy regime, science regime, and technological regime; Geels, 2004, 2011). This rule-set develops through a co-evolutionary process of accumulation and alignment. Informed by neo-institutional theory, these rules can be divided into three types: first, cognitive (a), such as shared beliefs, lifestyles, or user practices; second, normative (b), for instance, values, norms, roles rights, and responsibilities; or last, regulative (c), the explicit formal rules (Geels, 2004, 2011; Grin et al., 2010; Smith et al., 2010). Geels (2011) states that these rules have a 2-fold nature. They are both "medium and outcome of action" (p. 27), accounting for the socio-technical regime's reproduction. These rules (i.e., the socio-technical regime) guide the progression of the more material socio-technical systems. The demarcation between the socio-technical regime and a socio-technical system is important to grasp the concept of the first-mentioned, although still ambiguous in the literature and a matter of deliberation (Holtz et al., 2008; Geels, 2011). Geels (2011) acknowledges the critiques that the regime is partly equalized with the system. He clarifies that the socio-technical regime refers to the intangible "deep-structure" (see above, e.g., beliefs, heuristics, routines, visions, and norms), ensuring the stability of an existing socio-technical system. Whereas, socio-technical systems represent the more tangible elements (e.g., artifacts, market shares, and infrastructure). Nevertheless, the tension and incoherence between the more institutional understanding of the regime and more material understandings which include actors or artifacts that develop the rules persist (Markard and Truffer, 2008; Smith et al., 2010; Geels, 2011; Fuenfschilling and Truffer, 2014).

Due to regimes prevailing structures and alignments, regimes are "dynamically stable." Thus, they are characterized by lock-ins, where change processes run path-dependent and incremental (Grin et al., 2010; Smith et al., 2010; Geels, 2011). Instability evolves in regimes whose actors start to disagree and diverge on incumbent rules (Geels, 2002; Grin et al., 2010).

The socio-technical landscape (3) represents the structural, exogenous, and broader context for niches and regimes (Smith et al., 2010; Geels, 2020). The landscape includes a material and an immaterial domain. The material side of society comprises, for instance, infrastructures, factories, or spatial arrangements of cities. The immaterial domain consists of demographical trends,

Abbreviations: ST, Sustainability Transition; AFS, Agri-Food System; MLP, Multi-Level Perspective; SLR, Systematic Literature Review; ANT, Actor-Network Theory.

political ideologies, societal values, and macro-economic patterns (Geels, 2004, 2011). Three types of landscape dynamics are present in the literature: first, factors that do not change or if at all, only of a slow pace (e.g., physical climate); second, trend-like patterns that change in the long term toward a certain direction; and third, rapid external shocks (e.g., wars and pandemics; Driel and Schot, 2005; Geels, 2011). In the short run, niche or regime actors do not influence landscape developments, although, through multiple actions, developments occur with the human agency (e.g., urbanization and globalization; Grin et al., 2010). The landscape may exert enhancing and restraining forces (by reinforcing regime trajectories) for change processes. In the first case, this may lead to supportive windows of opportunity for niches to scale out. For instance, user preferences may change due to negative externalities or cultural changes, leading to regime tensions (Grin et al., 2010; Smith et al., 2010).

A former review on the use of the MLP in AFS transformations revealed insights into AFS authors' conceptualisations and understandings (El Bilali, 2019). An increasing amount of AFS research on sustainability transitions (ST) was predicted and a call for a deeper investigation of MLP levels and dynamics within AFS articles was pronounced. The article comprised AFS studies until the beginning of 2018. As outlined previously, different theoretical notions of MLP levels (esp. regime) exist. It seems that these theoretical notions were not considered in this former review. Furthermore, recent MLP literature dived deeper into the fluency of MLP levels, elaborating on the space between those MLP levels (Fischer and Newig, 2016; Bush et al., 2017; Kivimaa et al., 2019). Thus, from the fast pace of articles on AFS ST using MLP evolving in recent years, we expect significant new insights. These reasons were taken up to conduct a systematic literature review (SLR) to present an overview of the current use and recent elaborations as well as conceptualisations of MLP in AFS articles dealing with ST. Hence, we address the following research question:

How is the MLP framework applied in recent research on AFS transitions?

Compared to El Bilali (2019), we will dive deeper into the MLP levels and provide a more detailed investigation of those. Thus, the aim of this study is neither to elaborate on transition dynamics or outcomes (e.g., transition pathways) nor to present our understanding of sustainable AFS and transitions or how we conceptualize the MLP levels. We rather aim to provide an overview of recent AFS authors' approaches and understandings of the MLP and its levels in the course of ST of AFS.

2. Methodology

This systematic literature review on research on the use of the MLP in ST of AFS refers to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et al., 2021) as a basis for reporting. As a first step in the process, a protocol was developed containing the rationale, research question, eligibility criteria, search strategy, study records, as well as data synthesis plan according to PRISMA Protocols (PRISMA-P; Moher et al., 2015).[1]

2.1. Search strategy and quality assessments

We searched the database *Scopus* on 23rd February 2022, the same database where the aforementioned systematic literature review (El Bilali's, 2019) was conducted. We searched the string *Transition AND (MLP OR "multi-level perspective" OR "multilevel perspective" OR niche) AND (agri* OR agro OR food)*.[2] Only publications from 2018 onwards were included. As the focus is on peer-reviewed research articles, we excluded systematic literature reviews, book chapters, notes, and editorials. Peer-reviewed conference proceedings were included. Whether studies applied qualitative, quantitative, or mixed-methods research was no exclusion criteria. For the selection of publications, a two-step procedure was followed. First, a coarse sieving process through articles for inclusion was performed, based on the inspection of titles and abstracts. In case of doubts, articles were carried along. Second, a fine sieve was utilized for the refined quality assessment based on the full-text study. As a last step in the process, backward and forward citation searches were applied on 31st March 2022 to identify further relevant publications. The latter was solely applied to articles identified after the fine-sieving process in the Scopus database. Eligibility criteria comprised the following: first, the focus on the human agri-food sector; second, the usage of the MLP as the main framework or a combination of MLP with other frameworks; third, publications of English and German language only; and finally, a content concerning an ST, whereby the term transition should be utilized in the sense of "transformative change." Studies that did not meet the eligibility criteria were excluded from the review as well as publications from 2018 that were already part of El Bilali's (2019) review. Figure 1 depicts the articles' review and exclusion process. For the documentation of the review process, search results from the Scopus database were imported into a Microsoft Excel sheet. Reasons for the exclusion of articles were recorded.

For this review's research question, all findings (interpretations and conceptualisations) can make valuable contributions. Therefore, all resultant identified articles were included. Thus, poor reporting within an article does not necessarily implicate poor study quality (Boland et al., 2017), yet constitutes a limitation of this systematic review. To obtain an impression of each article's quality, we carried out a quality assessment during data extraction based on Cochrane Handbook version 6.3, 2022 (Higgins et al., 2022), Boland et al. (2017), and the critical appraisal checklist for qualitative studies by the Critical Appraisal Skills Programme (CASP, 2022).[3]

1 The protocol can be requested from the authors.

2 Compared to El Bilali (2019), this systematic review focusses on a deeper investigation of the MLP levels and their characteristics. However, a similar search string was applied as major additions did not add value.

3 The guiding questions for quality assessment are listed in the protocol which can be requested from the authors.

2.2. Evidence synthesis plan and data extraction

The use of the MLP (on transitions of the AFS) is not limited to a specific type of data. Similarly, this review's research question is independent of the research design applied in articles on transitions of the AFS. Therefore, this systematic literature review included qualitative, quantitative, and mixed-methods evidence and aggregated the findings into a single synthesis. For the synthesis, we chose a convergent integrative approach that allows a combination of quantitative, qualitative, and mixed-methods evidence during data processing (Lizarondo et al., 2020). Data were extracted based on a coding scheme that combined concept-driven and data-driven categories. An *a priori* framework of concepts and themes inspired by the research question and literature was developed. The focus laid on: bibliometrics (1), the thematic focus related to the AFS (2), the desired outcome of the transition and sustainability implication (3), the conceptualization and application of MLP and its elements (4), criticisms on MLP (5), enhancement or combination with other frameworks and theories or scientific stances (6), and finally, the research design (7). The coding process followed a three-step procedure. In the first round, we tested the coding scheme on the first 15 articles. Adaptations were undertaken as well as data-driven codes derived as authors' conceptualization of the MLP levels was captured exploratively. In the second step, the coding framework was applied to all identified articles. During the final monitoring, the first 10 articles were coded again to check whether codes were applied consistently throughout the process. Coding, data extraction, and synthesisation were performed with the software programme MAXQDA (VERBI Software. Consult. Sozialforschung. GmbH, Berlin, Germany). The reference management software Zotero was used to keep track of references.[4]

