

Review

The Multi-Level Perspective in Research on Sustainability Transitions in Agriculture and Food Systems: A Systematic Review

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Abstract: The multi-level perspective (MLP) is a prominent transition framework. The MLP posits that transitions come about through interaction processes within and among three analytical levels: niches, socio-technical regimes and a socio-technical landscape. This systematic review provides an overview on the use of the MLP in research on agro-food sustainability transitions. In particular, it analyses the understanding, conceptualisation and operationalisation of niches, regimes and landscapes. Niches considered in the selected papers include agro-ecology, organic agriculture, permaculture, conservation agriculture, integrated farming, and alternative food networks. Regime refers to industrial, conventional agriculture. The researched regime is often not clearly described and its operationalisation is a matter of deliberation. Landscape level is generally overlooked; when it is considered it refers to international trends and developments. Many scholars highlight the inadequacy of transition pathways in the MLP for the agro-food sector. Moreover, transition impacts are rarely addressed and the research field generally overlooks the analysis of the sustainability of niches and, consequently, of transitions. Research on transitions in the agro-food sector borrows from the MLP its generalizability and poor empirical operationalisation of niche, regime and landscape concepts. Therefore, integrative conceptualisation and operationalisation of the MLP elements is required to accommodate the complexity of sustainability transition processes and the peculiarities of the agro-food system.

Keywords: sustainability transitions; agriculture; food; multi-level perspective; MLP; niche; regime

1. Introduction

Sustainability transitions refer to “long-term, multi-dimensional and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption” (p. 956) [1]. Geels [2] posits that “socio-technical transitions . . . involve not just changes in technology but also changes in consumer practices, policies, cultural meanings, infrastructures, and business models”. Sustainability transitions have several features that make them a special topic in sustainability scholarship [3]: multi-dimensionality and co-evolution, multi-actor process, dialectic relationship between stability and change, long-term process, open-endedness and uncertainty, values contestation, and the central role of public policy. Kern and Markard [4] highlight that sustainability transitions are contested, complex, uncertain, long-term, multi-dimensional, and context dependent processes. The authors also point out the centrality of power and politics as well as the key role of public policies in sustainability transitions.

Since the publication of the first research agenda on sustainability transitions in July 2010 [5], the research field has broadened empirically, deepened intellectually and extended geographically. The sustainability transitions research field has also shown a “capacity for intellectual flexing and

stretching” [6] both geographically and in terms of topics addressed. An increasing number of publications address sustainability transitions in agriculture, food and rural areas (e.g., [7–17]). Nevertheless, sustainability transition scholarship tends to overlook agro-food systems [1,6,18,19].

Different frameworks have been used to conceptualize, understand and promote transition towards sustainability [1,3,20–25]. Lachman [22] reviews the more notable transition frameworks: the multi-level perspective on socio-technical transitions (MLP), strategic niche management (SNM), transition management (TM), technological innovation systems (TIS), techno-economic paradigm (TEP) shifts, and socio-metabolic transitions. The socio-technical transitions approach emerged from a Dutch research program [20,26]. Socio-technical transitions refer to an umbrella term that includes a family of approaches, such as the multi-level perspective [27,28], multi-phase model [29], strategic niche management [30–32] and transition management [33–35].

The multi-level perspective (MLP) was developed by Arie Rip and René Kemp [36], and further refined by Frank Geels and Johan Schot [20,21,37]. The MLP posits that transitions come about through interaction processes within and between three analytical levels: niches, regimes, and a socio-technical landscape [27,28,30,36,38–41]. Niches are spaces where innovative activity takes place and where protection is offered from dominant rules [27,41]. The socio-technical regime refers to the incumbent socio-technical system [27,42,43]. It includes the network of actors and social groups, the rules (formal and informal) they maintain to run the dominant system, and related technical and material elements [27,42]. Thus, regimes encompass technologies, institutions and actors [43]. According to Holtz et al. [43], the main characteristics of regimes are their purpose (cf. societal function such as food/nutrition), coherence, stability, non-guidance and autonomy. Regimes rarely undergo transformation or reconfiguration, and tend to change only incrementally [22]. The socio-technical landscape cannot be changed easily in the short run [28,36,37] and includes exogenous events and trends such as demographic changes, macro-economic trends, political developments, wars and crises, deep cultural and societal values, and climate change [22]. Landscape changes can generate opportunities for niches and/or represent a source of pressure for regime change [41].

Transitions are defined in the MLP as shifts from one socio-technical regime to another. They are the result of the dialectic interaction processes at the niche-regime-landscape interface; niche-innovations build up internal impetus and a momentum for change, while landscape changes create pressure that destabilizes the socio-technical regime, and the resulting destabilisation of the regime creates opportunities for niche-innovations to take the centre stage within the socio-technical system and replace the existing regime [21,27,44,45]. The MLP stresses that niche-regime-landscape processes should be aligned for a transition to happen [27].

The MLP distinguishes between different transition pathways, depending on the nature (symbiotic or competitive) and timing of the multi-level interactions [37]; they include: reproduction process (stable regime in absence of landscape pressure), transformation pathway (niche-innovations insufficiently developed, landscape pressure stimulates regime to gradually adjust), de-alignment and re-alignment pathway (niche-innovations insufficiently developed, major landscape pressure destabilizes the regime causing its de-alignment, prolonged co-existence of niche-innovations lead to re-alignment around one niche that creates a new regime), technological substitution (disruptive technical niche-innovations sufficiently developed when landscape pressure on regime occurs), and reconfiguration (symbiotic niche-innovations incorporated into the regime and trigger further adjustments under landscape pressure). Another transition pathway addresses the possibility of a transition paths sequence, that’s to say when transition starts following one path but later shifts to another one.

Sustainability transitions scholarship tended to overlook agro-food systems. Moreover, there is no comprehensive analysis of the use in, and consequently appropriateness to, agro-food systems of the multi-level perspective (MLP). To address this literature gap, the present systematic review provides a critical analysis of the use of the MLP in research on sustainability transitions in the agro-food sector. Specifically, the paper casts light on the understanding and operationalization of the MLP elements (niche, regime and landscape). It also reviews the main critiques of the MLP as well as proposals for

the improvement of the heuristic framework to make it more suitable for the analysis of agro-food sustainability transitions.

2. Methodology

The paper is based on a systematic review. A search was carried out on 21 April 2018, on Scopus database using the Title-Abs-Key string: transition AND (MLP OR {multi-level perspective} OR {multilevel perspective} OR niche) AND (agri* OR agro OR food) (Figure 1). The search yielded 286 documents. First, 24 review articles were excluded as the present paper focuses only on research regarding agro-food sustainability transitions. Likewise, one book, 19 book chapters, 4 conference papers and one conference review were eliminated. Following a review of titles, 44 documents were not considered for further analysis. In particular, documents that refer to trophic, ecological and ecosystem niches (see, Niche construction theory) were excluded. In case of doubts, documents were kept. An additional 122 records were excluded based on abstract screening as they did not deal with agro-food (agriculture and/or food) and/or did not use the MLP. At this point, 43 documents were directly added to “Selected research articles” list as they dealt with sustainability transitions, addressed agriculture and/or food, and used the MLP. Some papers use the MLP but they do not refer to agro-food (e.g., [46]). Likewise, documents that deal with changes in land use (see, multi-layer perceptron, MLP) without any direct relation to agro-food were excluded. In some cases, it was clear that papers address sustainability transitions in agro-food but not whether they use the MLP—niche term mentioned in abstract can also refer to other transition frameworks such as SNM (e.g., [47–49]) and TM (e.g., [50,51]); in these cases, a scrutiny of full texts was necessary. Therefore, a further step of the systematic review consisted in the analysis of 28 full papers to make sure that they meet all inclusion criteria. At this stage, an additional 14 documents were excluded. Therefore, 57 research articles were selected for the systematic review.

