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Bibliographical reference
Da Costa, I., Bui, S., De Schutter, O., and Dedeurwaerdere, T. (2022).“A network perspective to niche-regime interactions and learning at the regime level”. *Environmental Innovation and Societal Transitions*, Vol. 43, pp. 62-79.
https://doi.org/10.1016/j.eist.2022.03.001

Environmental Innovation and Societal Transitions 43 (2022) 62–79

Contents lists available at ScienceDirect

Environmental Innovation and Societal Transitions

journal homepage: www.elsevier.com/locate/eist

A network perspective to niche-regime interactions and learning at the regime level

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ARTICLE INFO

Classification codes:
D83
Q01
O13
O33
L81
L14
L16

Keywords:
Sustainability transition
Regime learning
Niche-regime interactions
Multi-stakeholder learning
Corporate retailers
Local products

ABSTRACT

This study proposes an analytical approach to niche-regime-interactive learning, taking an inter-organisational-network-learning perspective. This approach is illustrated empirically with a network-learning episode in which several actors engage with each other for the marketing of local products in supermarkets. Its novelty is two-fold: 1) it integrates the notion of learner levels into the MLP, differentiating between learning-in and -by regime; 2) it proposes a different understanding of learning loops than usually found in ST studies, by considering them as encompassing both processes and outcomes. The paper makes both theoretical and empirical contributions: 1) it helps to elaborate multi-stakeholder learning; 2) it enables capturing learning dynamics within and between sub-system and system levels; 3) it helps to elucidate knowledge-power issues learning is subjected to; 4) it elucidates the value of this network perspective empirically, illustrating its descriptive and explanatory power in helping to further the knowledge on learning at the regime level.

1. Introduction

Inherited socio-technical systems have been challenged due to their negative environmental, socio-economic and health impacts. There is a widespread consensus that profound transformations are needed in the way those systems fulfil societal functions if they are to be truly sustainable (e.g De Schutter, 2017 and Ingram, 2018 for the agri-food system).

Sustainability transition scholars refer to such transformations as socio-technical transitions or system innovations. The multi-level perspective (MLP) on sustainability transitions (ST[1]) (Geels, 2002; 2011), a prominent framework in this field, describes transitions in terms of three analytical levels: "regimes", as the dominant, highly institutionalised and stable set of technologies, structures, rules, practices and underlying assumptions of socio-technical systems, supported by large networks of incumbent actors; "niches", as small networks of actors, developing radical innovations on the margins of regimes; and "landscape", as the wider political, social, economic and cultural environments in which regimes and niches are embedded. Transitions correspond to systemic, structural changes at the

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[1] Other, non-standard, abbreviations used through out the manuscript: Social Learning (SL); Single-Loop Learning (SLL); Double-Loop Learning (DLL); Triple-Loop Learning (TLL); Individual Learning (IL); Group Learning (GL); Organisational Learning (OL); (inter-organisational) Network Learning (NL); Local Product (LP); Hainaut Développement (HD); Made in Brabant Wallon (Made-in-BW); Local-Action-Group *Culturalités-en-Hesbaye-Brabaçonne* (LAG-CHB).

https://doi.org/10.1016/j.eist.2022.03.001
Received 16 June 2019; Received in revised form 4 March 2022; Accepted 4 March 2022
Available online 20 March 2022

regime level, implying a co-evolutionary reconfiguration of various aspects of an incumbent regime, including its cultural elements (e.g. values, beliefs, worldviews) (Avelino and Rotmans, 2009; Geels, 2002, 2011; Ingram, 2018; Kemp et al., 1998, 2007).

There is a general consensus in the field that transitions involve different concomitant, long-term, open-ended, non-linear processes, characterised by the interplay of several developments and complex dynamics among multiple stakeholders from the different levels, and thus marked by a high level of uncertainty (Elzen et al., 2012; Ingram, 2018; van Mierlo et al., 2020; van Poeck and Östman, 2021). Multi-stakeholder learning is commonly acknowledged as one of those processes, inasmuch as it may help to overcome a critical obstacle to successful transitions: the various technological, organisational and institutional lock-in and path-dependence mechanisms at work in incumbent regimes (Elzen and Barbier, 2012; Loorbach et al., 2009; van Poeck and Östman, 2021). Such mechanisms are often regarded as being tied to the predominance of "first-order learning" at the regime level (Kemp et al., 1998, 2007; Ingram et al., 2015; van Mierlo et al., 2020). Focused on performance and technical efficiency, first-order learning contributes to the prevalence of rather superficial, incremental changes at this level. Learning of that sort in fact helps to sustain the dominant technological paradigms, and leaves basically untouched the configurations and alignments of cognitive and normative elements that guide actions and interpretations of regime actors (Geels, 2004; Ingram, 2018; Smith et al., 2005, 2010). Therefore, it is often claimed that the driving force for the shift of an incumbent regime towards sustainability is likely to come from niches, which are regarded as "protected learning" spaces, where experimentation and radical innovations addressing problems of an existing regime could flourish and develop through "second-order learning" (Geels, 2011; Geels and Schot, 2007; Ingram, 2018; Kemp et al., 2007; Smith, 2007). By involving deeper reflection about a regime's basic architecture, second-order learning at the niche level may contribute to bring about the more profound regime changes required for STs (van Mierlo et al., 2020; van Poeck and Östman, 2021).

Despite being critical for transitions, multi-stakeholder learning involving niche and regime actors is only vaguely defined and operationalised in most studies in this field (Marques et al., 2012; van Mierlo et al., 2020). Some contributions provide useful insights on niche-regime interactive learning, however. They include: Smith (2007) on socio-technical translations between niches and regimes; Bui et al. (2016) on enrolment processes and the mechanisms through which changes in visions occur at the interplay between niches and regime, leading to a regime reconfiguration; Loorbach et al. (2009) on business strategies, multi-stakeholder processes and transitions; Elzen et al. (2012) with the concept of anchoring for looking at the linking processes between regimes and niches; Ingram et al. (2015) on niche-regime compatibility; and Ingram (2018) on boundary dynamics between regimes' and niches' knowledge systems. Yet, except for Ingram (2018), who frames her analysis from a knowledge perspective (with learning being understood as knowledge development), these studies focus on aspects of niche-regime interactions other than learning, which is considered only indirectly. For example, Smith (2007) relates translations to learning outcomes only implicitly, as he eventually refers to them as first- or second-order learning, lessons, or translations; and Bui et al. (2016) make no reference to learning at all. Moreover, in line with a general orientation in ST studies towards niches (Geels, 2018), these contributions concentrate largely on developments at this level (Elzen and Barbier, 2012; Smith, 2007), overlooking the regime (except for Loorbach et al., 2009).

Yet, if indeed niche-regime interactive learning is acknowledged as one of the key processes for achieving (at least some of) the structural transformations implied by a regime shift, gaining a better knowledge of learning at the regime level, particularly in the context of interactions with niches, seems crucial. This paper aims to shed some light on this matter. To that end, it develops and tests an analytical approach to niche-regime interactive learning, based on insights from scholarly works on organisational and network learning, two well-established learning fields from organisational behavioural studies, yet loosely applied or utterly neglected by transition scholars (van Mierlo and Beers, 2020). More specifically, the paper combines the social learning theories of action and the concepts of learning loops (Argyris and Schön, 1978), with the concept of inter-organisational network learning and the notion of learner levels (Knight, 2002; Knight and Pye, 2004; Knight and Pye, 2005). It then integrates these theories into the MLP, distinguishing between learning-in and learning-by socio-technical systems: while *learning-in* corresponds to learning within sub-sets of actor networks of a socio-technical system, *learning-by* corresponds to learning spread across a regime as a whole.

This network perspective to learning in socio-technical systems is illustrated empirically with a case from the Belgian agri-food system, in which various stakeholders (e.g. corporate retailers, small-scale-local producers, public authorities) engage with one another for the marketing of local products (LPs) in supermarkets, leading to the development of a LP network in the country. Although the local producers participating in this network episode cannot be regarded as a niche *per se*, this case is relevant for testing the proposed network-learning approach as it exhibits some key features associated with niche-regime networks (e.g. involving both non-mainstream actors and regime organisations with well-established business models; power imbalances; lock-in effects; experimentation with innovative rules and practices that contrast with traditional ones). A key empirical question is whether interactions and developments related to this Belgian LP network were limited to the sphere of the LP network, involving solely the actors participating in this learning episode (i.e. sub-system level learning), or instead, whether they went (or had the potential to go) beyond learning situated within the LP network, engendering learning across the Belgian agri-food regime as a whole (i.e. system level learning).