4 The coding scheme can be requested from the authors.

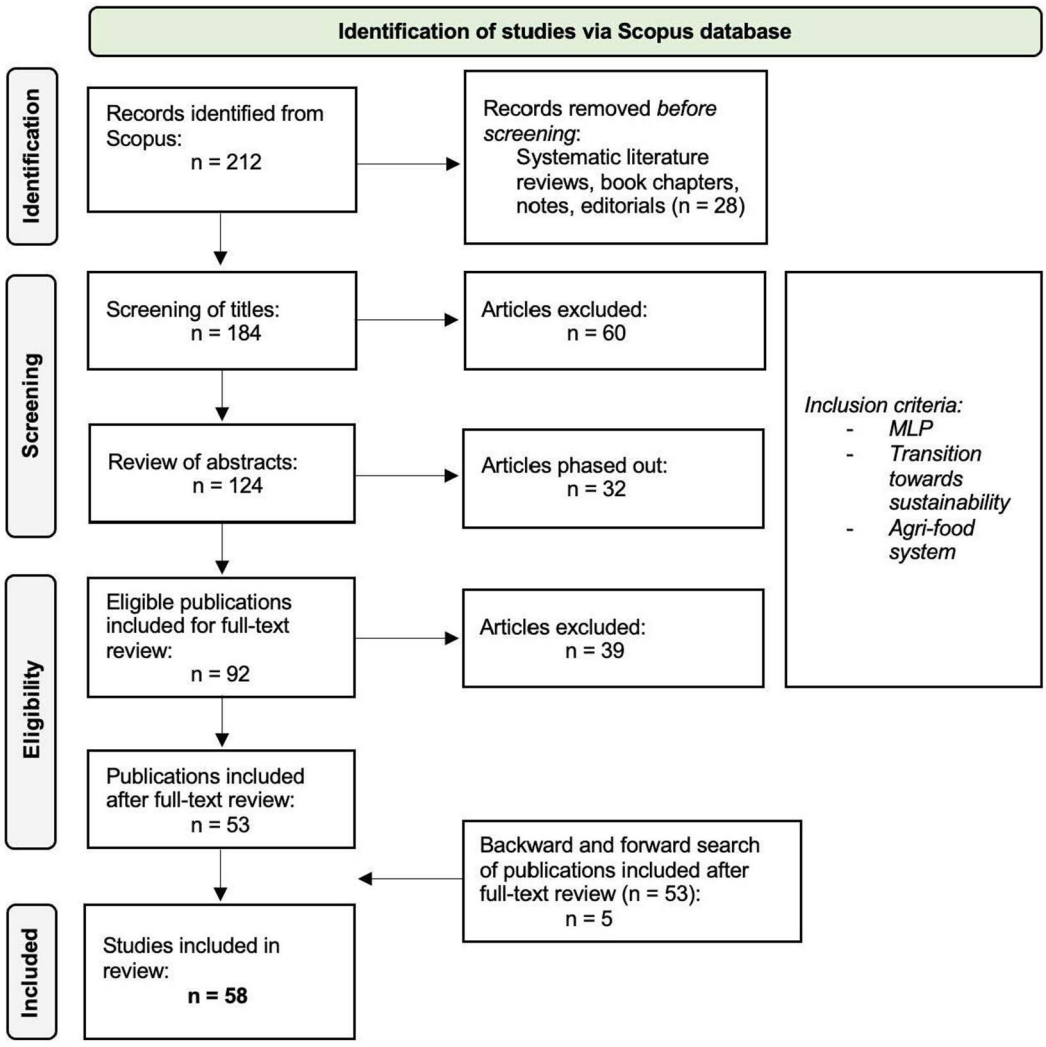

FIGURE 1
Flowchart of the process of the systematic literature review. Adapted from Page et al. (2021).

3. Results and discussion

3.1. Records identified for the review

The search in Scopus initially yielded 212 articles; 184 publications remained after the removal of systematic literature reviews ($n = 16$), book chapters ($n = 8$), notes ($n = 3$), and editorials ($n = 1$). Following title and abstract screening, 92 documents were excluded, and a further 39 articles were removed after the full-text review. The reasons were the unavailability of the English or German version ($n = 1$) or articles from the year 2018 that were already included in a former review ($n = 7$; e.g., Hassink et al., 2018; Järnberg et al., 2018; Punt et al., 2018). Further publications were excluded as they neither covered the human AFS [$n = 52$; instead zoology, botany, energy, and mobility (e.g., Andrade-Díaz et al., 2019; Vihotogbé et al., 2019; Paterson et al., 2020; Rivera et al., 2020)], nor applied the transition framework MLP [$n = 51$; instead MLP in the sense of "multi-layer perceptron" (e.g., Babaeian Diva et al., 2019; Alburshaid and Mangoud, 2020)], nor contained a focus on a transition toward sustainable development of AFS ($n = 20$). Ensuing cited and citing reference search (i.e., backward and forward citation searching), five more articles were included (i.e., Boillat et al., 2022; Costa et al., 2022; Hundscheid et al., 2022; Ortiz and Peris, 2022; Sobratee et al., 2022). The flowchart in Figure 1 gives an overview of the selection process.

TABLE 1 Overview of bibliometrics of publications focusing on sustainability transitions of the agri-food system applying multi-level perspective (MLP) from 2018 onwards.

Journal		Country	
Sustainability	19	Netherlands	11
Agriculture and Human Values	3	Spain	8
Agroecology and Sustainable Food Systems	3	UK	8
Environmental Innovation and Societal Transitions	3	Austria	6
Journal of Cleaner Production	3	Italy	6
Agriculture	2	US	6
Geoforum	2	France	5
Journal of Rural Studies	2	Belgium	4
Sustainable Production and Consumption	2	Portugal	4
Technological Forecasting and Social Change	2	Sweden	4

The number of publications in the top 10 journals and countries of all authors is indicated based on the database Scopus.

3.2. Bibliometrics and research methods

Sustainability transitions in AFS receive increasing attention (cf. Tables 1, 2). The journal *Sustainability* stands out, with 19 out of the 58 identified articles (cf. Table 1). The authors' institutional background lies predominantly in European countries and the United States. Countries from the Global South are underrepresented. This aspect has not changed since the aforementioned former review. The countries where case studies took place show a more diversified picture, covering the continents Asia, Africa, Oceania, North and South America, and Europe. With this lens (and without being able to estimate the cultural origin of the authors), it seems that most research is done *on* the Global South rather than *with* local research institutions. The latter could address the issue of "decolonising" transition research raised in the literature (Ghosh et al., 2021). Qualitative research approaches outweigh (cf. Table 2). This aspect leads to a dominance of studies deriving deeper understandings of certain aspects (e.g., niche–regime relationship in a certain case study) but represents a limitation of research on more pervasive causal links. Therefore, the need for more quantitative or mixed-methods research becomes apparent. Partly, there is poor reporting on the methods used and the methodological approach (e.g., Henfrey and Ford, 2018; Wigboldus et al., 2019; Passos Medaets et al., 2020; Jia, 2021). This results in a lack of transparency in how the authors derived their findings. Similarly, this aspect also constitutes a limitation of this SLR as the articles' quality in this regard could not be assessed in all cases. The nature of qualitative data analysis is more interpretative which is why it is even more important to clearly elaborate on the research design to ensure reliability.

3.3. Agri-food system sectors

The identified articles can broadly be assigned to four different AFS sectors: agriculture, aquatic environment, policies, and food consumption and diets. The majority of articles focus on the agricultural sector (cf. Table 2). Within this domain, three areas are apparent: first and the most prominent area, alternative practices and cultivation methods [e.g., manure management, agroecology, organic agriculture, or climate-smart agriculture (e.g., Anderson et al., 2019; Long et al., 2019; López-García et al., 2019; Schiller et al., 2020; Bui, 2021; Salavisa et al., 2021; Anselmi and Vignola, 2022)]; second, animal husbandry (cf. De Herde et al., 2020; Deviney et al., 2020; Averbuch et al., 2021); and third, innovations (technological; e.g., cf. Contesse et al., 2021; Jia, 2021; de Boon et al., 2022). Especially within alternative practices, research on agroecology is prominent ($n = 8$, cf. Table 2) and enjoys increasing interest. It can be assumed that the Food and Agriculture Organization (FAO) has contributed to this by emphasizing agroecology's role to achieve sustainable agricultural systems (FAO, 2018b). Gudbrandsdottir et al. (2021), Wöhler et al. (2020), and Sanon et al. (2021) laid focus on the aquatic environment, concentrating on fishery and pharmaceutical exposure. Policies were a matter of interest on EU and national levels (cf. McInnes, 2019; Wieliczko et al., 2021). Furthermore, MLP was utilized in the analysis of transformations of consumers' habits and diets (Fogarassy et al., 2018; Dannenberg et al., 2020; Gaddis and Jeon, 2020; Hundscheid et al., 2022; Sobratee et al., 2022).

Broadening the lens toward a systems perspective, the majority of studies focus on more interrelated activities within the AFS. Power relations and structures of governance or politics are the

TABLE 2 Overview of resultant articles of the systematic literature review.

Year	Publications per year	References	Unit of study—country	Focused agri-food system's sector/topic	Reported data collection and evaluation methods of articles
2022	10*	Anselmi and Vignola (2022)	Costa Rica	Organic agriculture (participatory guarantee systems)	Literature review, semi-structured interviews, observations, and content analysis
		Boillat et al. (2022)	Senegal	Agroecology	Semi-structured interviews, review of documents, and social network analysis
		Costa et al. (2022)	Belgium	Local-product network	Semi-structured interviews, codification, field observation, and documentary analysis
		de Boon et al. (2022)	-	Agricultural innovations	Literature review
		Giagnocavo et al. (2022)	Spain	Agriculture and agroecology	Mixed methods (N/S), triangulating desk research, and experimental and project results (N/S)
		Holtkamp and van Mierlo (2022)	Italy	Agriculture (pesticide ban)	Participatory observation, semi-structured interviews, focus group discussion, qualitative content analysis, and triangulation of methods
		Hundscheid et al. (2022)	Austria	Consumption (meat)	Quantitative and qualitative content analysis of media data
		Mehrabi et al. (2022)	-	Connecting consumers and farmers ("consumer/citizens"), agroecology	Literature review
		Ortiz and Peris (2022)	Guatemala	Agriculture (farmer organizations)	Interviews (qualitative), focus group discussions, and triangulating document analysis
		Sobratee et al. (2022)	South Africa	Sustainable diets	Stakeholder workshop, causal loop analysis, bibliometric analysis, and scoping review (triangulation)
2021	20	Averbuch et al. (2021)	Denmark	Agriculture (dairy sector)	Literature review (interpretive synthesis), cross-check with articles and primary data (e.g., government documents, records, and statistics), and longue durée approach
		Bui (2021)	France	Agroecology	Interviews (qualitative), codification, observations, archival work (triangulation), and "flat" longitudinal analysis
		Contesse et al. (2021)	Chile	Agriculture (integrated pest management)	Semi-structured interviews, deductive-inductive codification, observations, and document analysis
		Deviney et al. (2020)	North Carolina	Agriculture (swine manure management)	Semi-structured interviews, codification, and online searches (data triangulation)
		Goulet (2021)	Brazil	Agriculture (pesticide alternatives)	Semi-structured interviews, observations, and content analysis of institutional documents
		Gudbrandsdottir et al. (2021)	Norway and Iceland	Salmon value chain	Semi-structured interviews, focus group discussions, codification, and constant comparative analysis
		Jia (2021)	-	Agricultural innovation system	Not specified
		Kaweesa et al. (2021)	Uganda	Conservation agriculture	Semi-structured interviews, focus group discussions, and workshop discussions

(Continued)

TABLE 2 (Continued)