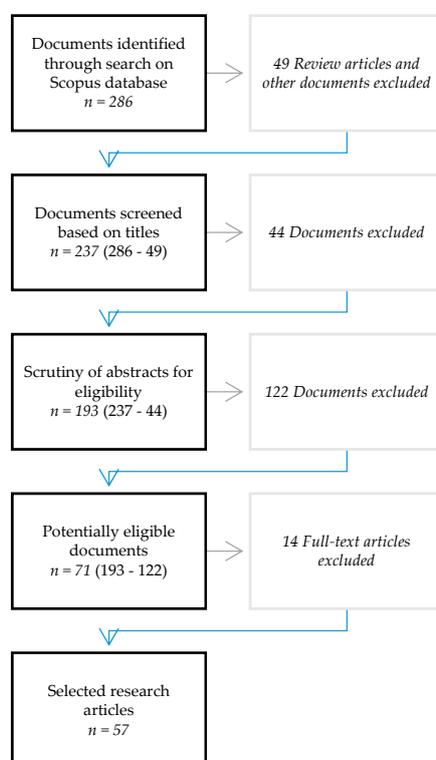


Figure 1. Process and steps of the systematic review. Only research papers that deal with agro-food (agriculture and/or food) and use the multi-level perspective (MLP) were included in the systematic review. Source: Adapted from Moher et al. [52].

For the selected research papers, the analysis focused on the following issues: topical focus and bibliometrics; conceptualisation of the MLP elements: niche, regime(s) and landscape; understanding of transition pathways; assessment of transition impacts and outcomes (cf. food security); criticisms of the MLP and proposals for improvements, and the integration of the MLP with other transition frameworks (e.g., TM, SNM).

3. Results and Discussion

3.1. Bibliometrics and Topical Focus of Research on Agro-Food Sustainability Transitions Using the MLP

3.1.1. Bibliometrics

The bibliometrics of research on agro-food sustainability transitions using the MLP (sources/journals, authors, affiliations, countries) are presented in Table 1.

Table 1. Bibliometrics of research on agro-food sustainability transitions using the multi-level perspective (MLP): top-ten journals, authors, affiliations and countries.

Journal (a)	Author (b)	Affiliation (c)	Country (d)
Sustainability Switzerland (8)	John Grin (3)	Wageningen University and Research Centre (11)	United Kingdom (14)
Journal of Rural Studies (4)	Jan Hassink (3)	Erasmus University Rotterdam (4)	Netherlands (13)
Environment and Planning A (3)	Willem Hulsink (3)	University of Amsterdam (3)	Belgium (6)
Environmental Innovation and Societal Transitions (3)	Julie Ingram (3)	University of Gloucestershire (3)	Canada (5)
Technological Forecasting and Social Change (3)	Cees Leeuwis (3)	Cardiff University (3)	France (5)
Agricultural Systems (2)	Margaret Ayre (2)	–	Austria (4)
Agriculture and Human Values (2)	John Morrissey (2)	–	Germany (4)
Environmental Science and Policy (2)	Ruth A. Nettle (2)	–	United States (4)
Experimental Agriculture (2)	Marc Schut (2)	–	Australia (3)
Research Policy (2)	Pierre Marie Stassart (2)	–	Sweden (3)

Figures in brackets refer to the number of documents by journal (a), author (b), affiliation (c), country (d).

There is a general trend towards an increase of the output of papers on agro-food sustainability transitions using the MLP (from about one paper per year up to 2011 to 12 in 2017) (Table 2). Given this upward trend, it is expected that the number of articles published in 2018 will be higher than in 2017.

Agro-food sustainability transitions research using the MLP is mainly published in Sustainability (eight papers), followed by the Journal of Rural Studies (four papers), Environment and Planning A (three papers), Environmental Innovation and Societal Transitions (three papers) and Technological Forecasting and Social Change (three papers). Nevertheless, it should be highlighted that the 57 selected articles were published in 34 journals. Research results are largely published in the domains of social sciences (36 papers), environmental science (23 papers) and agricultural and biological sciences (19 papers). There are some differences with the sustainability transitions mother field in the prominence of journals. In fact, the most prominent journals in the mother field are Journal of Cleaner Production, Energy Policy and Technological Forecasting and Social Change. Environmental Innovation and Societal Transitions, the journal associated to the Sustainability Transitions Research Network (STRN), features in both top-ten lists. Sustainability, the journal with the highest number of research papers on agro-food sustainability transitions using the MLP, ranks only sixth in the list of key journals in the sustainability transitions research field [19].

The most prominent authors in the field in terms of publications number are John Grin (three papers), Jan Hassink (three papers), Willem Hulsink (three papers), Julie Ingram (three papers) and Cees Leeuwis (three papers). There is a north-south divide in affiliations of authors. Research on agro-food sustainability transitions using the MLP is mainly performed in Dutch and British

universities and research centres. Wageningen University and Research Centre (11 papers out of 57) is by far the leader in this research field. The list of affiliated countries is dominated by the United Kingdom (14 papers) and the Netherlands (13 papers). Although the list also features some countries from the Global South (e.g., Argentina, Burundi, China, Mauritius, Nigeria), it confirms that the research field of sustainability transitions is still biased to the Northern hemisphere [22].

3.1.2. Topical Focus: Agriculture Sub-Sectors and Food Chain Stages

Most of the selected research articles focus on crop production; other agriculture sub-sectors such as animal production [53–56] and fisheries/aquaculture [57] are largely underserved. However, some papers address different agriculture sub-sectors; for instance, Santhanam-Martin et al. [58] analyse the relation between natural landscape and livestock. Interestingly, there are also some research articles that deal with urban agriculture [59] and urban food systems [60–63]. Alternatively, the topical focus of the research is on transition in the use of some agricultural inputs such as fertilizers [64].

Concerning the food chain stages, production is the most addressed one. Distribution and sourcing/procurement [65–69] are properly addressed. Processing stage [70,71] is underrepresented in research on agro-food sustainability transitions using the MLP. In general, the MLP is rarely used alone to analyse transition in consumption. Nevertheless, some articles address different stages of the food chain, e.g., production and consumption [72–75].