The paper is organised as follows Section 2. develops the analytical approach and its conceptual elements; it makes the case for an inter-organisational network perspective to socio-technical system learning Section 3. presents how this approach is applied to the analysis of learning related to the Belgian LP network Section 4. presents and discusses the key findings from this learning episode Section 5. concludes.

2. Learning in sustainability transitions from a network perspective

2.1. Learning in STs and niche-regime interactive learning

Transition scholars addressing learning in STs have frequently borrowed insights from other well-established learning concepts and

theories, including in particular the literature on social learning (SL) in natural resource management (van Mierlo and Beers, 2020). SL is commonly defined as an interactive process, involving multiple, heterogeneous stakeholders producing new shared knowledge and meanings, which may lead to joint actions (Beers et al., 2016; Ingram et al., 2015; Loorbach et al., 2009; van Poeck et al., 2020; van Mierlo et at., 2020).

The main criticisms addressed to studies on SL relate to a lack of conceptual clarity and comprehensive empirical analysis, which would limit their ability to capture the complexity of SL in transitions[2](Armitage et al., 2008; Beers et al., 2016; van Poeck et al., 2020). This is in part due to the rather unconnected and superficial way learning theories borrowed from other fields are applied in transition studies (van Mierlo and Beers, 2020). For example, the concepts of learning loops from organisational learning studies are usually applied to describe first- and second-order learning outcomes (van Mierlo and Beers, 2020), without much elaboration on how they relate to multiple-loop processes. The literature on learning in STs has also been criticised for its focus on learning impacts or outcomes, with little attention to SL processes; and for entertaining confusion between learning processes and outcomes. This links to a blurred line between the phenomena of learning and societal changes that impedes a proper understanding of how the two phenomena relate to one another[3] (Armitage, et al., 2008; Beers et al., 2016; van Poeck et al., 2020). Moreover, it is often ignored that changes may result from other factors rather than learning (van Mierlo et al., 2020). As well observed by van Poeck and Östman (2021:156), "*authors sometimes treat both elements* [learning and change] *as synonyms or take for granted that societal change is the result of learning, thereby ignoring other potential factors*." In addition, there seems to exist certain ambiguity between SL and the mechanisms through which it occurs, particularly interactions amongst stakeholders (Armitage, et al., 2008; Beers et al., 2016). In fact, the dynamic interplay between all the different factors and mechanisms influencing learning, and its effects on SL processes and outcomes has been largely ignored (Van Poeck et al., 2020).

Some recent contributions raise these criticisms, and offer insights into how to bridge related conceptual and empirical gaps Van Poeck and Östman (2021:158) regard learning *"(…) as a continuous process of doing and undergoing* [reflection] *the consequences of actions that takes place through encounters between persons and their (social and material) environment*." The papers presented in a Special Issue of the Environmental Innovation and Societal Transitions describe learning in transitions as *"a process of acquiring and generating new knowledge and insights, and of meaning-making of experiences in communicative interaction, in a reciprocal relationship with the social, (bio-)physical and institutional context*", seeing it as *"a non-linear, iterative process in which ideas and possibilities for collaborative action are being developed, experimented with and pursued in a diversity of networks*" (van Mierlo et al., 2020:253). However, although these more elaborated definitions of learning in STs include expressions such as "*encounters*", "*communicative interaction*", or "*collaborative action*", niche-regime-interactive learning remains a rather neglected issue. For instance, van Poeck and Östman (2021) illustrate their analytical framework with a niche experimentation; and although one of the contributions (van Mierlo and Beers, 2020) to the Special Issue examines how organisational learning along with three other learning traditions could be "*helpful for opening up the black box of learning in transitions*", and acknowledges its value for investigating learning in socio-technical regimes, none of the five contributions to this Special Issue look at niche-regime interactive learning or learning at the regime.

Niche-regime interactions are only implicitly included as a learning setting in ST studies, normally referred to as transition initiatives or experiments. Learning at the regime level is mostly ignored, with niche experiments alone being considered as the key *locus* for learning. Studies on niche-regime interactive learning are scarce, with little being known on whether/how niche experiments can influence learning at the regime level. Some transition scholars seem to assume that successful niches will surely help to overcome regimes' lock-in mechanisms; others instead consider that, though crucial, successful niches alone are unlikely to disrupt regimes and foster their shift towards sustainability (Geels, 2011; Smith, 2007; van Poeck et al., 2020).

It is widely acknowledged that truly collaborative learning involving regime and niche actors will face various challenges related to, for example, mistrust, power differentials[4], competing worldviews, and conflicting knowledge and cultural systems (Armitage et al., 2008; Ingram, 2018). Yet, little is said on how to address those challenges. Some contributions on SL in transitions from educational science, though not specific about niche-regime interactions, do provide insights on how to address some of the challenges to niche-regime collaborative learning Van Poeck et al. (2020). and van Poeck and Östman (2021) propose an analytical framework to learning in ST initiatives that allows investigating how SL emerges from interactions in contexts of pluralism and dissonance; Beers et al. (2016) integrate processes and outcomes, and define social learning in STs *"as a process of generating new knowledge that takes place in communicative interaction (turns of communicative actions and reactions)"*. Yet, such contributions still emphasize individual learning in contexts of interaction and collaboration among "people", with little elaboration on niche-regime interactive learning or when the "learner" is a regime organisation or network, rather than an individual.

2.2. SL in organisational and network learning studies

Organisational learning (OL) is a well-established scholarly research field that offers rich contributions to conceptualise and

[2] A comprehensive review of those criticisms is beyond the scope of this paper. For overviews **see**: Armitage (2008); Beers et al. (2018); Reed et al. (2010); van Mierlo et al. (2020); van Mierlo and Beers (2020); van Poeck et al. (2020); van Poeck and Östman (2021).

[3] We are grateful to an anonymous reviewer for highlighting this point. Though recognising learning and change as two distinctive (yet interconnected) phenomena, an in-depth discussion about learning and change would be beyond the scope of this paper. For an in-depth discussion about this critical issue in learning in STs **see** van Poeck et al. (2020); van Poeck and Östman (2021); and for a discussion on the links between network learning and network change **see** Knight and Pye, 2004.

[4] For a comprehensive discussion on power (and knowledge) in the context of STs **see** Avelino and Rotmans (2009) and Avelino (2017).

investigate learning in business organisations. It addresses issues such as how companies interact and learn together, how they respond to pressures and tackle problems related to unsustainabilities of their industries, and how they adjust in order to meet expectations about their roles and responsibilities in society (Antal and Sobczak, 2014).

This paper proposes combining insights from two OL approaches,: 1) the SL theories of action and the concepts of learning loops; and 2) the inter-organisational network learning, and the notion of learner levels. While the former has been applied in studies on SL and transitions (**see** Sections 1 and 2.1), the latter has never been systematically applied (to the authors' knowledge at least) in conceptual or empirical works in the field.

2.2.1. Learning loops

As in other learning traditions, the academic debate on OL is closely related to organisational change and to the very concept of knowledge. It is widely accepted that OL is a collective, relational and consensual process of knowledge creation, dissemination, interpretation and integration, through which organisational change can take place (Argote, 2013; Tosey et al., 2011; Tsoukas and Vladimirou, 2005).

In their seminal work on learning in organisations, Argyris and Schön (1978) conceive SL as based on three elements - governing values, action strategies and consequences, which together help to explain the links between cognition and actions. Actors design their "action strategies" to satisfy goals and operationalise beliefs according to "governing values". "Consequences" are the outcomes of the action strategies, which may be intended, when there is a match between outcomes and governing values; or unintended, when there is a mismatch between them.

Learning occurs precisely as response to those mismatches, as actors continuously loop back and forward between different action strategies, implying learning follows a circular logic and has a non-linear nature. Argyris and Schön identify single and double-loop learning as two possible responses, corresponding to two different learning approaches. Building on these concepts, OL scholars have proposed a third approach referred to as triple-loop learning (Tosey et al., 2011). Each loop involves different levels of reflexivity and particular ways of prioritising issues when making choices about the action strategies (Flood and Romm, 1996).