Year	Publications per year	References	Unit of study—country	Focused agri-food system's sector/topic	Reported data collection and evaluation methods of articles
		Leeuwis et al. (2021)	-	Food system, poverty	Not specified
		Long and Blok (2021)	Netherlands	Agri-food tech start-up sector	Qualitative and inductive approach: Interviews (qualitative), codification, triangulation with gray literature, and internet searches
		Nemes et al. (2021)	Argentina, Australia, Austria, Canada, France, Hungary, Italy, Japan, Luxembourg, Norway, South Korea, Spain, and UK	Alternative and local food systems (production, consumption)	Different methods applied in country case studies (qualitative research design), incl. interviews, inductive codification, expert questionnaire, expert workshop, report analysis, and press reviews
		Özatagan and Karakaya Ayalp (2021)	Turkey	Urban agri-food system	Exploratory research design, document analysis, semi-structured interviews, and observations
		Polita and Madureira (2021a)	Portugal	Short food supply chain	Qualitative research design, interviews (qualitative), review of contextual data, and content analysis
		Polita and Madureira (2021b)	Portugal	Agroecology	Literature review, semi-structured interviews (explorative), structured interviews, and qualitative and quantitative content analysis
		Ribeiro and Turner (2021)	New Zealand	Egg sector, honey sector	Literature review and qualitative insights from a former study (interviews)
		Salavisa et al. (2021)	Portugal	Organic agriculture	Literature review, analysis of secondary sources (e.g., reports and websites), and semi-structured interviews
		Sanon et al. (2021)	Burkina Faso	Fishery	Mixed methods: literature search, semi-structured interviews, focus group discussions, qualitative data analysis (codification), quantitative household survey, statistical analysis, and triangulation
		Sarabia et al. (2021)	Spain	Urban food system	Interpretative research: document analysis, literature review, semi-structured interviews, codification, and participatory observations
		Van Poeck and Östman (2021)	Belgium	Short food supply chain	Practical epistemology analysis of workshops (observation transcripts) and contextual interviews and document analysis
		Wieliczko et al. (2021)	EU rural areas	Agriculture (policy)	Analysis of EU regulations and policies and literature review
2020	12	Belda-Miquel et al. (2020)	Spain	Alternative model of production, distribution, and consumption (food purchasing group)	Document analysis, participant observation, semi-structured interviews, and qualitative content analysis (deductive-inductive codification)
		Cembalo et al. (2020)	-	Circular economy	Literature review (N/S)
		Dannenberg et al. (2020)	Germany	Online retail	Mixed methods: analysis of secondary data and statistics (newspaper articles, media, and official national statistics), semi-structured interviews, and qualitative content analysis

(Continued)

TABLE 2 (Continued)

Year	Publications per year	References	Unit of study—country	Focused agri-food system's sector/topic	Reported data collection and evaluation methods of articles
		De Herde et al. (2020)	Belgium	Dairy sector	Semi-structured interviews, qualitative analysis, and secondary sources (e.g., conference talks and discussions),
		Dumont et al. (2020)	Belgium	Vegetable production	Open-ended interviews, review of the literature and online information, semi-structured interviews, quantitative technical and economic appraisal (N/S) of interview transcripts, and cross-check of data with further interviews with agri-food system actors
		Farhangi et al. (2020)	Netherlands	Urban agriculture	Exploratory case study research: semi-structured interviews, document reviews, site visits, observations, and quantitative data of actants' agency (betweenness, closeness, and centrality degree) through experts' opinions
		Gaddis and Jeon (2020)	South Korea	School lunch program	Literature review and content analysis of primary and secondary sources
		Giombelli and Triches (2019)	Brazil	Short-chain university food procurement	Explorative and qualitative approach: online survey, semi-structured interviews, descriptive and qualitative analysis, and secondary data analysis (e.g., websites and government documents)
		Gugerell and Penker (2020)	Austria	Agri-food sector (community-supported agriculture, zero-waste supermarket, and edible insect company)	Online content analysis (websites, blogs, journals, and newspapers), semi-structured interviews, focus group discussion, and deductive-inductive codification
		Passos Medaets et al. (2020)	Brazil	Agriculture	Not specified
		Schiller et al. (2020)	Nicaragua	Agroecology	Semi-structured interviews, workshops, secondary sources (e.g., scientific and gray literature, government policies), and construction of innovation history timeline throughout the process
		Wöhler et al. (2020)	Germany, Netherlands	Pharmaceuticals in aquatic environment	Literature search, semi-structured interviews, and qualitative analysis (codification)
2019	10	Anderson et al. (2019)	-	Agroecology	Literature review
		Heyen and Wolff (2019)	Germany	Organic agriculture	Literature search and expert interviews (project Trafo 3.0)
		Hosseinifarhangi et al. (2019)	China	Urban agriculture	Qualitative research approach: literature review, secondary sources (reports, documents), observations, site visits, participation in meetings, events, activities, semi-structured interviews, and discussions (analysis of betweenness, centrality, closeness throughout the process, and verified by experts)

(Continued)

TABLE 2 (Continued)

Year	Publications per year	References	Unit of study—country	Focused agri-food system's sector/topic	Reported data collection and evaluation methods of articles
		Jakku et al. (2019)	Australia	Grains industry	Semi-structured interviews and qualitative analysis (deductive-inductive codification)
		Long et al. (2019)	Western and middle Europe (Netherlands, Spain, Denmark, Sweden, Italy, Finland, Ireland, France, Hungary, UK, and Switzerland)	Climate-smart agriculture	Qualitative research design: secondary data, semi-structured interviews, and deductive-inductive codification
		López-García et al. (2019)	Spain	Agroecology	Quantitative survey, qualitative in-depth interviews, and codification
		McInnes (2019)	Canada	Food policymaking	Expert witness statements and discourse analysis (qualitative)
		Roberts and Geels (2019)	UK	Agriculture	Quantitative information from statistical databases, secondary historical sources (qualitative), and narrative analysis
		Schaffer et al. (2019)	Sweden	Agroforestry (agriculture)	Participatory action research and workshops
		Wigboldus et al. (2019)	Peru, Ethiopia, and Bangladesh	Urban food system, agriculture	Not specified
2018	6**	Fogarassy et al. (2018)	Switzerland and Hungary	Consumption (attitudes)	Quantitative questionnaires and personal interviews
		Henfrey and Ford (2018)	-	Ecovillage movement, permaculture	Not specified
		Jedelhauser et al. (2018)	Switzerland	Circular economy of phosphorus system	Desk research (e.g., policy initiatives, research projects, academic papers), expert interviews, scenario analysis, and substance flow analysis from a former publication
		Kuokkanen et al. (2018)	Finland	Nutrient system	Content-focused analysis of discourses (qualitative), in-depth interviews, and inductive data-driven analysis
		Rut and Davies (2018)	Singapore	Urban agriculture (local food production)	Secondary sources (e.g., policy reports), semi-structured interviews, codification, and observations
		van der Windt and Swart (2018)	Netherlands	Agriculture (land sharing approach)	Participatory observation (meetings, documents, and interviews)

The table covers the publications per year, country of case study, focused agri-food system area as well as data collection, and evaluation methods.
*Only articles included published by the search date (23rd February 2022).
**Only articles published after 21st April 2018 were considered. The seven articles included in a former review on the use of MLP in agri-food system transformation (El Bilali, 2019) were left aside.

most prominent (cf. Rut and Davies, 2018; Anderson et al., 2019; De Herde et al., 2020; Gudbrandsdottir et al., 2021; Leeuwis et al., 2021; Wieliczko et al., 2021; Boillat et al., 2022). For instance, Deviney et al. (2020) focus on manure management impacting the health of people and the planet, and on decision-making processes in general. Next to the agricultural sector, social relations and policies are analyzed. Gaddis and Jeon (2020) analyse school lunch programs, their implications on human health, and eco-friendliness with special attention to the role of women and small-scale producers. In this sense, the authors consider the health effects of certain diets as well as the environmental and social domains.

Predominantly, articles cover ongoing transitions. Solely, Roberts and Geels (2019) analyse a past and concluded transition. They derive an understanding of political defection from the analysis of a transition from mixed to specialized agriculture. From the findings, they draw more generalizable conclusions that they,

among other things, relate to today's sustainability debate. The overrepresentation of articles covering ongoing transitions can be explained because sustainable development of the AFS is far away from being reached.

3.4. The sustainability approach in agri-food articles

A precise direction and understanding of the ST are rarely presented in detail (e.g., van der Windt and Swart, 2018; Schaffer et al., 2019; Sobratee et al., 2022). The authors give a cursory glance at the *what* (i.e., what future is desired), for instance, more just and sustainable societies (cf. Belda-Miquel et al., 2020), usually without elaborating on the sustainability concept. The researchers put more emphasis on the *how* (i.e., how the ST can be achieved) and outline possible ways and recommendations toward the sustainable development of AFS. The illustration of transition pathways (i.e., the *how*) constitutes one intention of transition research (Köhler et al., 2019; Ribeiro and Turner, 2021). Therefore, it is not surprising that these pathways are analyzed and shown. A variety of reasons for the necessity of an ST is given (i.e., the *why*). For instance, ecological crisis, resource depletion, food security and access, severe and inequitable environment, biodiversity loss, or climate change are only a few of the manifold reported reasons (e.g., Anderson et al., 2019; Averbuch et al., 2021; Kaweesa et al., 2021; Giagnocavo et al., 2022; Mehrabi et al., 2022). Some authors approach sustainability through the analysis of their object of study, for instance, a project that aims for "more sustainable urban food systems" (Van Poeck and Östman, 2021, p. 156) or initiatives aiming for alternative food production (Farhangi et al., 2020). Through this "case-lens," the direction of the ST is already illustrated from the outset, presented from the case studies.