3.2. Conceptualisation and Operationalization of the MLP Elements

3.2.1. Niches

Darnhofer [76] points out that niches are involved in interrelated changes regarding “new technologies and practices, new configurations of actor groups, new beliefs and values, new networks, new policies” (p. 17). According to Loorbach [77], niches can refer to “new technologies, new rules and legislation, new organizations or even new projects, concepts or ideas” (p. 20). Niche innovations in the agro-food arena include alternative food systems/networks and farming systems (e.g., organic agriculture). Transitions towards organic agriculture and agroecology are prominent case studies in the selected articles. In fact, considered niches include agro-ecology [78–81], organic agriculture [82,83], permaculture [84], urban agriculture [59], conservation agriculture [85], integrated farming [86], care farming [87–89], alternative food networks [65,66,68,73] (Table 2).

Bui et al. [66] consider niches as initiatives in which alternative rules and practices are developed by a network of actors and point out that “The concept of niche is very congruent with the definition of alternative food networks, except that it is not restricted to food networks. In fact, the concept of niche originates from evolutionary economics which analyses technological evolution. It is therefore primarily interested in the fact that alternative networks support new technology” (p. 93). Konefal [90] provides examples of many agro-food niches in the US, e.g., organics, community-supported agriculture, farmers’ markets, urban gardens, farm-to-table restaurants, biodynamic agriculture, alternative animal husbandry systems (free range, grass fed). Marsden [91] considers organics, fair trade and local food networks as niches. However, Vivero-Pol [92] warns that alternatives (food sovereignty, food justice, de-growth, commons, veganism, right to food) do not necessarily have reformist, transformative agendas. Therefore, it is important to be clear about the analysed niche and the novelty it proposes with respect to the current regime [93]. Interestingly, while the concept of niches in the MLP originally referred to protective/protected spaces (e.g., research and development laboratories, demonstration projects) where innovation activity takes place [27,41], scholars in the agro-food sector use the concept mainly to refer to alternative agro-food systems.

Table 2. Case studies on agro-food sustainability transitions research using the MLP.

Year	No of Articles	Research Article	Case Study	Country
2018	7 ^a	Hassink et al. [88]	Care farming	The Netherlands
		Ingram [84]	Permaculture	UK (England)
		Järnberg et al. [94]	Agricultural development	Ethiopia
		Nygaard and Bolwig [95]	Jatropha biofuel	Ghana
		Punt et al. [96]	Animal testing in safety evaluations	Multi-country/Europe
		To et al. [71]	Waste from sugar processing (bagasse)	Mauritius
		Zwartkruis et al. [97]	Agricultural nature conservation	The Netherlands
2017	12	Audet et al. [65]	Montreal seasonal food markets	Canada
		Belmin et al. [98]	Geographical Indications	France
		Feyereisen et al. [99]	Fair trade milk	Belgium
		Hauser and Lindtner [82]	Organic agriculture	Uganda
		Isgren and Ness [78]	Agroecology	Uganda
		Jacobs et al. [64]	Phosphorus use	Multi-country/North America
		Loconto and Barbier [100]	Agriculture sustainability standards	Undefined
		Meynard et al. [74]	Agri-food sector	Multi-country
		Paschen et al. [101]	Privatised agricultural extension	Australia
		Seoane and Marín [83]	Organic apiculture	Argentina
		Vivero-Pol [92]	Food	Multi-country
Vlahos et al. [86]	Integrated peach farming	Greece		
2016	10	Bui et al. [66]	Alternative food networks	France
		Davidson et al. [53]	Alternative beef production	Canada
		Jurgilevich et al. [72]	Circular economy in the food system	Undefined
		Maru et al. [102]	Integrated agricultural research for development (IAR4D)	Multi-country/East and West Africa
		Pant [80]	Agroecology	Multi-country
		Papachristos and Adamides [103]	Functional foods	Undefined
		Pitt and Jones [69]	Food for Life (FFL) catering mark	UK
		Schut et al. [104]	Innovation platforms	Multi-country/Africa
		Stahlbrand [67]	Soil Association's Food For Life catering mark	UK (England)
Vankeerberghen and Stassart [85]	Conservation agriculture	Belgium		
2015	8	Ingram [105]	Sustainable agriculture	Multi-country/Europe
		Ingram et al. [16]	Sustainable agriculture	Multi-country/Europe
		Konefal [90]	Sustainability metrics and standards in agriculture	USA
		Moragues-Faus and Morgan [60]	Urban food policy	Multi-country/UK and Sweden
		Morrissey and Dunphy [106]	Sustainability assessment	Undefined
		Santhanam-Martin et al. [58]	Landscape and dairy farming	Australia
		Schermer [56]	Dairy farming	Austria
Sutherland et al. [107]	Renewable energy	Multi-country/Germany, Czech Republic, UK		

Table 2. Cont.

Year	No of Articles	Research Article	Case Study	Country
2014	7	Bush and Marschke [57]	Aquaculture	Undefined
		Duru et al. [81]	Agroecology	France
		Hassink et al. [89]	Care farming	The Netherlands
		Hinrichs [6]	Food systems	Undefined
		Levidow et al. [79]	Agroecological research	Multi-country/Europe
		Morrissey et al. [75]	Agri-food sector	Multi-country
		Slingerland and Schut [108]	Jatropha biofuel	Mozambique
2013	8	Crivits and Paredis [68]	Local food systems (food teams)	Belgium
		Diaz et al. [109]	Algae blooms	France
		Hargreaves et al. [110]	Organic agriculture	UK
		Hassink et al. [87]	Care farming	The Netherlands
		Immink et al. [55]	Livestock sector	The Netherlands
		Li et al. [111]	Participatory maize breeding	China
		Lutz and Schachinger [73]	Local food networks	Austria
2012	2	Bell and Cerulli [59]	Urban agriculture (community gardens)	United Kingdom
		Lawhon and Murphy [112]	Genetically modified organisms (GMOs) in food production	Undefined
2011	1	Elzen et al. [54]	Pig husbandry	The Netherlands
2010	1	Beers et al. [113]	Agriculture	The Netherlands
2003	1	Wiskerke [70]	Wheat and bread	The Netherlands

^a This figure refers to the number of research articles published in 2018 by the search date (21 April 2018).

While the majority of papers using the MLP focus on relations between the elements of the heuristic framework (niche, regime, landscape) and how they affect the transition dynamics and processes in the agro-food sector, some articles analyse internal niche processes. For instance, Paschen et al. [101] investigate social practice elements in the internal processes of the privatized agricultural extension, that is considered as a ‘niche-in-the-making’ in Australia. Apart from the fact that the analysis shows that one cannot only talk of a ‘transition-in-the-making’ but also of a ‘niche-in-the-making’, it also highlights the importance of considering internal niche processes (e.g., niche formation and development) in sustainability transitions. In fact, transitions occur only when niche-innovations are enough robust to challenge the dominant socio-technical system. The robustness and maturity of the niche are two necessary conditions to ensure its scaling up and out i.e., reaching larger groups of people and having greater impact [69], thus contributing to agro-food transitions. However, scaling up may lead to the loss, or at least ‘dilution’, of niche values; for instance in the case of agro-ecology, Pant [80] examines the ‘paradox of mainstreaming agroecology’ that “... refers to an apparent contradiction between upscaling niche innovations ... and the concerns for a loss of core values and principles of agroecology in the mainstreaming process” (p. 305).