Single-loop learning (SLL) is a rather non-reflexive approach, focused on searching for alternative action strategies that best meet particular ends defined according to existing governing values (Flood and Romm, 1996; Tosey et al., 2011). This task-oriented, means-end thinking can only contribute to changes in action and behaviour, implying SLL is an adaptive or corrective learning approach, related to continuous improvements on efficiency and performance of what is already done, contributing to stability in practices and routines (Argote, 2013; Flood and Romm, 1996; Mariotti, 2012; Tosey et al., 2011). In transition studies, SLL (referred to as first-order learning) is associated with the predominance of incremental, superficial changes at the regime level, which leave the regime's basic architecture essentially intact (e.g Ingram, 2018; Smith, 2007; van Mierlo and Beers, 2020; van Poeck and Östman, 2021).

Double-loop learning (DLL) involves inquiring not only about "*how*" to improve what is already done, but also about "*what*" should actually be done (Flood and Romm, 1996:594). DLL involves debating on governing values, meaning that responses to mismatches between intentions and outcomes may go beyond the search for alternative action strategies to meet desired ends and satisfy dominant governing values, by also bringing into question and eventually altering those values (Argyris, 2008; Tosey et al., 2011). Thus, DLL is a rather transformative learning that may contribute to more fundamental changes than SLL (Argyris, 2008). Likewise, transition scholars often associate DLL (referred to as second-order learning) with radical innovations at the niche level, and hence with the deep, profound learning implied by STs. Inasmuch as DLL challenges dominant, fundamental values and framing assumptions, it may help overcoming lock-in and path-dependence (van Mierlo and Beers, 2020), and significantly affect not only regimes' established practices and routines, but also cognitive and normative elements guiding regime actors' actions and interpretations.

Triple-loop learning (TLL) incorporates the further and more fundamental inquiry at to "*why*" what is already done should actually be done at all; thus introducing concerns about the power-knowledge dynamics affecting SL (Flood and Romm, 1996). Indeed, as sense-making processes are guided by dominant governing values (Holmqvist, 2003), DLL is likely to be subjected to coercive forces, resulting in partial reflexivity (Flood and Romm, 1996). By contrast, TLL involves reflection on the diversity of issues and dilemmas intrinsic to SL, and on the alternatives to address them (Flood and Romm, 1996; Tosey et al., 2011). By challenging what is taken into account in prioritising processes, TLL may contribute to more transformative outcomes than the other two learning approaches. In a context of niche-regime interactions, marked by power imbalance, dominant regime organisations are likely to determine the way issues are prioritised according to their own governing values, practices and experiences, controlling the nature of what is learnt, and where and how learning should take place. Natural resource management scholars such as Reed et al. (2010:5) have a similar understanding of the critical role power relations play in SL. They argue that "*[t]he power dynamics implicit in bringing different knowledge holders together influence the subsequent learning outcomes*". Furthermore, Armitage et al. (2008) and Pahl-Wostl (2009) suggest TLL may impact the boundaries and power structures of a socio-technical system, fundamentally affecting its properties and governance. Though indirectly and unintentionally, transition scholars have also established links between TLL and power relations. For instance, Avelino and Rotmans (2009:558) recognise that "*creating or communicating knowledge is also a form of power exercise in itself*"; and Beers et al. (2016:3) hold that, in order to be transformative, SL should not only produce new or changed knowledge and actions, "*but also*

new relations and new interdependencies between actors".

It is also important to mention the recent work by van Poeck and Östman (2021:164-166), improving the application of the concepts of learning loops in STs with the introduction of the notions of short- and long-learning loops, which they define in terms of disturbance and change of habits, and of what is included in, or excluded from "privileging"[5] and sense-making processes when a problematic situation is addressed: 1) in a short-learning loop *"(…) the disturbance* [of habits] *does not result in a process of inquiry* [and] *habitual believes are excluded from the privileging"*, leading to the *"consolidation or enrichment*" of existing habits; 2) in a long-learning loop a "*process of inquiry takes place*" and habitual believes are included in the privileging, opening-up *"(…) potentiality for the (trans) formations of habits"*.

2.2.2. Learner levels

OL studies consider learning can be pursued within different learning settings (e.g. organisations, networks), and by different learning entities or learner levels (Knight, 2002; Knight and Pye, 2005). From an organisation-centred perspective, learning takes place within an organisational setting, and can be pursued by three different learning entities: 1) individuals within organisations, 2) groups of individuals within organisations, and 3) single organisations as a whole.

The notions of learning settings and learner levels relate to two corresponding dichotomies that are part of a central debate on OL studies, between: 1) individual and collective learning (Tsoukas and Vladimirou, 2005), and 2) learning-in and -by organisation (Popper and Lipshitz, 2004). While learning-in organisation refers to individual- or group-learning taking place in an organisational setting, learning-by organisation refers to learning institutionalised across an organisation as a whole (i.e. the organisation is the learning entity) (Knight, 2002).

The majority of OL theories have an atomised view of learning, placing emphasis on the occurrence of learning-*in*, and its appropriation -*by* a single organisation, neglecting other learner levels beyond an organisation's borders (Antal and Sobczak, 2014; Argote, 2013; Mariotti, 2012). Furthermore, similarly to the SL literature (**see** Section 2.1), mainstream OL studies tend to focus on learning outcomes, with little attention to processes (Argote, 2013), thus overlooking the inherent circular logic, non-linear nature of SL implied by the concept of learning loops.

2.2.3. A network perspective to inter-organisational network learning

Some more recent approaches to OL have addressed these issues by adopting alternative epistemological stances, and following a social-constructivist perspective. Building on the philosophical assumption that *"all knowledge is, in a fundamental way, collective"*, OL is considered as a dynamic, highly social and political process, involving the creation of knowledge through consensually processing and interpretation of information, depending on *"historically evolved collective understandings*" (Tsoukas and Vladimirou, 2005:973).

In line with such alternative epistemologies, Knight (2002) and Knight and Pye (2004; 2005) develop a "network perspective" to inter-organisational network learning (henceforth referred to in this paper as "network learning" or simply NL), and propose to consider inter-organisational networks as a forth learner level in addition to the three aforementioned. Furthermore, similarly to OL, they differentiate between learning-in and -by inter-organisational networks. While learning-in network refers to learning in network-sub-sets or in the learner levels encompassed by a network; learning-by network corresponds to collective learning by the group of actors and organisations that constitute a network as a group – i.e. the network is not only the learning setting (*learning-in*), but also the learning entity (*learning-by*) Knight (2002: 436) holds that the constructs of learning can be applied not only at individual but also at any other (system) level, *"(…) provided we accept that the detailed conceptualization of learning and associated constructs, such as memory, are not identical across the levels. (…) So, the important question is not 'can networks learn?', but rather 'how do networks learn?'"*; and her answer is that networks learn *"through intranetwork interactions*". She claims that, as with OL, NL processes are processes of "(…) *institutionalization of coordinated practices and/or the embedding of shared views and interpretations"*, which are contingent upon interactions between network members (*ibid*. 446).

Knight and Pye's NL concept draws attention to the importance of taking into consideration the many factors affecting a "NL episode" - learning episode being the unit of analysis; and recognises the recursive dynamics, interrelations and multi-directional (non-linear) influences within and between processes, outcomes and the broader context in which they take place. Such relational view of learning impacts how the relationships between change and learning are perceived over time and in the context of networks. Knight and Pye (2004:487) argue that complex settings, such as wide, inter-organisational networks, call for attention to *"(…)the emergent and uncertain aspects of learning (i.e. both process and outcome developments over time) rather than the concept of* change*, which often invites narrow distinctions between time0 and time1 (…)"*.