Some authors take up Markard et al. (2012) popular definition of ST (which was largely informed by studies focussing on energy transitions), without further elaboration (Anderson et al., 2019; Gaddis and Jeon, 2020; Gugerell and Penker, 2020). Ribeiro and Turner (2021), however, elaborate on weak and strong sustainability and review current sustainability narratives. They conclude that their "article welcomes the impermanence of the term sustainability" and identify it as a "fluid analytical concept" (p. 6). Nevertheless, it is the reflection on *sustainability* in *sustainability transitions* that is lacking a substantial examination in most of the articles (e.g., Fogarassy et al., 2018; Heyen and Wolff, 2019; Anselmi and Vignola, 2022; Costa et al., 2022). The answers researchers derive from their data on sustainability problems are essentially informed by their ontological perspectives (Geels, 2010). Thus, sustainability issues are essentially context-dependent (Jia, 2021; Susur and Karakaya, 2021) and AFS comprise a multiplicity of interrelated activities and actors, again dependent on each individual's assumptions (Leeuwis et al., 2021). For instance, assumptions about causal agents or causal mechanisms differ between distinct social theory traditions (Geels, 2010). This is why authors should aim for a more reflective elaboration on ST in their cases which may benefit the scientific discourse.

3.5. Application of MLP in AFS articles

Across all authors, manifold ways are being presented to utilize MLP in AFS ST. The ways can broadly be assigned to six different areas. First, for the development of future scenarios (Jedelhauser et al., 2018); second, for the enrichment of newly developed models, frameworks, or concepts (Cembalo et al., 2020; Ribeiro and Turner, 2021; de Boon et al., 2022); third, in the analysis of transition dynamics or as an explanatory approach of how change happens (Jedelhauser et al., 2018; Wöhler et al., 2020; Sanon et al., 2021; Hundscheid et al., 2022); fourth, for elaboration on alignment processes within and between levels (Goulet, 2021; Kaweesa et al., 2021); fifth, in the study of interactions, positions, and influence of human and non-human actants and agency (Kuokkanen et al., 2018; Giombelli and Triches, 2019; López-García et al., 2019; Deviney et al., 2020; Farhangi et al., 2020; Contesse et al., 2021; Polita and Madureira, 2021a; Ribeiro and Turner, 2021); and finally, for the identification of barriers in transitions (Hosseinifarhangi et al., 2019; Long et al., 2019; McInnes, 2019; Deviney et al., 2020; Anselmi and Vignola, 2022). In some articles, the authors remain rather vague on how they utilized MLP (Fogarassy et al., 2018; Schaffer et al., 2019; Cembalo et al., 2020). Regarding the three MLP levels, the niche represents the most prominent object of study (e.g., Rut and Davies, 2018; Belda-Miquel et al., 2020; Gugerell and Penker, 2020; Boillat et al., 2022) as will be discussed in the following section.

3.6. Niche: understanding and conception in AFS articles

3.6.1. Definitions and thematic classification

The authors present a wide range of characteristics in the description of niches on the micro level. Size (1), innovative capacity (2), organizational form (3), actors and activities (4), and radicality (5) stand out in different ways. The variables place specificity, power, and politics of the respective cases exert influence on the characteristics ascribed to the niches but also on niche-building processes (Rut and Davies, 2018; Gugerell and Penker, 2020). For instance, a strong government presence or authoritarian control causes significant challenges in the development of radical socio-technical regime divergences (Rut and Davies, 2018). If reference is given to the size (1) of the niche, the authors refer to a rather small network of actors without specifying concrete numbers (Bui, 2021; Gudbrandsdottir et al., 2021; Salavisa et al., 2021; Costa et al., 2022). For instance, Bui (2021) underscores that niches are smaller than the regime and Özatagan and Karakaya Ayalp (2021) pertain to "individual and isolated practices" (p. 283), probably in the sense of individual initiatives whereas other authors see the possibility of multiple initiatives within the niche (e.g., Gugerell and Penker, 2020). Amongst others, Gugerell and Penker (2020) and Giagnocavo et al. (2022) refer to niches as safe spaces in need of funding (Long et al., 2019; Gudbrandsdottir et al., 2021; Leeuwis et al., 2021), where protection (e.g., Jakku et al., 2019; Boillat et al., 2022) or even shielding (van der Windt and Swart, 2018) is offered from the dominant regime.

The authors refer to the innovation development (2) on the micro level (e.g., van der Windt and Swart, 2018; Long et al., 2019; López-García et al., 2019; Cembalo et al., 2020; Wöhler et al., 2020) and describe niches as "pioneering innovators" (Cembalo et al., 2020, p. 203; see also Stöhr and Herzig, 2022). Emphasis is laid on experimentation, testing, new ideas and practices (Henfrey and Ford, 2018; Bui, 2021), and on proposing structural answers to lock-ins (De Herde et al., 2020). van der Windt and Swart (2018) bring up the temporal dimension and describe niches as "temporary social spaces" (p. 2). Regarding the organizational form (3), niches seem to be predominantly self-organized (Belda-Miquel et al., 2020; Polita and Madureira, 2021b) and Nemes et al. (2021) characterize niches as "bottom-up participatory initiatives" (p. 592) composed of a range of heterogeneous actors, institutions, networks, and infrastructures (Schiller et al., 2020). Collaboration and networking activities (4) are presented as important practices at the niche level (e.g., van der Windt and Swart, 2018; Anderson et al., 2019; Belda-Miquel et al., 2020; Farhangi et al., 2020; Leeuwis et al., 2021), creating a "sense of belonging" (Belda-Miquel et al., 2020, p. 13). Polita and Madureira (2021b) go even further by attributing niches to the role of "articulators" (p. 20) that must manage to link different innovations between various niches to provide collaborative responses to regimes and landscapes. Belda-Miquel et al. (2020) underscore the social features of the niche as democratic spaces, with human flourishing and even participation.

The radicalness (5) of niches as well as the divergence from or opponent to the incumbent regime is emphasized (e.g., Rut and Davies, 2018; Bui, 2021; Özatagan and Karakaya Ayalp, 2021; Anselmi and Vignola, 2022; Boillat et al., 2022; Holtkamp and van Mierlo, 2022). On the other hand, some authors bring out that more moderate activities have their right to exist on the niche level (Rut and Davies, 2018; Farhangi et al., 2020; Contesse et al., 2021; Nemes et al., 2021). Rut and Davies (2018) discover niche projects as "consensual attempts to incorporate alternatives within existing regimes" (p. 285) that refrain from re-configuring the regime and rather seek to become competitive in line with regime criteria. For the development of technological innovations, some authors report collaborations from niche and regime actors that pursue similar goals (Hosseinifarhangi et al., 2019; Farhangi et al., 2020). In this sense, Bui (2021) expresses concerns that empirical usage of MLP levels (here niches) demands reflexivity, e.g., in attributing incremental innovations that do not diverge from the incumbent regime, a niche status. For instance, in the case of the transition to integrated pest management (IPM) in Chile (Contesse et al., 2021), IPM innovations were demanded from within the regime (due to sudden landscape pressures, i.e., a pest). Whether these occurring innovations can be seen as a niche or rather as a regime-initiated innovation can be discussed. Similar findings were reported by El Bilali (2019). Caution and reflexivity in the allocation of niche-level activities are required.

Thematic fields within the niche range from alternative practices, for instance, agroecology (e.g., Anderson et al., 2019; Dumont et al., 2020; Bui, 2021; Boillat et al., 2022), participatory guarantee systems (Anselmi and Vignola, 2022), organic agriculture (e.g., Heyen and Wolff, 2019; Averbuch et al., 2021; Salavisa et al., 2021), conservation agriculture (Kaweesa et al., 2021), integrated pest management (Contesse et al., 2021), food purchasing groups (Belda-Miquel et al., 2020), or farmers markets (McInnes, 2019) through more technological innovations (e.g., for manure management, in fisheries, pesticide application, and alternatives; Hosseinifarhangi et al., 2019; Jakku et al., 2019; Farhangi et al., 2020; Goulet, 2021) to community concepts, such as ecovillages (Henfrey and Ford, 2018) or eco-friendly school lunch programs (Gaddis and Jeon, 2020). However, different interpretations exist. Dumont et al. (2020), for instance, assign organic agriculture already to the regime level and see agroecology as the niche in the analysis of vegetable production in Belgium. Some authors view agroecology, organic agriculture, or alternative food systems as such as the niche (e.g., Anderson et al., 2019; Nemes et al., 2021), others explicitly refer to the activities that drive these concepts or paradigms forward as the micro-level. Examples thereof comprise (grassroots) initiatives, producers, or a network of actors dedicated toward an alternative paradigm (e.g., Rut and Davies, 2018; Gaddis and Jeon, 2020; Gugerell and Penker, 2020; Bui, 2021; Boillat et al., 2022) but also management approaches, such as integrated pest management or innovative management practices in fisheries are seen as niches (Contesse et al., 2021; Sanon et al., 2021).

3.6.2. Social innovations vs. technological novelties

In line with the MLP literature (e.g., Geels, 2020), the development of innovations and novelties, diverging from the regime, are niche's natural mission (e.g., van der Windt and Swart, 2018; Wöhler et al., 2020; Bui, 2021; Gudbrandsdottir et al., 2021; Nemes et al., 2021; Anselmi and Vignola, 2022; Boillat et al., 2022). Niche novelties within the AFS seem to be disproportionately socially driven innovations than solely technological novelties (Kuokkanen et al., 2018), addressing "social issues overlooked by the agro-industrial regime" (Nemes et al., 2021, p. 292). For instance, Wöhler et al. (2020) identify "awareness raising, involving education and knowledge transfer" (p. 5) as a niche innovation. Radical visions of new forms of coordination and governance are being developed, rules, power relations, and prevailing structures are being challenged, or social networks are being constructed within the niche level (Henfrey and Ford, 2018; van der Windt and Swart, 2018; Gugerell and Penker, 2020; Averbuch et al., 2021; Bui, 2021). Alternative models and structures, e.g., for production and consumption or value chains, are evolving (Belda-Miquel et al., 2020; De Herde et al., 2020; Polita and Madureira, 2021b). Rut and Davies (2018) voice that socially driven innovations challenge traditional transition thinking (i.e., technological). Those innovations evolve and follow no strategic or manageable path. Thus, they require more support and awareness of the socio-political context for scaling up and out. However, some authors refer to niche innovations solely in the sense of technological novelties (e.g., specific integrated pest management practices (fungi and pheromones) instead of heavy use of pesticides, technological innovations in manure management, and technological innovations in high-tech urban agriculture; Deviney et al., 2020; Farhangi et al., 2020; Goulet, 2021; Gudbrandsdottir et al., 2021).