Internal niche processes are also fuelled by the high level of diversity among niche actors that lead to a lack of consistent ascription to a unified worldview, as pointed out by Davidson et al. [53] that highlight “a wide range of motivations, histories and sentiments” (p. 367). Vivero-Pol [92] shows that the normative values on food (i.e., food as commodity vs. food as commons) shape food transition trajectories and points out that “... the view of food as commodity is positively correlated with a gradually-reforming attitude, whereas food as commons is positively correlated with the counter-hegemonic transformers, regardless of the self-defined position in the transition landscape (regime or niches)” (p. 1) and that “... alter-hegemonic attitudes are not positively correlated with the alternative discourse, and they may inadvertently or purportedly reinforce the neoliberal narrative” (p. 1). Furthermore, internal niche processes are not the only ones to blame for this lack of clarity that can lead to ambiguity as niche actors are also obliged to deal with some elements of the existing regime which, for instance, ensures they “... are simultaneously ‘in’ and ‘against’ the market” (p. 312), that they want to change [99]. In fact, Huybrechts [114] explains that actors within the fair trade movement “... wish to use market mechanisms as a tool to increase their social impact, but at the same time promote a political project that questions the functioning of the market” (p. 17).

3.2.2. Regimes

As in the case of transition research field, also in studies on agro-food sustainability transitions, conceptualisation and operationalization of regimes is only briefly and partially discussed as “... the attention is not so much on defining and describing what a regime is, but on the dynamics of transitions and on transition management” (p. 624) [43]. In general, the regime in the selected papers mainly refers to the intensive, conventional, industrial agro-food sector and its associated rules and practices [66,109]. This is true for both crop production and animal husbandry. In the case of the latter, for instance Davidson et al. [53] consider “... alternative beef production as a niche operating within the dominant regime of global industrial agri-business” (p. 359), adding that features of regimes can also contribute to the emergence of the niche (see, alternative beef production). Agro-food regime elements include business codes and regulations, food safety laws, existing business networks, logistics transport and infrastructure [6]. The agro-food regime is characterized by mainstream practices and approaches dominated by industrial farming and integrated food supply chains [75]. In fact, modern agro-food systems are highly standardized with multiple layers of rules governing the practices of agricultural production and food processing as well as distribution networks [115]. Järnberg et al. [94] suggest that “... the regime includes key government actors and their associated institutional structures in the agricultural sector, the political discourse on agricultural development, dominant agricultural practices, and the associated patterns of ecosystem services and human well-being” (p. 412). While Holtz et al. [43] highlight that a useful delineation of the regime in the agro-food domain “... should

include the farming side but also consumers and the structure of trade" (p. 630), many scholars focus only on one side of the food chain and overlook production-consumption linkages. Referring to the agro-food regime in England, Ingram [84] states that "the regime's dominant narrative is largely techno-centric with technical innovation, efficiency and competitiveness at the core of government and industry strategies, with the mainstream concept of sustainable intensification capturing this . . ." (p. 122). Konefal [90] connects " . . . the control of food and agriculture by input companies, processors, and retailers . . ." (p. 629) to the agro-food regime in the US. Likewise, Lutz and Schachinger [73], argue that "the current food regime . . . encourages growth, competition, and the subjugation to and cooperation with food-corporations" (p. 4791).

Out of the three types of rules in socio-technical regimes, i.e., regulative, normative and cognitive [42], the focus of scholars is on regulative ones, probably because they are more tangible than the two other categories (viz. normative and cognitive rules). In fact, Geels [27] argues that regime elements can be tangible (e.g., laws, regulations, protocols, standards) or intangible (e.g., policy paradigms, shared visions and beliefs, social norms, cognitive routines). Culture is one of the few intangible elements of the regime that is addressed in some articles [53,78]. Referring to early work on the MLP by Geels [28], Isgren and Ness [78] apply regime dimensions (guiding principles, technologies/practices, market relations, knowledge, policy and culture) to the agroecology niche in Uganda in order to anticipate the implications at the regime level of niche scaling up. Meanwhile, Järnberg et al. [94] argue that " . . . when scaling their innovations through the regime structures, the green niche actors to a certain degree lose control over the process" (p. 417).

The concepts of 'lock-in' and 'path dependency' [116–118] are recurring themes in analyses of agro-food regimes [53,55,64,65,78,83,90,99,104] to explain its resistance to change. For instance, in the case of pig farming in the Netherlands, system lock-ins take the form of barriers in the meat supply chain and market that hinder improving animal welfare in pig production [55]. Stabilizing strategies used by regimes include lobbying as well as the formation of networks and alliances [119]. Therefore, the analysis also focuses on the networks of actors and social groups that support the dominant agro-food system. Davidson et al. [53] argue that "socio-technical regimes remain in place despite anomalies in part because the pathways for activity within those regimes are 'hard-wired' by well-established routines and relationships" (p. 368). Nevertheless, as Fuenfschilling and Truffer [120] highlight, all socio-technical regimes have internal contradictions and cracks that can allow for some change.

Raven [121] and Konrad et al. [122] point out that more attention should be paid to horizontal interactions i.e., multi-regime and multi-niche interactions. Some of the selected papers deal with multi-regimes and address the interface between agriculture and energy [71,95,107,108], nature [97] or healthcare [87–89]. Immink et al. [55] criticize the lack of coordination between niches and argue that " . . . niche initiatives are often characterized by mutual independence in that they are developed independently from each other, inventing the wheel all over again rather than synergizing each other" (p. 153). Sutherland et al. [107] conceptualize " . . . transitions towards renewable electricity production as examples of multi-regime interaction between national-level agriculture and electricity regimes" (p. 1543).

Another issue is that related to system boundaries. Holtz et al. [43] pointed in 2008 that "what actually is 'the regime' to be researched and possibly managed is however usually not given through clear system boundaries but is a matter of framing and deliberation" (p. 623) and this is often still the case in research on agro-food sustainability transitions.

3.2.3. Landscape

Landscape level is generally overlooked in research on agro-food sustainability transitions using the MLP. While some scholars state clearly that landscape is not addressed, e.g., Isgren and Ness [78] who put " . . . landscape dynamics are not addressed in depth, to keep the study focused" (p. 7), most papers overlook the landscape level without any further explanation. This confirms that landscape

category is sometimes used only as a 'residual garbage can' [27] to put whatever does not fit into niche or regime categories. Nevertheless, some of the selected papers address various external trends and exogenous factors that affect transition towards sustainable agro-food systems. These trends and factors include globalization and agro-food market internationalization [55,90,98], population growth [90], global financial crisis [108], changes in diets and lifestyles [55], (neo)-liberalization [88,90], international treaties and conventions [97,111], the Common Agricultural Policy [79,99] in the context of the European Union, increasing concerns about animal welfare and the environment [55,88], climate change [73,90]. According to Immink et al. [55], "... cultural values, international rules in economics and trade, macro-political developments and new global standards are all part of landscape developments that can exert pressure on the current sector" (p. 153). Järnberg et al. [94] posit that the landscape level "... in the case of Ethiopian agriculture includes, e.g., its integration in international markets, various globalization processes, and the overall political situation in the country" (p. 411). According to Lutz and Schachinger [73], the food system is "... subject to various external landscape pressures such as volatile energy prices, global financial instability, poverty, social inequality, hunger, malnutrition, resource degradation, and climate change" (p. 4783). The authors call for considering not only the socio-economic landscape but also the biophysical landscape (e.g., climate change, arable land availability, soil fertility) in studies dealing with agro-food sustainability transitions.