2.3. A network perspective to learning in socio-technical systems

Grounded in a perception of learning as being a continuous, social, relational and non-linear phenomenon of knowledge development, application, institutionalisation and embeddedness, which can take place at any system level, and that both affects and is affected by the inner and outer environment in which it takes place (Ingram, 2018; Knight, 2002; Knight and Pye, 2005; van Mierlo

[5] "Privileging" can be understood similarly to the aforementioned "prioritising processes". According to van Poeck et al. (2020) and van Poeck and Östman (2021:160) privileging is a key process in learning in STs that defines "*which knowledge, skills, values etc. are valid and which are not in a given situation (…) what is taken into account and what is not"*, hence *"directing learning in certain directions and towards certain outcomes* [that have] *less or more potential to enable a ST"*.

et al., 2020; van Poeck and Östman; 2021); and building on Knight and Pye's NL concept, this section proposes an inter-organisational-network perspective to learning in socio-technical systems. The proposed approach combines the concepts of learning loops and of inter-organisational NL (including the notion of learner levels), with the MLP's analytical levels.

The concept of learning loops is interpreted here as encompassing both the processes and the outcomes of a learning episode, as through continuous forward and backward loops of action–consequence-reflection–response, processes affect outcomes and, in reverse, outcomes influence processes. It takes into account the recursive relations between them, and the internal and external environments of a learning episode, hence reflecting the circular, non-linear nature of learning[6]. Regarding processes, learning loops allow inferring the extent to which a learning episode may contribute to knowledge development, depending on whether it involves: 1) concerns with action strategy only (SLL); 2) questioning of governing values and basic assumptions (DLL); or also 3) reflection on knowledge-power issues (TLL). As to outcomes, loops allow inferring whether new knowledge has been developed, and, if so, whether it has impacted: 1) coordinated practices (SLL); 2) shared cognitive and normative elements (DLL); and 3) the governance of a focal network and/or socio-technical system (TLL).

Learner levels allow looking at several learning entities and their interactions, and thus provide elements to evaluate the *loci* of learning processes and outcomes, as well as their institutionalisation at different system levels. The integration of the aforementioned learner levels into the MLP's concepts of regime and niche result in the definition of five learner levels in a socio-technical system:

- Level 1 – Individual Learning (IL): learning by individuals within niche or regime organisations;
- Level 2 - Group Learning (GL): learning by a group of individuals within niche or regime organisations;
- Level 3 - Organisational Learning (OL): learning by a single niche or regime organisation;
- Level 4 – (Inter-organisational) Network Learning (NL): learning by a niche network, a network of regime organisations, or a niche-regime network[7].
- Level 5 - System Learning: learning by a socio-technical system as a whole (i.e. the socio-technical system is the learning entity).

While Levels 1 to 4 correspond to learning in sub-system levels, i.e. *learning-in* socio-technical system; Level 5 corresponds to *learning-by* socio-technical system. It is worth noting that "System Learning" is also NL, considering a socio-technical system can be understood as an extremely broad inter-organisational network that encompasses several other networks. Inasmuch as the regime comprises wide, inter-organisational networks of incumbent actors, and actors with a default disposition for reinforcing prevailing practices and systems at play (Turnheim and Sovacool, 2020), *learning-by* system can be interpreted as *learning-by* regime. Therefore, regime is considered here as both the learning setting (for Levels 1 to 4) as well as the learning entity (Level 5).[8] This typology of learner levels of a socio-technical system allows evaluating whether learning processes and outcomes are situated only in sub-system levels directly linked to a learning episode (*learning-in*); or whether they are also widespread across, being embedded within the whole system, beyond the limits of the learning episode (*learning-by*) Table 1. synthesises this network approach to learning in socio-technical systems.

Building on Knight (2002) and Knight and Pye (2005), the case for this network perspective to *learning-in* and *–by* regime relies on two premises.

First, learning-by regime can be assumed to have occurred only if the three loops are completed and institutionalised across whole networks of regime actors, thus allowing to overcome regime lock-ins, questioning and impacting not only coordinated practices (Cell 14) and shared cognition (Cell 13), but also the governance of a whole socio-technical system (Cell 15). Inasmuch as the rebalancing of power relations is a key transition mechanism (Avelino, 2011; Avelino and Wittmayer, 2016; Avelino and Rotmans, 2009; Bui, 2021; Rossi et al., 2019), transitions indeed require a third loop at the regime level, affecting prioritising processes, boundaries, and governance structures. This assumption is congruent with Pahl-Wostl (2009:359), who considers that "[m]*any kinds of double-loop learning can only be effective if accompanied by triple-loop learning (…)*". Similarly, Beers et al. (2016) consider that SL has resulted in a learning outcome when new actions, new knowledge and new relations are interwoven, which they recognise as somehow associated with SLL, DLL, and TLL, respectively.

Second, learning-by regime should be seen as more than the sum of the learning in sub-system levels (Cells 1 to 12) that constitute a socio-technical system. Instead, it requires sub-system-learning outcomes to be institutionalised both across the sub-system levels, *and* across the regime level, resulting in changes to the regime's attributes. As with OL and NL, and from a relational perspective of learning, regime-learning processes are processes of institutionalisation of outcomes that can only occur through interactions within

[6] Unlike Pahl-Wostl (2009:359), who though recognising the iterative nature of SL, assumes it "*proceeds in a stepwise fashion moving through the phases of single to double to triple-loop learning*", we take the view here that there is no timing, order or sequence between the three loops, and that processes influence outcomes, and vice-versa.

[7] It is important to make three observations: 1) a niche network is not necessary an inter-organisational network, in fact, it may not involve organisations at all; 2) a network of regime organisations may include sectors of a socio-technical system (e.g. food retail industry within the agri-food system), or involve regime organisations from several socio-technical systems (e.g. when a strategic network is established with a particular purpose); 3) niche-regime interactions are assumed here as inter-organisational networks.

[8] The notion of regime may relate to different understandings in the ST literature. Some see it as a concept that depicts the set of rules underlying a socio-technical system, "*the paradigmatic core*" (Fünfschilling and Truffer, 2014) or the "*semi-coherent institutional rationalities*" (Miörner and Binz, 2021) guiding a sector. Others refer to it as an analytical level, comprising coalitions of incumbent actors (Lindberg and Kammermann, 2021), as well as technologies, practices and institutions (Kivimaa et al., 2019). In this paper, we adopt this latter use of the notion of regime.

Table 1
– Socio-technical system learning: learning loops and learner levels.

Learner Level					
	Level 5 System Learning	[Cell 13]	[Cell 14]	[Cell 15]	Learning-by Regime
	Level 4 Network Learning	[Cell 10]	[Cell 11]	[Cell 12]	Learning-in Regime
	Level 3 Organisational Learning	[Cell 7]	[Cell 8]	[Cell 9]	
	Level 2 Group Learning	[Cell 4]	[Cell 5]	[Cell 6]	
	Level 1 Individual Learning	[Cell 1]	[Cell 2]	[Cell 3]	
		Single-Loop Learning	Double-Loop Learning	Triple-Loop Learning	
			Learning Nature		

and across the various networks (sub-systems) that constitute a socio-technical system. This assumption is in line with Reed et al.'s (2010) claim that SL to be considered as so has to impact the understanding by "*individuals*" involved, and go beyond IL, involving wider social units as a whole.

3. The Belgian local-product network: an empirical application to a learning episode

This network perspective to learning in ST is applied to the case of the Belgian LP network, considered here as an episode of niche-regime-network learning.