3.6.3. Niche motivations

Distinct motivations of actors for niche-level activities are reported. These can broadly be divided into intrinsic motivations (e.g., social values, empowerment of marginalized groups, and food sovereignty), environmental aspects (e.g., as a response to pressure (e.g., pests) or more preventive in the sense of nature conservation), unsatisfaction with the current system (e.g., reliance on food imports), and economic motives (e.g., market gap and profit expectations; Henfrey and Ford, 2018; Rut and Davies, 2018; van der Windt and Swart, 2018; Salavisa et al., 2021; Anselmi and Vignola, 2022; Costa et al., 2022). Anselmi and Vignola (2022) consider that different motives lead to conflicts and diverging engagement, challenging the level of trust between the members within the niche. Because of these distinct motives, Bui (2021) recommends refraining from designating actors ex-ante as niche actors, solely based on whether "they do or do not use an alternative technology or contribute to its development" (p. 4). Instead, the author proposes to infer this interpretation from the empirical results.

From the presented findings, the distinction between niche-level *actions* and niche-level *actors* for past transitions and ongoing transitions comes to the fore. Defining niche-level actors in past transitions seems more straightforward as (if data is available) the entirety of activities can be taken into consideration. For ongoing transitions, the term niche level actions (e.g., Özatagan and Karakaya Ayalp, 2021) might be more appropriate, as individual beliefs and activities can change throughout the process, even leading to switching between different levels, depending on whether the actor's personal aims have been achieved and interests are addressed.

3.6.4. The concept of the protected space

Leeuwis et al. (2021) argue that temporary protection of niche-level initiatives and innovations is required to become mature and competitive. Particularly, AFS authors elaborate on first, the *who* (i.e., who is providing this protection), and second, the *how* (i.e., how is protection offered). First, as protecting entities for niches, these authors identified non-governmental organizations (NGOs), state actors, governments, municipalities, and cities as guardians (Rut and Davies, 2018; Hosseinifarhangi et al., 2019; Gaddis and Jeon, 2020; Özatagan and Karakaya Ayalp, 2021; Van Poeck and Östman, 2021; Boillat et al., 2022; Giagnocavo et al., 2022). Deviney et al. (2020) identify the landscape level as a source of support that can offer community engagement and funding, as well as favoring policies and incentives. Regime actors (i.e., incumbent firms) can equally serve as patronages for technological innovations (Farhangi et al., 2020). In this sense, Farhangi et al. (2020) relativise the radicalness of the innovation which might indicate that this pairing might not lead to a radical reorganization of the system. Protection can be offered from the niche as well, e.g., alternative cooperatives models acting as protected spaces for innovations (De Herde et al., 2020).

Second, in terms of *how*, Holtkamp and van Mierlo (2022) discover that radical social innovations are providing their protection and identify the concepts of paving, networking, and meaning-making (see Section "*Niche strategies*") what they compare to Smith and Raven (2012) empowering, nurturing, and shielding. Gugerell and Penker (2020) take up Smith and Raven (2012) empowerment strategy and identify another form. Next to "fit and conform" and "stretch and transform", they describe a "process of staying independent and small" that protects the regime. In that sense, it can be questioned whether "staying independent and small" is contradictory to the concept of empowerment by Smith and Raven (2012), where developing competitiveness and innovation's diffusion are essential characteristics of the empowerment stage. Funding seems to function as a major source of protection and is afforded by municipalities, states, governments, NGOs, and organizations (Hosseinifarhangi et al., 2019; Long et al., 2019; Gaddis and Jeon, 2020; Long and Blok, 2021; Özatagan and Karakaya Ayalp, 2021; Van Poeck and Östman, 2021; Boillat et al., 2022). State support through favorable national policies is also seen as an important lever (Schiller et al., 2020). Although, the protection offered does not seem to be without compromises. Boillat et al. (2022) underscore that the niche protection in Senegal offered by NGOs and organizations from Europe and Northern America is creating transnational ties, dependencies, and holds control mechanisms. Leeuwis et al. (2021) argue that protection should be temporary and forms of "overprotection" (p. 772) need to be prevented as they might lead to a lack of self-sufficiency once protection is lifted.

3.6.5. Niche strategies

The authors identified different strategies that niches are following to strive for influence and contribute to the socio-technical transition: alignment processes (1), anchoring (2), coalition forming, cooperation and alliance building (3), and paving (4). The concept of alignment (1) is still ill-defined in the literature (Goulet, 2021). Alignments can pose obstacles to transitions, for instance, in the incumbent regime, leading to robustness and stability, creating path-dependencies and resistance. On the other hand, favorable alignments can arise within the niche or between niche and regime entities, if former competitors combine their interests (e.g., social groups, rules, and interests; Geels, 2018; Goulet, 2021). Goulet (2021) characterizes these alignment processes as a "matter of linkages between niche and regime components, and of the coherence of these linkages" (p. 8). For coherence, a high degree of commonality between the different entities is of importance, rather than separateness.

Anchoring (2) describes a similar concept of linking niches and socio-technical regimes or niches and other niches (Polita and Madureira, 2021b). The three forms, *technological, network,* and *institutional* anchoring (cf. Elzen et al., 2012), were similarly identified in AFS studies (López-García et al., 2019; De Herde et al., 2020; Gaddis and Jeon, 2020; Schiller et al., 2020; Kaweesa et al., 2021; Polita and Madureira, 2021b). Network anchoring is the most prominent form which is not surprising due to the omnipresence of social innovations in AFS studies. Schiller et al. (2020) discover a fourth form of anchoring, *discursive anchoring*. They describe

it as a form of "seeding" alternative thinking (*here* agroecological thoughts) into different sectors (e.g., through research institutes, market-oriented initiatives). Polita and Madureira (2021b) describe a process of a novelty that only marginally "anchored the regime" (p. 16) with low commitment from institutions and stakeholders. It occurs only in some points of the niche–regime interface and remains there due to the mobilization between innovations. They refer to it as a further form of anchoring (*marginal anchoring*), up to now unnoticed in the literature. Although, it can be questioned if the process the authors are depicting rather describes a form of network anchoring (i.e., the mobilization between innovations). Since, anchoring does not yet implicate durable links. It is rather defined as a process where the connections are still vulnerable and can be subverted again (Elzen et al., 2012).

A clear differentiation between alignment processes and anchoring in transition literature in general (Elzen et al., 2012) but also in the identified AFS articles (Goulet, 2021) is lacking. Elzen et al. (2012) suggest that an "alignment of the three forms of anchoring is crucial to transform anchoring into a durable link" (p. 15), without further specifying if the word alignment represents a specific concept or is meant as a kind of harmonization between the three forms. In general, both concepts occupy similar terms, using *linking processes, alliances, coherence,* or *coalition building* (López-García et al., 2019; Schiller et al., 2020; Kaweesa et al., 2021; Polita and Madureira, 2021b). Future studies could focus on setting both concepts in relation and test whether divergent applications lead to profound findings and improvements.

The third cited strategy, coalition forming, cooperation, and alliance building (3), is part of both the aforementioned concepts but appears also independently. Coalitions among niche actors but also cooperation and collaborations with the regime are identified (Giombelli and Triches, 2019; Gugerell and Penker, 2020; Bui, 2021; Gudbrandsdottir et al., 2021; Long and Blok, 2021; Mehrabi et al., 2022). For instance, "nudging regime actors by providing alternative solutions" (Gugerell and Penker, 2020, p. 9) is one way of exerting influence on the regime. Coalition forming and interaction between niche actors is seen as a strategy that might lead to the decentralization of incumbent power relations within regimes as the pressure can be exerted simultaneously and various capabilities (e.g., practices, infrastructures, and knowledge) can be aggregated (Bui, 2021; Mehrabi et al., 2022). However, dissent on the effectiveness and intensity of niche–regime collaborations exists. Anderson et al. (2019) see the risk of linking up too much with actors empowered by the agri-food regime as this risks softening radical novelties and visions. Holtkamp and van Mierlo (2022) introduce paving (4) as a strategy where civil society (i.e., niche actors) creates favorable political opportunities to strengthen their ideas and visions. The authors identified this concept in combination with networking activities and meaning-making (creating collective identity, legitimacy, and emotional narratives) for a successful implementation of niche agri-food novelties.

Interestingly, although founders of the MLP initially attribute less importance to the niche level for transition processes as a whole (as presented in the introduction), it constitutes the dominant focus of AFS authors when analyzing so-called agri-food *system transitions*.

3.7. Space between MLP levels

Previous transition literature already indicates that boundaries between MLP levels are fluid rather than clear-cut (Holtz et al., 2008; Smith et al., 2010; Geels, 2011). This can similarly be ascertained in recent AFS articles (e.g., Rut and Davies, 2018; Long et al., 2019; López-García et al., 2019; Schiller et al., 2020; Contesse et al., 2021; Polita and Madureira, 2021b). Schiller et al. (2020) remark that the clear-cut distinction of levels only constitutes a heuristic construct and the co-existence of niches and overlapping of niche and regime actors determine the actual reality. In the transitions literature (not limited to AFS), more research is evolving describing the overlapping space and actors between niche and regime (e.g., Diaz et al., 2013; Fischer and Newig, 2016; Kivimaa et al., 2019; Bünger and Schiller, 2022). Naturally, rapprochements are biased by the researcher's respective theoretical lens which influences the choice of wording and attributions for this space. In the AFS articles, for instance, Actor–Network Theory (i.e., usage of intermediary; Contesse et al., 2021) or innovation systems (i.e., the term technological system; Passos Medaets et al., 2020) are utilized, but often, a clear origin of the wording remains open. Below, different conceptualisations are introduced. Commonalities exist regarding the involvement of actors from both regime and niche as well as the attribution of a certain kind of transformative power, although the multiplicity of terms and the assigned characteristics still indicate ambiguity and distinct understandings in AFS literature but also transitions research in general.