The literature on the MLP posits that the socio-technical landscape has two main functions in sustainability transition processes, i.e., putting pressure on regimes to change and creating opportunities for niches. The selected research articles analyse both functions. However, also pressures on regimes should be considered as part of opportunities created by the landscape for niches. Changes in the socio-technical landscape can also create opportunities for the regime as pointed out by Davidson et al. [53] who argue that growing global demand for meat products has empowered conventional beef production in Alberta (Canada).

Different trends and changes can create opportunities for niches. Bell and Cerulli [59] conclude that "... changes in the landscape of urban food systems, including increasing food prices and growing concerns about the environmental impacts of industrial agriculture are creating conditions conducive to the emergence of community gardens" (p. 31) in London. Davidson et al. [53] pinpoint disruptive events and crises as important elements of the landscape, and exemplify that by the role of the outbreak of mad cow disease in Alberta (Canada) in 2003 in the emergence of alternative beef production.

An important role of the landscape is also that of offering protection of niches against the dominant regime [27,41]. According to Hinrichs [6], such protection may involve shielding the niche-innovation from initial competition; nurturing the niche-associated innovation system by supporting learning, capacity building and networking; and/or empowering the niche-innovation. This protection can be achieved also by introducing new 'rules of the game' (see, regulations) that are more favourable for the niche. For instance, Belmin et al. [98] show that the implementation of a Geographical Indication in the early 2000s strengthened the Corsican clementine niche against the citrus regime.

Schermer [56] highlights that the same change at the level of the landscape can create opportunities for multiple niches. In fact, the paper shows that on the occasion of the preparation of Austria's accession to the European Union, there was a deep and far-reaching restructuring of the whole dairy sector and its entire supply chain, which created windows of opportunity for many niches such as organic farming and direct marketing of dairy products. It also casts light on the fact that regulatory interventions at landscape level not only change the rules of the game regulating transactions between actors but can also induce changes of social practices of actors at the regime level.

Zwartkruis et al. [97] analyse the role of internationally agreed European and global targets relating to biodiversity and climate in land use changes in the Netherlands. The analysis shows that the nascent 'agricultural nature conservation' niche, that was fostered by the international commitments and agreements of the Netherlands, affects both agriculture and nature regimes. Likewise, Li et al. [111] show that international treaties and conventions on plant genetic resources affect the development

of participatory maize breeding niche in China. However, while the literature on the MLP generally suggests that the landscape has a positive impact on the niche, evidence shows that it is not always the case. In fact, Li et al. [111] refer to ‘intellectual property regimes’, that work against participatory breeding niche, and that are also the result of the external, international commitments of the country. In fact, Geels [27] notes that the assessment of landscape trends is often biased towards destabilization and pressure on socio-technical regimes and suggests that future analyses should address the stabilizing landscape roles on regimes and also investigate how regime reconfiguration contributes to changes in the landscape.

3.3. Understanding of Multi-Level Interactions and Transition Pathways

The MLP posits that dialectic niche-regime-landscape interactions shape sustainability transitions and determine their scope and impacts. Smith [123] points out that there has been insufficient consideration of the ‘linking’ between the different MLP elements. In general, the focus of the analysis in the reviewed articles is on how regimes hinder the development of niche alternatives and/or on how niche-innovations successfully induce changes in the socio-technical regime. The main problem for niches is that they are constantly confronted with but, often, have no direct influence on the ‘landscape-induced and regime-inherent’ processes [73]. Another addressed topic is how niche-regime linking mechanisms lead (or not) to regime shift. Smith and Raven [124] affirm that “... the dynamics of transition lie in how these innovative social niches engage with each other and with prevailing socio-technical regimes, especially whether they strive to ‘fit and conform’ to regimes or ‘stretch and transform’ them” (p. 1030). The literature also highlights that niche development is necessary but not sufficient to induce a regime shift, i.e., transition [125] and that a niche can contribute to the reconfiguration of the socio-technical regime despite its small size [51,66]. Niche-regime interactions can address different dimensions (e.g., markets, regulations, norms, cultural meanings, visions, infrastructure) and may include lobbying, negotiation, competition, learning [5]. These interactions are central in papers using the MLP. Such papers focus on how niche-innovations affect the conventional agriculture regime or a component of it e.g., agricultural knowledge system [84], agricultural research [79,102,104], agricultural extension [101]. As for empowerment strategies, niches can either ‘fit-and-conform’ (cf. adopting and mainstreaming dominant socio-technical practices) or ‘stretch-and-transform’ (cf. undermining the incumbent regime and transmitting niche-derived practices into it) [124].

Holtz et al. [43] stress that “... what a scientist frames as a regime, is an alignment of actors with their individual goals, perceptions, knowledge and values, technological possibilities, institutional settings, infrastructure, etc.” (p. 628). This applies also for niches. It can be argued that niches and regimes are about networks and groups of actors that align and subscribe to certain rules and practices. Therefore, niche-regime relations are also about how ‘niche-actors’ and ‘regime-actors’ interact and build, or not, bridges allowing for cross-fertilisation that can lead to system reconfiguration. Diaz et al. [109] emphasize this social component of sustainability transitions and point out that “this active work of building bridges through reinterpretation, of enrolling regime actors, of seizing windows of opportunity, highlights the ‘social’ aspect of social-technical transitions” (p. 62). The bridge concept is what Feyereisen et al. [99] refer to as ‘double-stretch between breaks and continuities with the regime’ (p. 306). This resonates with the ‘anchoring’ mechanisms suggested by Elzen et al. [126], i.e., niche-regime interaction that leads to a durable niche-regime linkage. In fact, niches can anchor to regimes by proposing new rules or institutions, fostering new technical systems (practices, processes, technologies) or building new networks and social groups.

Linking processes can involve networking niche actors and regime entities [127], reinvention and adaptation [105], translation [123], hybridization of niche experiments and regime practices in multi-actor forums [86,126]. Hauser and Lindtner [82] suggest that “increased cooperation with government officials and researchers, notably those who at first disbelieved in organic agriculture, enhanced the outreach of organic agriculture” (p. 176) in post-war Uganda. Ingram [84] argues that

niche-regime linking processes enable knowledge exchange (networking, translation) and mutual learning. Sutherland et al. [93] suggest that actors in the agro-food system may be 'hybrid actors', i.e., play roles in both niche and regime. Likewise, Diaz et al. [109] and Ingram [84] posit that niche-regime interaction can create windows of opportunity for niche actors to gain support by creating coalitions and networks with sympathetic regime actors. However, niche actors should be aware that the regime, and its actors, may tend to marginalize niches [91] or conventionalize/co-opt them [79,128–131]. The notion of 'anchoring' is similar to that of 'bricolage' [132], a process that allows the integration of heterogeneous elements and collaboration between different actors that wish to foster transition [99]. Transition in the lens of 'bricolage' thinking becomes a continuous process of learning-by-doing and adjustment based on interactions between the different involved actors, so incremental/evolutionary rather than radical/revolutionary change.