3.1. Learner levels

This empirical application of the network perspective to learning in socio-technical system follows the multi-level approach according to learner levels as presented in Section 2.3. More specifically, it addresses the following levels with correspondence with

Table 1:

- Level 3 – OL - The empirical analysis takes into account the key actors participating in the development of the Belgian LP network[9]: corporate retailers, small-scale local producers and provincial organisations, each considered as a single organisation. Fieldwork focuses on two corporate retailers, which for confidentiality reasons are referred here as Retailer1 and Retailer2[10]. In addition to being among the top three retailers in Belgium, the main reason for considering these two retailers is because they were the first in the country to consistently develop strategies to market LPs in their stores. The analysis also considers, whenever possible, other learner levels encompassed by retailers, though not as a strand of analysis *per se*: GL within the retail organisations (e.g. stores, LP teams, departments); and retailers' employees (e.g. store directors, managers, coordinators) as IL (respectively, Level 2 and Level 1 in Table 1). As for the provincial organisations, the fieldwork covered the three LP initiatives that first emerged in Belgium: Promogest, Hainaut Développement (HD) and Made in Brabant Wallon (Made-in-BW). Promogest and HD were both pre-existing, para-public, provincial agencies for rural development and agricultural extension services of the provinces of Liège and Hainaut, respectively. Made-in-BW, in contrast, was specifically created to manage a logistic platform for LPs in the Province of Walloon Brabant.
- Level 4 – NL – The analysis considers the LP network itself, distinguishing three network sub-sets, according to the provinces where the aforementioned LP initiatives unfolded: Liège, Hainaut and Walloon Brabant; and the Belgium food retail industry. It is worth mentioning that in each LP network sub-set the analysis also looks at the small-scale producers participating in the LP initiatives; together, the three LP network sub-sets represented around 33% of producers participating in the Belgian LP network in 2016. Moreover, the analysis of the Walloon-Brabant sub-set also includes the Local-Action-Group *Culturalités-en-Hesbaye-Brabaçonne* (LAG[11]-CHB), which initiated the logistic platform carried by Made-in-BW, through a box-scheme project.
- Level 5 - System learning – The analysis zooms out to the Belgian agri-food regime. It is important to bear in mind that, considering transitions are complex, long-term processes, this analysis could only infer about the potential of this LP-network-learning episode in terms of contributing towards a transition of the Belgian agri-food system. This should not be seen as a limitation exclusive to this study, instead it is a challenge for any study of learning in STs. As observed by van Poeck and Östman (2021:156), *"(…) given the open-endedness of STs (…), it is impossible to investigate how learning practices today directly and certainly affect long-term societal transitions*"; instead, as they do in their empirical analysis, it is only possible to assess "*(…) learning processes and their outcomes in terms of the potential to enable or constrain STs*." Furthermore, in view of the global nature of socio-technical regimes (Fuenfschilling and Binz, 2018; Smith et al., 2010), dominated by multinational corporations (as the retailers in the LP episode), and with value-chain activities spread around the globe, this study can only get some clues about the potential repercussions of this NL episode on the agri-food system in Belgium, let alone in Europe or worldwide.

3.2. Learning loops

Inspired by Knight and Pye (2005), this study evaluates learning loops according to constructs for context, process and content, which are then further differentiated between descriptive and conceptual elements. While the former correspond to the narrative part of a learning episode, describing its unfolding, the latter refer to the complex and recursive relationships between context-process-content's descriptive elements. As regards more specifically the Belgian-LP-network-learning episode[12]:

- Learning context's descriptive elements correspond to the different endogenous (e.g. actors' history, strategies, and willingness to experiment) and exogenous (e.g. broader industry/system context, competition, changing attitudes in society, government's policies) factors, directly or indirectly, related to the LP network (i.e. the focal learner network), which may have enabled or constrained learning; conceptual elements take into account the recursive interactions between the contextual factors, and how they influenced learning content and processes, and the way the learning episode unfolded (e.g. how previous experiences influenced actors' motivations or resistance to engage with one another).
- Learning processes' descriptive elements are operationalised by action-oriented-sub-plots that capture critical events of the LP episode's storyline (i.e. actions and interactions among actors from the different learner levels). Sub-plots are then mirrored by three process-conceptual themes according to the development of: 1) "commitment", corresponding to choice- and decision-making; 2) "meaning", referring to sense-making; and 3) "methods", relating to innovation and reorganisation processes.
- Learning content corresponds to the episode's focal topic (i.e. local products) and its learning outcomes. Its descriptive elements refer to key, realised and prospective, new developments occurring within and between the temporal boundaries of the LP episode and that are relevant to its focal topic. New developments (i.e. learning outcomes) are then mirrored by conceptual themes

[9] Consumers, of course, are relevant actors. However, due to the time schedule of the broader research project this study was part of, it was impossible to incorporate in the analysis learning constructs related to the influences of LP episode on consumers. Instead, this study could only get some clues on effects on consumers' behaviour, through documentary data sources and information provided by other actors.

[10] While Retailer 2 asked for a confidentiality agreement, Retailer1 actually preferred its name to be mentioned. Yet, as a way to protect the identity of Retailer2, both retailers are anonymised.

[11] LAGs are composed of public and private, social and economic actors, and manage the funds related to the EU-LEADER funding programme for rural development.

[12] For a summary of descriptive and conceptual elements of processes and outcomes related to the LP-network learning episode **see** Table 2.

according to effects on: 1) "structures", corresponding to impacts on how things are organised to meet goals, and accommodate new meanings and commitments related to LPs, including the establishment of new structures; 2) "interpretations", such as influences on values, norms, core purposes, priorities; and 3) "practices", relating to adjustments on existing or establishment of new practices related to the implementation of (eventual) new meanings and/or commitments[13].

3.3. Time boundaries

The LP-network-learning episode examined here started in 2008. It was still unfolding almost ten years later, at the time the fieldwork was conducted (2016-2017).

The analysis of such ongoing learning episodes, with relatively short-time windows, makes it difficult to assess their transformative potential. Learning outcomes, particularly those related to multiple-loops, are likely to take a long time to diffuse and embed (i.e. institutionalise) across an organisation or a network, let alone within a whole socio-technical system. Also, over time what seem to be only new practices relating to SLL "*are likely to impact upon shared cognitive structures, and indeed network structures*", thus having context-process-content elements that can be related to double- or triple-loop learning (Knight, 2002:445-6). Furthermore, the recursive relationships between context-process-content can only be fully captured by a long-time window. Indeed, time is an important aspect in any study of learning (Knight, 2002). This is even more obvious when it comes to studying learning in STs, which are complex, open-ended, long-term processes, requiring multiple learning episodes, along with various other phenomena, which means a comprehensive analysis can only be conducted retrospectively (Loorbach et al., 2009; Geels, 2011; van Poeck et al., 2020).

3.4. Data sources and fieldwork

The study of the LP-network-learning episode followed an analytical descriptive and ethnographic approach, based on qualitative analysis of 32 semi-structured interviews with the various actors participating in the LP episode since its onset, conducted between April 2016 and August 2017[14], supplemented with field observations and several documentary materials (e.g. media articles; websites and annual accounts of the different actors interviewed; internal strategy papers, minutes of internal meetings; training programs).

Interviews with retailers covered a wide range of staff members directly or indirectly involved with LPs. Respondents occupied different positions within their organisations, and were from different corporate levels (headquarters, regional directions, stores). Visits to retailers' stores were conducted prior to each interview in order to get a general feeling of the way LPs were marketed and, if needed, slightly adjusting interview protocols accordingly. As for the other actors, interviews were complemented by observations conducted during meetings, in which the various actors interacted with each other.

Interview protocols were based on a common analytical grid applied to all actors, and covered different aspects of learning derived from the literature, aiming to capture context-process-content's elements[15]. Information on contextual factors was also collected via literature review and documentary data sources. Interviews were transcribed and then manually coded according to the descriptive and conceptual elements referred in Section 3.2. Documentary materials and observations were used for crosschecking and tabulation of interviews, in order to confirm the codification was accurate.

4. The Belgian local-product-network-learning episode: findings and discussion

The main findings regarding the unfolding of the LP-network-learning episode in Belgium are presented according to the context-process-content's descriptive and conceptual elements detailed in Section 3 and Table 2. Due to space limitations, the analysis focuses on some illustrative processes and outcomes from each conceptual theme. The findings are discussed in terms of learning loops by learner levels, and considering the paper's premises presented in Section 2.3.

4.1. Learning processes

The development of the Belgian LP network started around 2008, in a global context marked by increasing criticisms of the agro-industrial food sector, pressures on corporate retailers for more sustainable behaviour (e.g. offer of healthier and fairer products), and increasing demand for locally produced food, aligned with fierce competition and decreasing economic performance in the food retail industry.

[13] In view of the iterative, non-linear relations between learning loops, it is important to bear in mind that the differentiation between process- and outcome-conceptual themes is fuzzy, and their association with different learning loops should be considered with caution, as it may be interpreted differently depending on the learner level, and vary according to time. Generally, SLL can be related to developing-method-sub-plots and effects on practices; and DLL is likely to imply the unfolding of developing-meaning-sub-plots, eventually influencing interpretations. The association of TLL with the conceptual themes is more difficult to establish. For instance, TLL can be somehow related to both: effects on interpretations, as it may lead to reflection and increasing awareness about knowledge-power issues in SL (e.g. enhanced trust), as well effects on structures, as it may involve developing-commitment-sub-plots related to prioritising processes, which may impact regime's governance properties.