AFS authors label the space where the roles of niche and regime actors overlap as *intermediate level* (Contesse et al., 2021), *hybrid forums* (López-García et al., 2019), *niche–regime interface* (Polita and Madureira, 2021b), or *multi-stakeholder innovation platforms* (Leeuwis et al., 2021). Inspired by Elzen et al. (2012), López-García et al. (2019) describe it as an "*institutional anchoring space*" (p. 9) where niche-regime linking takes place. Anderson et al. (2019) bring in the "*domains of transformation*" as an overlapping and interconnected space between an alternative (here agroecology) and the incumbent regime. In these domains (e.g., access to natural ecosystems, knowledge and culture, and networks), niche and regime meet and can confront each other. Henfrey and Ford (2018) complement the MLP with a fourth level, the *"empowered niche"* or *"niche-regime"* (p. 110). They describe it as an "intermediate form" (p. 110), incorporating features of both levels. It describes the phase where the niche holds enough power (e.g., support) to present a potential alternative or threat to the regime. Leeuwis et al. (2021) emphasize the opportunity for collaborative research in this space. The potential of involving regime actors in learning processes and the creation of shared visions is underscored (Long et al., 2019). It is characterized as a permeable, dynamic place for exchanges, redefining links, with instability regarding one level toward another (Contesse et al., 2021; Polita and Madureira, 2021b). It can operate as a lever for scaling emergent innovations up and out (López-García et al., 2019). Cities, municipalities, or regions seem to function as initiators, providing and protecting this space (López-García et al., 2019; Gugerell and Penker, 2020; Özatagan and Karakaya Ayalp, 2021). De Herde et al. (2020) see the inclusion of incumbent actors as a focal lever for the niches to

gain more relevance and redefine these actors' role perceptions and power relations.

In the transitions literature beyond an AFS focus, distinct terms for this space and the respective actors are used. For instance, *intermediary* from the innovation system's approach (Fischer and Newig, 2016; Kivimaa et al., 2019) or *hybrid actor* or *change agent* are exclaimed (Diaz et al., 2013; Bünger and Schiller, 2022). In AFS articles, actors' categories within this level comprise *hybrid actor* (López-García et al., 2019; Boillat et al., 2022), *intermediary* (Hosseinifarhangi et al., 2019) or *regime-based niche-regime intermediary* (Contesse et al., 2021), *sustainable entrepreneur* or *front-runners* (Long et al., 2019), or *change agent* (Gugerell and Penker, 2020). Change agents seem to play an important role in introducing, managing, or realizing transitions (Gugerell and Penker, 2020). López-García et al. (2019) see hybrid actors as agents without direct competencies in the specific domain of the novelty (e.g., agriculture and agricultural innovation). For instance, they call administration officers or municipalities hybrid actors and see their role in "catalyzing" (p. 10) niche–regime interactions because of their two-sided nature as both niche and regime actors. Slightly differently, Özatagan and Karakaya Ayalp (2021) deviate from assigning municipalities directly to the niche level. Instead, they rather see municipalities exerting niche-level favorable actions. Caution is proposed in attributing hybrid actors the ability to up- and outscale transformations alone (López-García et al., 2019). Further activities from niche actors and, for instance, food movements are needed. A call for a richer analysis of the roles and functions of these hybrid actors in transitions is exclaimed (Schiller et al., 2020).

The variety of terms and characteristics shows that there is no clear conceptualization for this space in the AFS articles but also in transitions literature beyond AFS, yet. In AFS literature covering ST using MLP, this space between niche and regime seems to be a recent development as it was not considered in El Bilali's (2019) review. So far, research mainly focusses on the overlapping space between niche and regime. The space between the other levels (e.g., regime–landscape) remains rather neglected. Future research could broaden the lens to these domains and explore if this proves useful for transition research.

3.8. Regime: application and conception in AFS publications

3.8.1. Regime construction and understanding

As agri-food regimes, AFS authors refer to the currently dominant conventional and industrial agri-food value chain stages (e.g., Henfrey and Ford, 2018; Belda-Miquel et al., 2020; Goulet, 2021; Polita and Madureira, 2021b; de Boon et al., 2022; Mehrabi et al., 2022). The socio-technical regime is built up by its multiple interrelated domains (i.e., sub-regimes), such as the prevailing laws, policies, knowledge and skills, culture and practices, networks, and discourses that are reinforcing its reproduction (e.g., Belda-Miquel et al., 2020; Wöhler et al., 2020; Contesse et al., 2021; Leeuwis et al., 2021; Salavisa et al., 2021; Anselmi and Vignola, 2022). For instance, denoted regime practices are described as "the way of doing things" (Mehrabi et al., 2022, p. 10), e.g., high use of chemicals in pest management (Contesse et al., 2021). Regime actors are depicted as the actors and groups involved in and reproducing those practices (e.g., Hosseinifarhangi et al., 2019; Dannenberg et al., 2020; De Herde et al., 2020; Farhangi et al., 2020; Wöhler et al., 2020), such as corporate retailers (Costa et al., 2022), conventional farmers, or those actors who promote agricultural intensification and related conventional food practices (Holtkamp and van Mierlo, 2022) as well as policymakers (Kuokkanen et al., 2018). Regime actors are either viewed as resisting forces to change (Anderson et al., 2019; Heyen and Wolff, 2019; Deviney et al., 2020; Anselmi and Vignola, 2022) or in some cases as actors who accommodate changes toward sustainability in their own best interest (Kuokkanen et al., 2018; Rut and Davies, 2018; Hosseinifarhangi et al., 2019; Farhangi et al., 2020; Contesse et al., 2021).

Differences persist in regimes configuration that may relate to distinct regime foci (and incoherence) in the literature, as outlined in the introduction. On the one hand, informed by institutional theory, the regime is depicted as the rules *structuring* a socio-technical system (Roberts and Geels, 2019; De Herde et al., 2020; Hundscheid et al., 2022). On the other hand, there is a branch that takes the materials, incumbents, actors, and coalitions as a starting point for the analysis (Kuokkanen et al., 2018; Giombelli and Triches, 2019; Farhangi et al., 2020; Costa et al., 2022), whereby the latter approach seems to stand out. This can only be estimated as some regime conceptualisations lack a clear configuration (e.g., Fogarassy et al., 2018; Heyen and Wolff, 2019; de Boon et al., 2022). El Bilali's (2019) review indicates that these inconsistencies might have already been found in previous studies, although he refers to the regime as rules and regulations without elaborating on other theoretical regime perceptions from transition literature.

In this review's AFS articles, further uncertainties exist in the socio-technical regime's demarcation from the socio-technical system. Equation of these two concepts is partly undertaken (e.g., Schiller et al., 2020). Some authors underscore the difference by referring to regimes' intangible deep structure (Bui, 2021; Leeuwis et al., 2021). Geels argues that these uncertainties (most commonly in empirical articles) may stem from a focus on "macro-patterns of transitions" rather than "micro-sociological dynamics" (p. 31). These uncertainties demand more caution in the use of the regime concept and a deeper theoretical analysis of the concept when applying it.

3.8.2. Regime characteristics

In the characterization of the regime level, the scale (1), time (2), stability (3), and lock-ins and path-dependencies (4) stand out. Regarding the scale (1), it is notable that many authors refer to national-level events (e.g., regulations and policies) when they refer to the regime (Farhangi et al., 2020; Schiller et al., 2020; Averbuch et al., 2021; Gudbrandsdottir et al., 2021), such as Dutch food policies (Farhangi et al., 2020) or "national regulatory framework" (Gudbrandsdottir et al., 2021, p. 13). This seems to be independent of the respective territorial focus as Schiller et al. (2020) and Averbuch et al. (2021) concentrate on national transitions (i.e., Nicaragua and Denmark) and Farhangi et al. (2020) on a local scale (i.e., Amsterdam). Dannenberg et al. (2020) offer a more dynamic description. For instance, they refrain from linking particular

objects (e.g., institutions and technologies) or spatial scales (e.g., national policy frameworks) to the regime (but also the other MLP levels) and focus on the time (2) objects or trends survive. In that sense, short- or middle-term phenomena are appointed to the regime level. For instance, Averbuch et al. (2021) allocate "short-term national-level socio-cultural phenomena" (p. 3) to the regime. Dannenberg et al. (2020) describe the regime as political measures of a particular period (e.g., curfews during the COVID-19 pandemic). How long a phenomenon or object needs to exist until it becomes part of, for instance, the landscape remains unclear. Time is not only used as a characteristic in the differentiation of MLP levels but also utilized in the description of the pace of change happening at the regime level. Authors underscore that generally, systemic regime change occupies a longer period, including preparation, trial, and practice (Giagnocavo et al., 2022; Hundscheid et al., 2022). However, if pressure is strong enough, change processes can speed up (e.g., landscape-level pressure during the COVID-19 pandemic or agricultural pests; Dannenberg et al., 2020; Contesse et al., 2021).

Regime's stability (3) ranges from static versions to more vivid and differentiated interpretations. The aforementioned aligned domains of the regime (e.g., policy, market orientation, industry, technology, markets, and culture) ensure this stability and provide the regime's "deep structure" (Averbuch et al., 2021; Leeuwis et al., 2021). The interaction between those areas dictates how it approaches challenges to preserve this structure (Averbuch et al., 2021). Incremental innovations occur in a regime that functions as a selection and retention environment (Kuokkanen et al., 2018). On the one hand, stable socio-technical regimes are presented. Cognitive convictions and cultural identity, e.g., in the case of meat consumption (Hundscheid et al., 2022), strong state control (Özatagan and Karakaya Ayalp, 2021), or power relations that foster strong positions of incumbent actors at the expense of other actors (Anderson et al., 2019; Gudbrandsdottir et al., 2021) are safeguarding regimes' stability. Alignment of those regime elements makes regimes robust and stable, impeding changes, characterized by inertia (Belda-Miquel et al., 2020; Goulet, 2021; Hundscheid et al., 2022). On the other hand, much more vividly evolving views of the regime level and its stability are being presented that allow space for contestations, disagreements, and uncertainties over certain pathways instead of simply assuming alignment (Kuokkanen et al., 2018; Farhangi et al., 2020; Passos Medaets et al., 2020; Bui, 2021; Contesse et al., 2021; Hundscheid et al., 2022). For instance, authors identified alternative paradigms evolving in the regime (Bui, 2021), regime actors actively influencing the selection environment (accommodating sustainability change; Kuokkanen et al., 2018), or regime actors as drivers for change, initiating networking activities across MLP levels (Farhangi et al., 2020). These findings hint at the existence of rather heterogeneous regimes than solely homogeneously aligned regimes which were criticized in transition literature (e.g., Shove and Walker, 2010). This seems to be a newer development since El Bilali's (2019) review where lock-ins, path-dependencies, and stability were the main regime characteristics.