While many scholars suggest that some compatibility between the practices and visions of the niche and the regime is necessary to have a successful niche-regime anchoring/linking [16,49,54,85,109], Bui et al. [66] point out that niche and regime actors can link even if they have radically different visions about sustainable agriculture and food. Referring to agroecology, Isgren and Ness [78] stress that it is tension with regime rules and institutions that shape and define the transformative potential of a niche; "agroecology would not be a niche with transformative potential unless it was somehow in tension with an existing socio-technical regime or competing transition pathways" (p. 14). Feyereisen et al. [99] elaborate on linking mechanisms and suggest that "... transition is a two-dimensional process through which the trajectories of niches and regimes evolve and reciprocally influence one another" (p. 299).

Linking mechanisms can even include that niches receive support from regime actors e.g., care farming niche was supported by the Ministry of Agriculture (agriculture regime) and the Ministry of Health Care (care regime) in the Netherlands [88]. In fact, while the most common niche-regime relation is competition, there is a growing body of literature that points to the possibility of having productive alliances and collaborations between socio-technical regimes and niche-innovations [133–135]. Isgren and Ness [78] link potential niche-regime cooperation to funding strategies and put that "the way that both niche and regime actors scramble for resources (but largely from different sources) enables them to coexist, and even pragmatically cooperate" (p. 14). Nevertheless, linking with the regime is not always an indicator of niche empowerment as it may simply mean that "actors in ... niche depend on the regulatory, economic and technical elements within the dominant regime" (p. 399) [53]. Ingram [105] recommends to go beyond the analysis of niche-regime linkages in transition studies and argue that "rather than envisaging linkage between a hierarchy of levels analysis needs to look at the connections between a novelty and its setting, whether this setting is niche or a regime" (p. 73).

Bui et al. [66] compare four case studies in France: a community procurement platform (Agricourt), a farm incubator (Les Compagnons de la Terre), an AMAP (Association pour le Maintien de l'Agriculture Paysanne cf. community-supported agriculture) and a community organization for water quality preservation (Aqui'Brie). They investigate both niche development trajectories and niche-regime interactions, and suggest that niche activities would, ideally, enrol new actors thus leading to a gradual reconfiguration of the local agro-food regime through two mechanisms viz. construction of a new vision of local agro-food system shared by the network of relevant actors, and embedding of the new shared vision in the agro-food regime through local public action and policies. What is clear is that the dynamics as well as the outcomes of niche-regime interactions are context-specific. Therefore, Slingerland and Schut [108] pinpoint that "... structural conditions can be both enabling and constraining for transitions and ... niche-regime interactions need to be understood in the context of specific country objectives" (p. 7558). Structural and context-related conditions include infrastructure, policies, institutions, actor networks, capabilities and resources (financial and human).

To et al. [71] show that governance structures and institutional context are crucial in successfully managing transitions towards sustainability. Transitions require multi-actor collaborations and partnerships, as between the government and sugar processing industry in Mauritius; that allowed

a successful development of bagasse niche through vision articulation, social network building and learning. However, referring to the strategy of collaboration with the government and the extension system, Järnberg et al. [94] warn that “while this strategy offers the possibility of a direct impact at potentially large scale, it also leads to a range of trade-offs for the green niche actors and ultimately reduces the prospects for a sustainable agricultural transformation” (p. 409). The reviewed papers also highlight that sustainability transition is a negotiation process [99]. This is due, among others, to the fact that there are different interpretations and understandings of sustainability values and principles. Referring to fair trade milk in Belgium, Feyereisen et al. [99] point out that “... fairness is often a matter of divergent interpretations, and its final actualisation is the product of emergent and negotiated relations” (p. 297). Collaboration, and eventually negotiation between actors from the niche and the regime, can take place in different settings such as innovation platforms, which allow for collective action and interaction between different stakeholders (e.g., farmers, researchers, policy makers, donors) [104].

The diversity of normative interpretations of sustainability and visions of the different actors involved in the dialectic relations related to sustainability transitions processes brings into play the process of legitimization [136]. Different strategies and activities are used in niche legitimization processes. Referring to care farming sector in the Netherlands, Hassink et al. [89] argue that “media exposure, contacts with ministries and politicians and the development of a quality system have contributed to the legitimacy of the sector” (p. 1). However, the regime can use different strategies to face the increasing legitimacy of niches. Referring to the British context, Marsden [91] highlights that “... the dominant food regime begins to espouse and appropriate some sustainability principles as it develops the capacity to absorb the landscape pressures before it, and the increased vibrancy and legitimacy of niche innovation below it” (p. 132). This might explain why ‘productivist’ agriculture socio-technical regime conserves its legitimacy, as argued by Santhanam-Martin et al. [58]; “... while scholarly and activist discourse labels productivist agriculture as fundamentally unsustainable, it nevertheless continues to be viewed positively by community members and policy-makers alike in discussions about community sustainability” (p. 216).

The selected research articles also address transition pathways resulting from niche-regime-landscape interactions. Hassink et al. [88] suggest that the development of care farming in the Netherlands has followed a de-alignment and re-alignment pathway; “... a de-alignment/re-alignment pathway was initiated, in which the de-alignment of the agricultural and care regimes, especially since around 1980, was followed by a re-alignment in the past twenty five years” (p. 191). However, the transition pathways proposed in the literature [37] seem inadequate for the agro-food sector. In this regard, Vlahos et al. [86] refer to a pluralistic pattern of change and point out that very often various transition paths unfold simultaneously rather than a single transition pathway. Feyereisen et al. [99] question the conceptualisation of transition as a regime shift and put that “transition is thus not the business of radical or alternative niches that operate beneath the system in order to suddenly replace it” (p. 299). Likewise, Ingram et al. [16] point out that “... the transition to sustainable agriculture might be understood as a complex of interactive processes leading to a series of adaptive changes, rather than as regime change” (p. 55). This resonates well with a more nuanced conceptualisation of transition presented recently by Geels [137] that suggests to move from “bottom-up disruption (driven by singular niche-innovations) to gradual system reconfiguration, which represents a more distributed, multi-source view of change” (p. 86). Audet et al. [65] question the adequacy of the typology of transition pathways in the MLP for social innovations as in these pathways “... niches impact the dynamics of transition to the extent that they are ‘sufficiently’ or ‘insufficiently’ developed, which does not account for the diversity in the types of niche innovations (social or technical), their various organizational forms or their heterogeneous strategies” (p. 4). Davidson et al. [53] point out that the patterns of changes induced by disruptive events (e.g., mad cow disease) are difficult to predict and to associate to a predefined transition pathway. Elzen et al. [54]

argue that it is difficult to discern a single transition path in transitions ‘in the making’ as multiple transition pathways are often pursued simultaneously by different niche actors and social groups.