[14] For a detailed list of the interviews, **see** Appendices A and B.

[15] For a summary of the issues addressed by the interview protocols **see** Appendix C.

Table 2
– LP-network-learning episode: summary of descriptive and conceptual elements related to processes and outcomes(1).

Process: Conceptual Themes(3)	Process Descriptive: Action-oriented process sub-plots [SP]	Content Descriptive: Realised and prospective new developments [O]	Content: Conceptual Themes(3)
Developing Commitment	[SP1] Deciding to start a LP strategy/initiative: triggers*(2) [SP2] Setting new rules* [SP3] Shaping store-local producer relationship* [SP4] Creating new roles and organisations*	[O1] Establishment of the LPs network* [O2] Impacts on authority within organisations and in the LP network [O3] New roles and organisations, and their assignments* [O4] Impacts on power relations* [O5] Implementation of the LP concept/ initiative	**Effects on** Structures
Developing Meaning	[SP5] Initial motivations and definition of objectives* [SP6] Defining "local"* [SP7] Trust building* [SP8] Partnership development [SP9] Developing the view of the new roles and structures within retailers: individual resistance and engagement	[O6] New meanings associated with LPs: motivations, purposes, trust* [O7] Impacts on shared perception within retailers* [O8] Impacts on individual level's interpretations amongst retailers' employees* [O9] Impacts on consumers' interpretations	**Effects on** Interpretations
Developing Methods	[SP10] Starting the LP concept/initiatives – first steps* [SP11] Developing and adapting contracts* [SP12] Making investments on LPs [SP13] Establishing (formal and informal) exchange channels [SP14] Monitoring customers behaviour regarding LPs	[O10] LPs publicity and promotion* [O11] LPs display* [O12] Stores-producer partnership for the offer of innovative products [O13] Orders, deliveries, and reception* [O14] Invoicing and payment* [O15] Product/assortment selection/new products [O16] New contract [O17] Pricing, discounts and margins [O18] Internal and external exchanges and interactions on LPs* [O19] Effects on individual-level practices [O20] Impacts on consumers' practices or buying patterns	**Effects on** Practices

Note: (1) Own development based on fieldwork and literature review, inspired by Knight (2002) and Knight and Pye (2004, 2005). (2) The "*" indicate the sub-plots and outcomes illustrated in Section 4. (3) The exclusive correspondence between processes' and outcomes' conceptual themes (i.e. developing meaning with effects on interpretation; commitment with structures; method with practices) implied by Table 2 is merely illustrative, and overlooks the multi-directional influence between context-content-process referred to in Section 2. Indeed, similarly to Knight and Pye's (2005) findings, the analysis of the LP episode points to several overlaps. For instances, sub-plots categorised within developing meaning (e.g. SP6 and SP7) are linked with developing-commitment sub-plots (e.g. SP2 and SP3) and developing-methods sub-plots (e.g. SP10); and have implications not only for interpretations, but also for network and organisational structures (e.g. O4) and for practices (e.g. O12). There are examples in the other direction as well: effects on practices (e.g. O20 and O11) influencing sub-plots related to developing meaning (e.g. SP6 and SP7) as well as effects on interpretations (e.g. O7). (3) There can be established some links between these three outcome-related conceptual themes and the types of learning outcomes identified by Poeck et al. (2020). For instances, effects on interpretations, structures and practices can be somehow associated with what they refer as "*conceptual outcomes*", "*relational outcomes*", and "*practical outcomes*", respectively.

4.1.1. Deciding to start a LP strategy

The first triggering events mentioned by the interviewees involved Retailer1, whose CEO in Belgium asked its sustainability director in the country (Retailer1-SustainabilityDirector) to develop a concept for promoting Belgian products in its stores at the local level. For a few years, during the national annual agricultural fair of Libramont, one of the largest of its kind in Europe, Retailer1-SustainabilityDirector engaged in informal conversations about Retailer1's interests in developing a LP strategy for its Belgian operations, with officers from Promogest, and from one of the main francophone farmers' union in the country, who later changed jobs becoming the officer in charge of HD.

4.1.2. Setting new rules

Retailer1 developed a charter that set up new rules and established specific marketing conditions for a LP circuit, set apart from the traditional one. This charter incorporated elements about, for instance, exclusivity, discounts, placement and display of LPs, and provided solutions to obstacles that had been identified by local producers (**see** Section 4.1.7).

4.1.3. Shaping store-local producer relationship

Retailer1's charter placed emphasis on the direct contact between producers and its stores, instead of the conventional arms-length relationship through central procurement and distribution departments. It acknowledged working directly with local producers as essential for trust-building, by enabling face-to-face discussion and by moving away from the highly unbalanced relationships of the mainstream circuit, as well as for credibility-enhancing with customers, by ensuring that produced labelled as LP were indeed "local". The direct relationship between stores and local producers was welcomed by the majority of Retailer1's interviewees, yet they recognised this was challenging: "*we are not used to having direct contact with [producers]*".

4.1.4. Creating new roles and organisations

Retailer1 decided to rely on an external organisation to coordinate its LP circuit. Internally, it created a dedicated area to LPs in all of its largest stores, and established two dedicated management positions: LP regional coordinators (Retailer1-LP.RegionalCoordinators), and LP managers at stores. Retailer2 opted for promotion of LP at gondola heads only (at the extremity of shelves in supermarkets), installed at the discretion of the store directors. A LP team was established at Retailer2 headquarters and a central LP coordinator was appointed. In both retailers, these new roles and structures worked in parallel to the existing, conventional circuit.

The Province of Walloon-Brabant created Made-in-BW as a new organisation specifically dedicated to LPs; the Provinces of Liege and Hainaut, by contrast, decided to ensure the marketing of LPs in supermarkets through their already existing agencies: Promogest and HD, respectively. Both Made-in-BW[16] and Promogest created logistic platforms; HD chose to foster LPs by providing support in communication and facilitation aspects.

4.1.5. Initial motivations and definition of objectives

Within the strategies of both retailers, LPs started as an experimental project without prior definition of specific objectives or sales targets. They expressed their motivations as directly linked to their sustainability policies, more specifically to the development of local partnerships for supporting local economies (i.e. developing the view of LPs as related to sustainability). However, commercial benefits associated with LPs seemed to have also represented a driver, as most retailers' interviewees emphasised that having a "*local anchor*" could act as a competitive differential, for instance, by improving the image of the retailers in the eyes of customers or the community. As observed by Retailer1-SustainabilityDirector, in such competitive market as the retail industry, survival depends on offering what customers want[17].

Provincial authorities, particularly in Liège and Hainaut, indicated similar motivations and purposes to launch their LP initiatives and to engage with retailers: to develop new markering opportunities for farmers, as a means to strengthen local rural development. In the Walloon-Brabant-network sub-set, as LPs stemmed from a multi-actor initiative, motivations and purposes were more ambitious, with supermarkets being seen not only as a new outlet for LPs, but also as a way to ensure the viability and consolidation of a logistic platform, aimed at supporting small-scale producers, and which, consequently, had commercial relations not only with supermarkets but also with a diversity of alternative stores (e.g. citizens' cooperatives). By allowing small-scale producers to reach a broader consumer base, collaboration with supermarkets was seen as an opportunity to: 1) upscale and enhance the transformative potential of the initial box-scheme initiatives; 2) relocalise the food system; and 3) build consumers' awareness on health, social justice, and environmental dimensions of food.

4.1.6. Defining "local"

Retailer1 developed its own LP concept based the local economy around its largest store format. Accordingly, a "local" producer would be a small enterprise, hiring less than ten full-time equivalent employees, and located within an area of maximum 40 km around a Retailer1's large store. Retailer2 defined "local" differently, as being any Belgian-origin product, whatever the distance to its stores.

4.1.7. Trust building

Developing and maintaining trust was a key sense-making-sub-plot which both influenced and was influenced by several other sub-plots[18], and different outcomes[19]. At the beginning of the LP episode, the aforementioned farmers' union and provincial agencies organised meetings to identify and explore how to overcome the obstacles created by retailers' traditional practices, which had not only made it difficult for small-scale food producers and processors to work with supermarkets, but had also resulted in deep mistrust among them. These meetings helped to assure local producers' interests would be respected, and were therefore essential to build trust between them and corporate retailers.