Lock-ins and path-dependencies (4) are introduced as reasons for the slow pace of change processes and regimes' stability. Technological or institutional path-dependencies reinforce systemic lock-ins (Kuokkanen et al., 2018) which are posed by regime actors (López-García et al., 2019). In the articles, these lock-ins are exemplified as "the dominant regime's interrelated market incentives and policies" that are forcing farmers into "high-external input dependent agriculture" (p. 13), international trade, that marginalizes communities in low-income countries (Anderson et al., 2019), power of retailers (Kuokkanen et al., 2018), or prevailing economic structures (Wöhler et al., 2020). In the case of implementing agroecology, Anderson et al. (2019) emphasize that lock-ins can only be overcome by shifts in political–economic power. Furthermore, changes at the landscape level or influential niches can open lock-ins (Rut and Davies, 2018). Distinct forms of lock-ins are presented: first, organizational (a); second, financial (b); third, cultural (c); and last, structural (d). The first form, organizational lock-in (a), represents the way the mainstream agri-food value chain is organized (Anderson et al., 2019; De Herde et al., 2020; Passos Medaets et al., 2020; Averbuch et al., 2021; Ortiz and Peris, 2022). Second, financial lock-ins (b), such as investments in technology, infrastructure, or competencies (i.e., sunk costs), are often undertaken in the long run and cannot be recovered. Cultural lock-ins as a third form (c) reconcile, for instance, shared beliefs, prevailing discourses or consumer preferences, and quality standards that favor certain decisions or products linked to the prevailing (farming) system (e.g., standardized color or size of foods) at the expense of others (De Herde et al., 2020; Van Poeck and Östman, 2021). And last, structural lock-ins (d) are related to the prevailing systemic structure, such as structural power that privileges certain actors empowered by the regime or a concentration of resources that structurally inhibits niche actions (Jedelhauser et al., 2018; Anderson et al., 2019; Belda-Miquel et al., 2020; De Herde et al., 2020; Goulet, 2021).

In short, the analytical emphasis remains rather on barriers and lock-ins associated with the regime. However, some authors describe a more vividly evolving and diversified agri-food regime.

3.8.3. Regime destabilization and change processes

Transition literature indicates that regime destabilization consists predominantly of a process of external pressure, followed by aligned strategic responses up to decreasing regime dedication (Turnheim and Geels, 2013; Kuokkanen et al., 2018). Kuokkanen et al. (2018) emphasize that these processes during regime destabilization are rather diffusing and overlapping than straightforward. Due to distinct expectations of the future, the outcome is unpredictable. Partnerships, landscape and niche pressure, activism, development of new roles whilst alteration of existing ones, negative reporting about the regime, or publicly expressed concerns constitute only some of the examples reported in the articles that provoke regime destabilization (Farhangi et al., 2020; Gaddis and Jeon, 2020; Bui, 2021; Özatagan and Karakaya Ayalp, 2021; Hundscheid et al., 2022). For instance, public–private partnerships have reduced resistance from regime actors regarding the implementation of agricultural technological innovations (Farhangi et al., 2020), and negative reporting about the regime (i.e., environment-related arguments against meat consumption)

led to scrutinizing the regime's beliefs and norms (Hundscheid et al., 2022).

When it comes to regime change, Averbuch et al. (2021) underscore the role of the regime's deep structure and challenge the transformative role of niches as the most important level for innovation and change. From their findings, they underscore that "niches must integrate within the regime's deep structure for a successful transition" (p. 14). In their case of transition to organic agriculture in Denmark, it only began to thrive after its integration within the regime's deep structure (e.g., restructuring through a government-controlled production system). Furthermore, other AFS articles indicate that alternative socio-technical configurations can emerge in regimes as well and simultaneously be sudden rather than incremental, exhibiting a certain degree of radicality (Rut and Davies, 2018; Contesse et al., 2021; Jia, 2021). This is especially the case if landscape pressure is strong and sudden. For instance, Contesse et al. (2021) analyse the case of a pest destroying harvests which lead to an abrupt regime-driven change toward sustainable pest management. This might imply that due to sudden crises, regime changes occur not only incrementally but rapidly, without the presence of strong niche pressure. Although, regarding ST, it can be argued that both cases are not showing inherent actions toward a more sustainable AFS in the first place but rather reacting to external pressures, with sustainability as a side-benefit. Generally, authors emphasize that most regime-initiated changes involve solely adjustments to the incumbent regime instead of radical shifts (e.g., Anderson et al., 2019; Long et al., 2019; Deviney et al., 2020; Averbuch et al., 2021; Bui, 2021).

3.9. Landscape: definitions, descriptions, and influencing factors in AFS studies

3.9.1. Landscape definition and dimensioning

The landscape receives less attention than niche or regime which has not changed much since the aforementioned former review. On the one hand, authors focus solely on niche or niche-regime interactions and tend to overlook this level, refraining from further elaborations. For the sake of completeness, common definitions from transition literature are cited that constitute nearly the only reference to the landscape level (Fogarassy et al., 2018; Heyen and Wolff, 2019; Schaffer et al., 2019; Gugerell and Penker, 2020; Long and Blok, 2021; Van Poeck and Östman, 2021; Boillat et al., 2022). On the other hand, some authors present more detailed elaborations which are listed below (Passos Medaets et al., 2020; Averbuch et al., 2021; Contesse et al., 2021; Gudbrandsdottir et al., 2021; Hundscheid et al., 2022). Thereby, especially influences on the landscape level and landscape as an actant stand out that we will present in the last part of this section.

In line with the transition literature, AFS authors describe the landscape as the exogenous, broader context in which niches and regimes take shape (Anderson et al., 2019; Giombelli and Triches, 2019; Belda-Miquel et al., 2020; Bui, 2021; Goulet, 2021; de Boon et al., 2022). Mostly, the description remains superficial. The landscape is defined as societal, environmental (e.g., crisis and climate change), and political processes, trends, crisis and changes, values and norms, culture and practices, and macro-economic patterns (van der Windt and Swart, 2018; Giombelli and Triches, 2019; Long et al., 2019; Wigboldus et al., 2019; Belda-Miquel et al., 2020; Deviney et al., 2020; Passos Medaets et al., 2020; Goulet, 2021; Anselmi and Vignola, 2022; de Boon et al., 2022; Mehrabi et al., 2022; Sobratee et al., 2022). It is outlined as the deep social structure, surrounding the regime and niche (Deviney et al., 2020; Dumont et al., 2020; Polita and Madureira, 2021b). More narrow landscape pressures toward sustainability identified by AFS authors are listed in Table 3, assigned to topical domains.

TABLE 3 Landscape factors toward sustainable development from agri-food articles and their assignment to topical domains.

Domains	Landscape-level pressures in the agri-food articles toward sustainable development
Economic	- discrediting of big food companies, - food speculations, - financial crisis, - globalization, - global value chains, - circular economy visions, - modernization, - fertilizer prices, - digitalisation and e-commerce
Environmental	- climate change and its implications on resource scarcity, - soil and environmental degradation, - changing weather patterns, - increased environmental awareness
Social and cultural	- dietary shifts, - consumer preferences (e.g., increasing demand for organics), - income concentration, - societal perceptions (e.g., regarding the use of pharmaceuticals), - academic debates, - social movements, - civil society (e.g., environmental NGOs)
Demographic	- population growth
Political regulations, norms, and policies	- international and regional policies and laws - Paris agreement, - Sustainable Development Goals, - Common Agricultural Policy (CAP), - policies on European level, - trade agreements, market access, and political tensions
Health	- food scandals (e.g., BSE, dioxin, and horse meat), - pandemics (COVID-19), - increased health awareness, - global food crisis

Own summary based on AFS articles.
Jedelhauser et al., 2018; Kuokkanen et al., 2018; Rut and Davies, 2018; Heyen and Wolff, 2019; Roberts and Geels, 2019; Belda-Miquel et al., 2020; Dannenberg et al., 2020; Farhangi et al., 2020; Gaddis and Jeon, 2020; Passos Medaets et al., 2020; Bui, 2021; Gudbrandsdottir et al., 2021; Kaweesa et al., 2021; Nemes et al., 2021; Salavisa et al., 2021; Sanon et al., 2021; Hundscheid et al., 2022.

3.9.2. Landscape-level description and elaboration

Further landscape descriptions are offered regarding, first, the immaterial domain (1); second, the scale (2); third, the period (3);

fourth, drivers and constraining forces (4); and last, windows of opportunity (5). Regarding the first aspect, interestingly, authors merely refer to the trends and the immaterial domain of the landscape (cf. Table 3). Reference to the material domain is rarely provided. Hosseinifarhangi et al. (2019) address the decline of arable land per person as a landscape trend that has more infrastructural implications. Jakku et al. (2019) refer to the lack of digital infrastructure that poses a constraint to the transition to smart farming technologies. van der Windt and Swart (2018) reference the material domain as "biophysical conditions such as infrastructures, geographies, and existing urban and nature areas" (p. 2) without further elaborations. The lack of the material domain is especially surprising since, as introduced in the beginning, AFS are not only socio-technical systems but they also comprise the ecological dimension that plays an important role. Therefore, it can be questioned why the material landscape, for instance when looking at agricultural transitions, receives little attention.

Second, the authors refer to regulatory phenomena on a European and international scale (Fogarassy et al., 2018; Long et al., 2019; Belda-Miquel et al., 2020; Averbuch et al., 2021; Bui, 2021). For instance, Averbuch et al. (2021) indicate "international-level rules and regulations" (p. 3) but also regional or national agricultural and rural policies were accounted for the landscape level (Bui, 2021). Third, the time period is focussed. Most authors refer to the long-term structure where changes occur rarely (Rut and Davies, 2018; van der Windt and Swart, 2018; Dannenberg et al., 2020; Goulet, 2021; de Boon et al., 2022) and over decades (Averbuch et al., 2021). Rapid shocks, like COVID-19, can speed up the pace of change (Roberts and Geels, 2019; Dannenberg et al., 2020; Leeuwis et al., 2021). Both periods, the long-term patterns and rapid shocks, are in line with landscape conceptualisations in transition literature as outlined in the introductory section (Driel and Schot, 2005; Geels, 2011).