3.4. Assessment of Transition Impact

As Schöpke [138] suggests recently, there is “an underlying tension in sustainability transitions research: between transitions as an open-ended process of fundamental change and the normative direction of this change: sustainability”. This tension is also reflected in research on agro-food sustainability transitions using the MLP.

The impact of transition is related to whether the niche succeeds in solving the pressing problems that led to its emergence such as eutrophication [109], water pollution [66], mad cow disease [53], food insecurity [82,94], food wastage [72], industrial mass production in pig farming [54]. For instance, extensive farming developed in Brittany (France) as a reaction to the persistent environmental problem of algae blooms witnessed in the region since the 1970s due to intensive agriculture [109]. Audet et al. [65] highlight that seasonal food markets tackle important issues such as food security. Jurgilevich et al. [72] consider local food systems as niches and highlight that “sustainability and food security are enhanced in localized food systems through specializing in regional products . . . ” (p. 9). Lutz and Schachinger [73] highlight environmental (e.g., low food miles and packaging), social (e.g., reconnecting producers and consumers) and economic (e.g., high prices for producers) impacts of a local food network (SpeiseLokal) in Austria. While most of the selected articles start from the transition and then analyse, eventually, its implication in terms of sustainability, Morrissey and Dunphy [106] focus on sustainability assessment across the value chain and the role that it can play in sustainability transitions journeys. What is clear is that the understanding of sustainability affects not only the selected transition pathway(s) but also the assessment of the impacts of any change or transformation in the agro-food system [6,139,140].

In general, papers using the MLP provide no detailed, quantitative (cf. indicators) assessment of transition impacts and overlook sustainability-related normative issues. However, there are some exceptions; for instance, sustainability-related normative issues (e.g., animal welfare) are central in the analysis of transition-in-the-making in Dutch pig husbandry performed by Elzen et al. [54]. Some scholars are aware of the need to assess also quantitatively the impacts of transition; for instance, Jurgilevich et al. [72] suggest that “whereas it is difficult and ambiguous to measure how the experiments influence the whole system, it is still possible to look at some indicators” (p. 11). Nevertheless, it can be argued that the selected papers are more concerned about transition processes and dynamics and do not elaborate enough on the ‘sustainability’ component of ‘sustainability transitions’. However, this problem is not specific to research on agro-food sustainability transitions using the MLP. In fact, as Truffer and Markard [18] point out, the normative aspects are not elaborated explicitly enough in sustainability transitions research field, which does not always answer the question of what is ‘sustainable’ in transitions. Also, Bush and Marschke [57] argue that the MLP does not address appropriately the politics of normative policy decisions of transition and the ‘by whom’ and ‘for whom’ questions. Vivero-Pol [92] stresses that “ . . . the normative consideration of food shapes the priorities for action (political attitude) and, to a certain extent, specific food policies we support/accept (preferred policy beliefs)” (p. 16). Crivits and Paredis [68] put that “although we adapted the concepts of niche and regime practices in order to compare different interactions with the food system, we do not wish to make any conclusive statements about which practice is more sustainable” (p. 329). Pitt and Jones [69] also highlight neglect of transition outcomes in the field and point out that “ . . . scholars of food system transitions . . . have been guilty of calls for scaling without explaining why this is desirable, or precisely what should be scaled: actors, programmes, practice or outcomes? This risks the aspiration to scale an innovation becoming a goal, driving transfers irrespective of the likelihood of beneficial outcomes” (p. 13).

3.5. Critiques of the MLP and Proposals for Improvement

3.5.1. Critiques to MLP

The MLP was criticized for its conceptualisation of agency, politics and power; superficial regimes specification; bias towards bottom-up change; vague role assigned to landscape [22,27]. Moreover, some scholars highlight its inadequacy for understanding agro-food sustainability transitions in some specific contexts. In particular, many scholars criticize the over-simplistic and clear-cut distinction between niche, regime and landscape elements in the MLP as well as how they are conceptualised. In fact, Vlahos et al. [86] question “... clear-cut analytical separation between the three levels of the multi-level perspective, as well as the relevance of a bottom-up procedure as a prerequisite for niche emergence vis-à-vis policy induced change” (p. 43). Also Davidson et al. [53] call for some caution regarding the divisions between niches and conventional regimes as most of the actors in the alternative beef production chain operate between alternative and conventional systems.

Audet et al. [65] point out that while the MLP suggests that transition would depend on the protection of niches that face the agro-food regime, the seasonal food markets in Montreal do not fit in this portrait as they evolve at the intersection of the regime and the innovative niche i.e., it is difficult to protect seasonal markets as an entity as they are subject to regime rules. This is in line with the suggestion of Lutz and Schachinger [73] that, referring to niche-regime-landscape interactions in local food networks, put “... niche-innovations do not develop and evolve isolated from and untouched by the regime’s and landscape’s dominant practices, technologies, rules, and structures. Rather, socio-technical regimes, landscapes, and niche-innovations can be seen as co-evolving and potentially competing or even colliding into one another” (p. 4783). The MLP seems more appropriate to analyze technical innovation based-transitions than social innovation processes in the agro-food system.

It is also difficult to assign the different elements to niche, regime or landscape. For example, Feyereisen et al. [99] consider “the Belgian dairy system as being the socio-technical regime, the fair trade milk label as the niche innovation, and the Common Agricultural Policy (CAP) and the market rules as the socio-technical landscape” (p. 299). However, other scholars assign policy and market elements to the socio-technical regime. This also shows that the geography of the different levels of the MLP—that is somehow related to the permeability of the boundaries of the three elements of socio-technical systems—needs further operationalization and refinement. For instance, it is not clear why one considers local policy as part of the regime and includes national policy in the landscape.

It is widely assumed that niche has potential to foster wide transformation or reconfiguration of the dominant regime, but Bui et al. [66] highlight that the MLP does not allow elucidating the mechanisms through which niches contribute to regime reconfiguration. Also To et al. [71] highlight that “more research is needed to illuminate the mechanisms by which policy innovations influence changes at the regime and niche levels in a developmental state. These future mechanisms need to be considered under different institutional environments, levels of capacity and development models” (p. 76). Ingram [84] argues that the role knowledge plays in niche-regime interaction has yet to be fully explored in transition literature. Isgren and Ness [78] add that the notion of regime in the MLP requires further elaboration as “it offers analytical breadth more so than depth and there is ambiguity regarding some dimensions, particularly ‘culture’” (p. 14).

Lawhon and Murphy [112] express four critiques to the MLP regarding the way the heuristic framework addresses political and social relations, participation, power and geography. Referring to the MLP, Hassink et al. [88] argue that “... several aspects need more attention like agency, interactions across system boundaries and multi-regime interactions” (p. 186). Agency seems to be one of the major weaknesses of the MLP. In fact, many scholars call for more room for agency in the heuristic framework [67,78,87,88,92]. Stahlbrand [67] and Isgren and Ness [78] stress the important role of civil society in food sustainability transitions. This is consistent with the critique addressed by Hargreaves et al. [141] that the MLP tends to neglect civil society actors while focusing on market ones (e.g., producers). Stahlbrand [67] also points to the essential contribution of public institutions.