4.1.8. Starting the LP concept/initiatives – first steps

The farmers' union organised several meetings between Retailer1 and local farmers in 2010 and 2011 to consult the latter, and identify the barriers and solutions for them to work together. Soon afterwards, Promogest and HD organised further meetings, extended to non-farmer producers. In 2012, Retailer1 conducted pilots in two of its largest stores in Liège and Hainaut, in partnership with Promogest and HD, respectively. Following the success of both pilots, Retailer1extended the LP concept to its entire Belgian operations. Retailer2 started its LP strategy around 2011, however it took longer to engage with provincial agencies and producers, what had to do with its different purposes and less ambitious LP strategy.

4.1.9. Developing contracts

Retailer1 developed a specific contract, simpler and shorter than the standard one, offering small-scale local producers special marketing, logistics and financial conditions. For instance, local producers were not submitted to price negotiation and could

[16] The Walloon-Brabant-network sub-set stemmed initially from a box-scheme project conducted and coordinated by the LAG-CHB for five years. At the end of LEADER-EU funding period, the actors involved (i.e. the LAG-CHB and local, small-scale farmers) decided to create a logistic platform to enlarge outlets for these producers, including at supermarkets, to also raise the awareness of a larger consumer base.

[17] For Retailer2, the LP strategy was less ambitious, targeting mainly specialty products, what was reflected in the little means it dedicated to LPs.

[18] For example, **see** sub-Sections 4.1.2, 4.1.3, and 4.18.

[19] For example, **see** sub-Sections 4.2.3, 4.2.6, 4.2.7, and 4.2.8.

determine the price of their products themselves; they benefited from a reduced payment period (30 days instead of 90); and were exempted from exclusivity clauses or investments requirements. Moreover, differently from traditional circuit's practices on returns, according to which suppliers are responsible for unsold products, Retailer1 bore the losses of unsold LPs. As a Retailer1-LP. RegionalCoordinator highlighted: "*Once we buy the product, it's our responsibility*". Basically, local producers were only required to do in-store demonstrations and tastings, and to have their own barcodes.

During the pilots, Retailer1 unofficially lent barcodes to producers. As the project evolved, together with Promogest and HD, it negotiated a new modality with GS1, the company that provided barcodes for Benelux. GS1 created a new contract, only for small-scale producers, for ten barcodes. This contract was answering the needs of small-scale producers, giving them the possibility to spend only 100 Euros for the barcodes they need, instead of buying 400 barcodes for 500 Euros with the regular contract.

4.2. Learning outcomes

Between 2012 and 2017, Retailer1's LP circuit, the most advanced among retailers in the country, had grown from about twelve to around 770 local producers[20]. Retailer1's LP assortment was quite broad, counting with about 9,600 products in 2016, consisting mostly of fresh food (e.g. fruits, vegetables, and dairy) and dry-grocery products (e.g. jams, chocolates and beer). Overall, LPs represented less than 1% of retailers' food turnover in Belgium, a share that varied from region to region, and from store to store[21]. Retailer1-SustainabilityDirector pointed out this share was reasonable if compared to the penetration of organic products in the retail industry, which was then about 3% worldwide on average.

4.2.1. Establishment of the LP network

The establishment of the LP network itself represented the major outcome related to structures, with significant impacts on local producers. Retailers' large customer base and the special conditions offered to local-, small-scale producers helped them to increase their revenue, contributing to the development and continuity of several small farms and processing units, and consequently, to job creation.

By contrast, the effects of the LP-learning episode on retailers' organisational structures were rather limited, since LPs were totally disconnected from mainstream sourcing chains. As observed by Retailer1-SustainabilityDirector, "*our [LP] initiative is totally independent from the global context. (…) it is a specific circuit; (…) an exceptional circuit, with its own sustainable objectives*".

4.2.2. New roles and organisations, and their assignments

The effects on retailers' structures referred mainly to the new roles created, which were non-mandatory and had narrow and quite flexible assignments. Moreover, LPs represented a small structure for both retailers (e.g. Retailer1-LP.RegionalCoordinators worked alone, without a team, and were mostly responsible for other tasks unrelated to LPs; and Retailer2's LP team consisted of 2.5 full-time equivalent in 2016, including its coordinator).

Regarding the network sub-sets, the most significant structural development was the creation of Made-in-BW as a hybrid organisation dedicated to LPs, with small producers, and the Province participating in its governance; as well as the establishment of two logistic platforms: one carried by Made-in-BW and another by Promogest.

4.2.3. Impacts on power relations

Power relations within the LP circuit differed considerably from the traditional one, as store-producer-direct-relationship gave producers more bargaining power than they would have in the conventional system. For instance, local producers supplying Retailer1 could define the price to be paid for their products, and decide to suspend deliveries or interrupt the contract. Within retailers, stores assumed more responsibilities than in the traditional circuit as, for instance, Retailer1's stores could choose the LPs they wanted, and place orders directly to producers. As emphasised by Retailer1-SustainabilityDirector, "*(…) it's really another system; (…) the stores are really involved in the choice of LPs, and the central purchasing body is not*".

4.2.4. New meanings

There were limited effects on interpretation or development of new meanings attributed to LPs as the concept evolved in both retailers. This is reflected by the negligible impacts on retailers' core purposes or priorities regarding LPs, which continued to be associated with sustainability mostly in terms of benefits for local economies. There was only a slight change in emphasis from pure sustainability aspects towards more strategic ones; as the concept evolved and exceeded expectations (e.g. positive customer reaction, and interaction with local producers, consistent sales growth), LPs grew in strategic importance for both retailers, particularly for Retailer1, for whom it became a long-lasting concept.

The effects on Liège- and Hainaut-network sub-sets' interpretations were also limited, without significant impacts on views or motivations, which remained mostly centred on supporting small producers. However, it should be noted that as Retailer1's LP strategy turned out to be a success, and as the demand for LPs increased, Promogest and HD grabbed the opportunity to use Retailer1's

[20] This number was relatively small if compared to Retailer1's quality-chain concept, which was integrated in the mainstream circuit and involved around 2,000 farmers in 2016.

[21] In fact, in Retailer1 this share was higher (less than 2% in average). Figures regarding Retailer2's LPs were undisclosed, but it was possible to infer from the fieldwork that this share was likely to be much lower than in Retailer1.

LP charter and specific contract as a basis for negotiating with other retailers a more favourable position for small-scale producers. This indeed allowed developing new marketing opportunities for the latter.

There was indication of a higher potential impact in the case of the Walloon-Brabant sub-set, with more comprehensive understanding of agri-food issues by the actors involved. The Province of Walloon Brabant differentiated itself from its counterparts by aligning its motivations and objectives with those of the other actors participating in Made-in-BW: supporting small-scale farmers; reconnecting producers and consumers; reconfiguring market governance; supporting the development of alternative local food chains to build a territorial food system.

Local producers seemed to have experienced the most significant effects on interpretations, as they moved from having a profound mistrust towards corporate retailers, to actually seeing them as trustworthy business partners. As observed by a Retailer1-LP. RegionalCoordinator: "*It started that I had to search for producers, but now they contact me because they are seeing the success of the project*".

4.2.5. Impacts on shared perception within retailers

Although interviews with retailers' staff indicated there was reflection on several aspects related to LPs (e.g. retailers' role in terms of sustainability, informing consumer, unbalanced power relations, importance of small-scale producers for local economies, relevance of consumers-producers contact and stores-producers direct relationship), it was unclear whether this had impacted shared perception within retailers. For instance, while a Retailer1-LP.RegionalCoordinator noted: "*it was the supermarkets that made it very difficult for some of them* [small producers]*, because we pushed the prices so low they had a very hard time selling their products*"; none of the interviewees mentioned the need to change mainstream practices that created such difficulties.

4.2.6. Impacts on interpretations of retailers' employees

Indeed, such reflection might be related to increased awareness at the individual level. The majority of Retailer1's interviewees acknowledged that working with local producers influenced their personal views and practices, and those of people around them, particularly their families. A Retailer1-LP.RegionalCoordinator observed: "*I always talk about it* [the LPs project]*; I have influenced my sister, my parents, at home, my wife, and my son*"; and another said: "*I am discovering products I have known as a little boy, but could not find in the supermarkets. (…) I had forgotten that products like these were still made. I hadn't realised they were still there*. (…).