Fourth, landscape pressure can favor or hinder sustainability changes. Authors describe the macro-level pressure on socio-technical regimes as a necessity for niches to breakthrough (Deviney et al., 2020; Farhangi et al., 2020; Averbuch et al., 2021; Kaweesa et al., 2021; de Boon et al., 2022). In particular, the authors refer to the enhancing forces that can be divided into the six categories, outlined in Table 3. Özatagan and Karakaya Ayalp (2021) report that landscape pressure emerges more forcefully if activists, ecologists, and producers alike voice criticism of incumbent AFS. Then again, landscape forces can also be in favor of the regime, maintaining its dominant status quo. These comprise, for instance, the lack of digital infrastructure in rural areas regarding the introduction of smart farming technologies (Jakku et al., 2019), the gap between awareness of environmental drivers and political actions (Long et al., 2019), distrust toward political institutions (McInnes, 2019), or current European subsidy policy (Salavisa et al., 2021). Finally, certain landscape dynamics can open windows of opportunity for niche construction or reorganization of regime actors (van der Windt and Swart, 2018; López-García et al., 2019; Dannenberg et al., 2020; Ribeiro and Turner, 2021). Although in the case of shocks, these are likely to be more fragile and of a time-limited nature (e.g., COVID-19; Dannenberg et al., 2020).

3.9.3. Influences on potential agency of the landscape level

Some AFS authors argue that niches and regimes can exert influence on the landscape level. Although, consistent with transition literature, not in the short run (Dannenberg et al., 2020; Farhangi et al., 2020; Gaddis and Jeon, 2020; Leeuwis et al., 2021; Sanon et al., 2021). On the one hand, these can produce advantageous landscape developments from a sustainability perspective. Favorable progressions on the macro-level comprise, for instance, the effect of new regimes through advances in technologies and the formation of new social practices (Farhangi et al., 2020) or successful strikes whose concerns will become integrated into rules and regulations impacting the landscape level (Gaddis and Jeon, 2020). On the other hand, an impairment that may limit landscape influence toward sustainable development constitutes the strong involvement of the state and its control over certain developments (Sanon et al., 2021).

The combination of Actor–Network Theory (ANT; e.g., Latour, 2007) and MLP was introduced to analyse human and non-human actants from all levels in terms of change processes (see Section 3.7). Findings suggest that the landscape level is not without agency. The literature produced diverging perspectives on this topic, from a more positivistic notion of the landscape level with almost no agency (Grin et al., 2010; Raven et al., 2012; Fischer and Newig, 2016) to rather constructivist lenses in some of the discussed AFS studies (Farhangi et al., 2020; Contesse et al., 2021). This can be explained by ANT's ontological assumptions. Based on their case study, Contesse et al. (2021) argue that a non-human actant, the Bagrada hilaris (an aggressive pest for several vegetables), provoked the creation of networks from different levels to bring the pest under control, contributing to sustainable pest management. Thus, they continue, if non-human agency is considered, the landscape no longer appears as a level without agency. Bearing the author's assumption in mind, we can follow this argumentation. Nevertheless, this can only be taken further if Latour's position that non-humans have agency is taken up. Further research is needed to test whether this perspective benefits ST studies and serves as an approach that turns the focus toward the landscape level.

In this section, we demonstrated that there is still a poor focus on the landscape level. To enhance this focus, Averbuch et al. (2021) call for more longue durée approaches that present a more comprehensive understanding of developments and might shift the focus to the landscape level. As the landscape level provides similarities with the concept of longue durée by the historian Braudel (Geels, 2011), this approach might constitute an entry point for future studies.

3.10. Criticism of MLP and conceptual refinements

Some of the common critiques of the MLP (e.g., lack of attention to agency, unclear operationalisation of MLP levels, bias toward bottom-up change, and lack of attention to power and politics; Geels, 2011; Lachman, 2013; El Bilali, 2019; Köhler et al., 2019) were equally echoed by recent AFS authors and addressed as an access point. Interestingly, some AFS authors

criticize the prevailing technological focus from the MLP (Jakku et al., 2019; Dumont et al., 2020). This is surprising as social and especially institutional features are conceptually brought along in the MLP (Grin et al., 2010; Geels, 2011). In AFS authors' criticisms, five topics stand out: first, the unclear conceptualization of levels (1) (Dannenberg et al., 2020; Dumont et al., 2020; Averbuch et al., 2021; Bui, 2021; Contesse et al., 2021; Boillat et al., 2022); second, lack of attention to agency, governance, and power relations (2) (Kuokkanen et al., 2018; Long et al., 2019; Roberts and Geels, 2019; De Herde et al., 2020; Gaddis and Jeon, 2020; Schiller et al., 2020; Contesse et al., 2021; Gudbrandsdottir et al., 2021; Polita and Madureira, 2021a; Ribeiro and Turner, 2021; Boillat et al., 2022; Holtkamp and van Mierlo, 2022); third, the dominance of qualitative methods (3) (Jedelhauser et al., 2018); fourth, lack of ecological theories regarding ST (4) (Henfrey and Ford, 2018; Gaddis and Jeon, 2020); and finally, spatial factors (5) (Rut and Davies, 2018; Gugerell and Penker, 2020; Sarabia et al., 2021). Below, some will be addressed in more detail. For further information, Supplementary Table 1 presents an overview of frameworks, theories, as well as authors' reported benefits of combining those with the MLP. In the table, these frameworks and theories are grouped into main themes, that authors integrated, among others, to address these criticisms and specificities of the AFS.

Regarding the unclear conceptualization of levels (1), authors argue that the threshold between MLP levels is rather fluid which leads to analytical confusion (e.g., Rut and Davies, 2018; Long et al., 2019; López-García et al., 2019; Schiller et al., 2020; Contesse et al., 2021; Polita and Madureira, 2021b). One approach to delineate MLP levels (and simultaneously identify historical influences on transitions) constitutes temporal, longitudinal, or longue durée analysis (Rut and Davies, 2018; Gaddis and Jeon, 2020; Averbuch et al., 2021; Bui, 2021; Sarabia et al., 2021; Giagnocavo et al., 2022). Bui (2021) suggests taking a flat empirical approach that allows assigning analytical levels (or social groups) ex-ante from the empirical findings. An unclear differentiation was especially voiced regarding the regime and landscape levels (Averbuch et al., 2021; Contesse et al., 2021). In that sense, a combination of ANT and MLP was utilized, among others, to shift the focus to the landscape level (Hosseinifarhangi et al., 2019; Farhangi et al., 2020; Contesse et al., 2021); although Geels (2010) voiced an ontological contradiction between MLP and ANT, he stresses that ANT's more constructivist approach denies structure and usefulness of analytical levels. Contesse et al. (2021) argue for its suitability in network analysis, describing relations and actions, and in addressing the fluidity of MLP levels. Furthermore, it addresses agency (2), another topic that is still denoted as neglected in the literature, although progress is visible (in this review's articles but also already in the former review by El Bilali's, 2019). Predominantly, AFS authors use qualitative research methods (3) (cf. Table 3). This calls for more quantitative and mixed-methods research in AFS studies focussing on ST.

4. Conclusion

With this systematic literature review, we provided an overview and update of recent elaborations and conceptualization on the use of MLP in AFS transitions toward sustainability. We focussed especially on a deeper analysis of the MLP levels. The fast pace of articles covering AFS in ST shows that AFS are becoming more established in ST research. To reiterate, we first discussed the targeted AFS sectors. Second, we elaborated on the sustainability approaches within the agri-food articles. Then, we presented the understanding and conceptualization of MLP levels by AFS authors, covering niche, niche–regime interface, regime, and landscape. We concluded with an overview of criticisms raised in the articles as well as elaborations and conceptual refinements (i.e., combination of MLP with other frameworks or theories).

Our findings show that the majority of studies are touching more interrelated activities within the AFS and not solely a single food chain stage. Ongoing transitions are targeted. Rarely, authors elaborate on their sustainability assumptions in sustainability transitions and rather analyse how the transition in the specific case study develops or approach it through the case lens, i.e., their object of study. Niches constitute the most prominent access point when analyzing AFS transitions toward sustainability. Scholars relate to social innovations rather than technological novelties. In AFS, niches seem to be predominantly self-organized entities. In terms of protection, all MLP levels can serve as protecting instances, also niches for other innovations. The temporality of those protections is highlighted as forms of overprotection and dependencies should be prevented to avoid the decrease of self-sufficiency. Refraining from assigning niche actors ex-ante and rather differentiating between niche-level actions and niche-level actors may be considered useful, especially in ongoing transitions, as actors' beliefs can change throughout the transition process. This applies also to regime actors.

Boundaries between MLP levels are rather fluid than sharp. A newer development in AFS research is the existence of an overlapping space between levels. Scholars hint at this space between niche and regime, where actors from both levels actively network and collaborate in favor of transition progress, although this space still lacks a common understanding regarding its characteristics and terminology. The spaces between the other levels are not considered. Uncertainty and incoherence exist regarding the regime and landscape. Scholars cite distinct interpretations from the literature without elaborating why the respective view was taken over. They refer to a regime informed by institutional theory, understood as the incumbent rule-set or to conceptions where materials and actors are considered as regime entities, whereby the latter stands out. Stable regimes are being presented but also more lively views, where contestation and disagreement exist which also seems to be a more recent development. In the case of sudden landscape pressures, regimes can react immediately toward more sustainable options rather than only incrementally, even without niche pressure. The landscape level is the least focussed, predominantly characterized by immaterial features which are surprising as ecology plays an important role in AFS. In combination with Actor–Network Theory, scholars demonstrate the presence of agency on the landscape level. In general, combinations of MLP with other frameworks prove useful to receive a deeper

understanding of, for instance, the role of actors and agency or spatial aspects in ST of AFS. Pathways for future research have been presented in the study. Generally, future research should aim for a clearer theoretical elaboration on MLP and offer more quantitative and mixed-methods approaches. The overlapping space between levels represents a promising field of research.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

FE planned the SLR, wrote the research protocol in agreement with CS and CH, conducted systematic research in agreement with CS, and wrote the first draft. CS and FE discussed the coding system. CH, CS, and FE discussed the results of the systematic research and agreed on the structure of the publication. CH and CS reviewed the content. All authors have seen and accepted the final version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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