Konefal [90] argues that the MLP under-theorizes the role of governance in sustainability transitions and highlights “... the need for the MLP to incorporate analysis of governance processes and ways that politics and power operate in them into its framework” (p. 629). The author shows how different multi-stakeholder initiatives—that dealt with the development of sustainability metrics in agriculture—have contributed to the conservation of the agricultural regime in the USA and points out that “... governance processes may channel sustainability transitions towards the interests of regime actors” (p. 629) or, even, be used as a means for niche co-optation [90]. Relatedly, Stahlbrand [67] argues that “... agency in food system work goes beyond a supporting or aligning role and proactively initiates regime change” (p. 3).

3.5.2. Integration of the MLP with Other Transition Frameworks and Research Disciplines

Many scholars highlight the need for integrating transition frameworks to better understand sustainability transitions processes [45,142–145]. In fact, synthesizing transition approaches and frameworks allows for benefiting from their respective strengths.

The selected research articles offer different combinations of transition frameworks: MLP and SNM [69,70,98,108], MLP and social practice approach [6,68,110]. Socio-technical systems are intertwined with social practices [27,110,144]. Therefore, the MLP is increasingly complemented with other approaches that give more importance to social factors in sustainability transitions such as the Social Practice Approach (SPA). In fact, Geels [27] suggests that the concepts ‘routinized practices’ in the SPA and ‘regimes’ in the MLP are similar. Likewise, Hinrichs [6] identifies SPA and MLP as two main approaches in sustainability transitions research field and argues that “taken together, these approaches offer different and useful ways to think about the dynamics, durability and significance of innovations in food and agriculture, and the part they play in transitions to sustainability” (p. 143). Crivits and Paredis [68] combine the concept of ‘practice’ (cf. SPA) with that of ‘niche/regime’ (cf. MLP) to develop an ‘applied practice approach’ that led to distinction between ‘niche practice’ and ‘regime practice’ in relation to food purchase. They argue that “this re-combination adds to the field of applied consumption research and describes consumption beyond the boundaries of individualist and structuralist models, as well as integrates a conceptualization of the a-linear reproduction of aligning and competing consumer practices” (p. 306). In fact, the authors consider “... consumption as a dynamic practice in which the individual behaviour is but one (albeit crucial) factor interrelating with a material-functional and socio-cultural structure” (p. 329–330). Also Hargreaves et al. [110] identify many crossovers and intersections between regimes (cf. MLP) and practices (cf. SPA) and recommend integrating both approaches to better comprehend transition processes. They go even further and argue that “... analyses that adopt only one of these theoretical lenses risk blindness to critical innovation dynamics” (p. 402). The integration of both frameworks allow an understanding of the transition as both change in socio-technical regimes and routinized practices. Wiskerke [70] and Pitt and Jones [69] refer to both SNM and MLP. Pitt and Jones [69] analyse scaling up and out processes as a form of policy transfer, which is crucial in food sustainability transitions. Wiskerke [70] explores the development and stabilisation of the Dutch wheat regime and the emergence dynamics of a sustainable cultivation system of baking wheat (*Zeeuwse Vlegel*).

The MLP is also increasingly complemented by other research methods and approaches. For instance, Diaz et al. [109] combines the MLP and an Actor Network Theory-based approach to analyse dialectical relations between extensive farming niche and intensive farming regime that is held responsible for algae blooms in Brittany (France). The use of the actor network theory (ANT) allowed for a better analysis of the dynamics of the evolution of the network around the niche since the 1970s. Likewise, Zwartkruis et al. [97] integrate the perspective of the MLP with those of integrated assessment modelling (IAM) and initiative based learning (IBL) to analyse the dynamics of land use in the Netherlands and especially the agricultural nature conservation role in shaping these dynamics. Bui et al. [66] combine the MLP with some elements from the French pragmatic sociology, and argue that “this combination makes it possible to take advantage

of the analytical perspective of transition studies while at the same time addressing some of their weaknesses by focusing specifically on changes in practices, actors' networks and visions" (p. 102). Bush and Marschke [57] compare resilience thinking with agrarian change approach and transitions theory (cf. MLP) and suggest that "social theories such as agrarian change and transition theory should be seen as complementary" (p. 1) to resilience approach. Duru et al. [81] articulate the conceptual frameworks of socio-ecological systems, farming systems and sociotechnical systems in an 'interdisciplinary multilevel conceptual framework' that can guide the strong 'ecologization' of agriculture at territory level. Hassink et al. [89] use the MLP with concepts from organizational ecology as well as social movement theory to interpret and contextualize the development of care farming in the Netherlands. Elzen et al. [54] enrich the MLP with insights from political science and social movement theory to explore normative contestation in the Dutch pig farming. Järnberg et al. [94] combine insights from socio-technical transitions (cf. MLP), social-ecological transformations and institutional entrepreneurship to analyse transformation of Ethiopian agriculture. These examples clearly show that there is a host of opportunities for cross-fertilisation between the MLP and other scientific approaches and theories that can allow for further refinement and operationalization of the heuristic framework.

4. Conclusions

To the best of my knowledge, this is the first paper that reviews in a systematic way the use of the multi-level perspective in research on agro-food sustainability transitions. It shows that the research field focuses on crop production; agriculture subsectors such as animal production and fisheries are underserved. It also mainly addresses the production stage of the food chain; food processing, distribution and consumption stages are underrepresented. Moreover, the research field is still North-biased and largely dominated by Dutch and British scholars and research institutions; countries of the global South are largely underserved.

The MLP is now a prominent framework in the agro-food sustainability transition research field, but it is increasingly complemented with other transition approaches and research methods. This was also a reaction to address some weaknesses of the MLP when it is used in the agro-food arena. In general, research on transitions in the agro-food sector borrows from the MLP its poor theoretical conceptualisation and empirical operationalization of the concepts of niche, regime and landscape. However, agro-food scholars that used the MLP made significant efforts and different adjustments to adapt—both conceptually and empirically—niche, regime and landscape elements to the agro-food sector in order to accommodate its peculiarities with respect to energy and mobility sectors. Despite that, some further conceptual and methodological work needs to be done to make the MLP fit-for-purpose, not only for the analysis of transition dynamics, which is a strength of the heuristic framework, but also transition pathways and sustainability impacts in the agro-food arena.

The way forward for research on agro-food sustainability transitions implies a deeper understanding of different socio-technical system levels and landscape-niche-regime interactions. Meanwhile, the research field needs to open to other disciplines. The challenges in the use of the MLP in the study of agro-food sustainability transitions calls for conceptual refinement, while recognizing the diversity of approaches and pathways of transitions to sustainable agro-food systems and their interaction with local contexts (environmental, social, economic, political and institutional). Integrative conceptualization, framing and operationalization of the MLP elements is required given the complexity of sustainability transitions processes and dynamics in the agro-food sector and should contribute to achieving the objectives of understanding and fostering transitions. Therefore, more multi- and trans-disciplinary research is required on the MLP's applicability in understanding, nurturing and managing transitions towards sustainability in the agro-food system, in developed and developing countries alike.

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