4.2.7. Orders, deliveries, reception, invoicing and payment

In contrast to the traditional ordering systems, in which orders were automatically calculated based on sales histories and stocks, Retailer1's stores placed LP orders manually, based also on a manual control of stocks, sending them directly to producers; who then delivered in small batches directly to the stores (or via a logistic platforms in some provinces), where reception was done via side-door and in priority for local producers. After deliveries, producers electronically invoiced Retailer1's central service, which would do the payment within 30 days (when the regular period for national suppliers was three months).

4.2.8. Display and publicity

Retailer1 placed LPs together in an exclusive area clearly identified by posters with information on the charter, pictures and addresses of producers, their farms or workshops, and information on their products. Practices for promoting LPs were also quite different from those used for the regular assortment: publicity was done locally, as each store had different LP producers; and, as is common with short-food circuits, producers themselves made a significant contribution to the advertising of their products, particularly by doing in-store demonstrations once or twice a year. Producers were also invited to present their products at the entrance of the stores, as was the case, for example, for fresh, seasonal products such as asparagus and strawberries.

4.2.9. Internal exchanges and interactions

Within retailers, internal exchanges and interactions (e.g. reports, meetings, training courses) related to LPs were rather limited, being restricted to those employees directly engaged with LPs, and in parallel to conventional channels.

4.3. Discussion

Based on the assumptions made in Section 2.3, this section interprets the evidence from the LP-network-learning episode about learning loops unfolding at various learner levels, in order to evaluate whether it had engendered (or had the potential to engender) learning at different sub-system levels, including those beyond the LP network itself (*learning-in*), and at the Belgian agri-food regime as a whole (*learning-by*).

4.3.1. Level 3 – Organisational Learning

Regarding retailers, the findings suggest that only one learning loop and some elements of a second loop had occurred, since LPs had not been institutionalised across retailers as a whole, with limited communication or adoption of new methods beyond the LP circuit. There was evidence of SLL (Cell 7 in Table 1) in both retailers, with the occurrence of innovative practices and some effects on organisational structures. DLL was rather limited (Cell 8), however, since there were no noticeable effects on retailers' interpretations: changes in retailers' action strategies, though quite innovative, still did not deviate from their governing values. Furthermore, reflection and impacts on power relations had been negligible, pointing to no-TLL at this level (Cell 9). It is worth noting there is indication of both SLL (Cell 1) and DLL (Cell 2) being completed at individual level (i.e. Level 1), suggesting some learning-in retailers had taken place.

Retailers' shallow learning related to the fact that, for instance, in line with motivations for meeting a small, but growing demand, their LP circuits were conceived as complementary, and never meant to replace or influence the traditional circuit. The limited internal exchanges and interactions associated with LPs suggest that new knowledge had not diffused and embedded across retailers' operating units in Belgium, let alone in other countries. This means that, even in Retailer1, where the LP concept had advanced most, dominant views and existing practices and structures remained intact and unchallenged. Indeed, LPs remained a niche market for retailers (less than 1% of turnover), with low or missing sales targets, hence without representing a new sourcing model.

Concerning provincial organisations and local producers, the findings point to slightly more substantial impacts on their views and interpretations, suggesting both SLL and DLL had been completed at least by some of these actors. Producers, for instance, acquired skills associated with practices completely new to them (e.g. invoicing, labelling, barcodes, deliveries and in-store promotional activities) (Cell 7); and developed new meanings related to significant increase in trust towards retailers (Cell 8). In Made-in-BW there were signs of deeper learning, with broader consideration of agri-food issues (DLL), and indication of the development of a shared governance (TLL), with awareness and reflection more broadly on power relations structuring the socio-technical system, suggesting a third learning loop may have started in Made-in-BW (Cell 9).

4.3.2. Level 4 – Network Learning

When looking at the LP network as a whole, the findings suggest there was substantial learning at this level; with elements indicating that the three loops had taken place (i.e. the LP network as a whole had learnt). In other words, not only new coordinated practices were developed, but also shared new meanings, and governance structures emerged (Cells 10, 11 and 12, respectively). For instance, local producers had more bargaining power than regular suppliers, implying power relations within the LP network differed substantially from those in the food retail industry as a whole.

The fact that the LP circuit was conceived as a marginal, complementary niche market, far from representing a new sourcing model for retailers, and totally disconnected from mainstream sourcing chains, points to rather scant (potential) impacts on the food retail industry as a whole. The most significant outcomes at this level referred to the diffusion across the industry of innovations such as Retailer1's specific contract or the new modality in the barcode system, which influenced the way provincial agencies and small producers built new business relationships with other corporate retailers. The limited influence of this LP episode on the food retail industry can be interpreted in terms of power imbalances, implying its reduced ability to affect prioritising processes (i.e. how learning issues were prioritised).

4.3.3. Level 5 – System Learning

The rather modest learning at the organisational and network levels points to inexpressive learning-by regime as whole. The Belgian-LP-network-learning episode made a limited contribution towards a regime shift: it led neither to the occurrence of the three loops at the regime level (Cells 13-14-15) (a *sine qua non* condition for transition, as this paper's first assumption); nor to widespread, institutionalised outcomes across the different system levels (paper's second assumption). In other words, learning was situated in sub-system levels only (i.e. *learning-in*), without noticeable developments or effects on the Belgian food system as a whole (i.e. *learning-by*). Therefore, although more hindsight is required to assess (potential) impacts of this learning episode, there is only scarce indication that this niche-regime-NL episode can engender learning-by regime, contributing to a transition of the agri-food system in Belgium towards sustainability, let alone worldwide.

4.3.4. Niche-regime interactions and regime learning

The "*mutual adaptations*" between Retailer1 and small-scale local producers have helped opening "*the incumbent regime*" to "*socio-technical learning*", which may have paved the way for "*further regime adaptations*" in the future (Smith, 2007:440).

Although there are significant differences between the three network sub-sets, with an important role played by the multi-actor governance in Walloon Brabant in steering transitions towards more sustainable directions (Bui et al., 2019), the findings point to limited "*translations*" (Smith, 2007) of practices and values from niche (i.e. the LP network) into regime within the timeframe of the LP episode, with modest influence of the former over the latter, hence missing a crucial learning process in transitions (Bui et al., 2019; Ingram, 2018). More importantly, similarly to the case of organic farming analysed by Smith (2007), one can argue that the more robust learning impacts observed on provincial organisations and small-scale producers might contribute to a "*mainstreaming*" of the LP network in Belgium. Subsequent regime adaptation would then rather contribute to maintaining the incumbent system than foster a sustainability transition.

Retailers' LP concepts might have contributed to raise awareness on local food chains, since LPs benefited from an increased visibility on the supermarkets' shelves, particularly in Retailer1's stores. However, since LPs represented only a small share of total purchases in supermarkets (less than 1% of retailers' turnover in average), the LP episode is likely to have left intact dominant aspects of consumer demands (i.e. low price and convenience of one-stop shopping). It is worth mentioning that, in Walloon Brabant, where the LP network also opened new potentialities for consumption behaviours to evolve towards food citizenship (e.g., consumers' co-operatives), effects might be higher.

Furthermore, the increase in consumer awareness might be only regarding 'proximity' of providers, obfuscating the issues of unbalanced power relations and sustainability, commonly raised in alternative short-food chains (Bui et al., 2019), and hence hindering associated possible TLL. Moreover, the availability of LPs in supermarkets is likely to delay consumers' move towards more sustainable alternatives, slowing down transition processes (Bui et al., 2019).

The limited influence of this niche-regime-NL episode on the socio-technical system can be interpreted in terms of niche-regime strength and compatibility (Smith, 2007; Ingram, 2018). Although the Belgian LP network has the attributes of a radical

innovation (e.g. strong boundaries, cohesion and internal learning processes) (Ingram, 2018), it had been designed and developed so as to complement the existing system, not to challenge it, and as such, it was rather an incremental innovation. Hence, its ability to diffuse and translate radically new practices and rules into the regime is rather limited, suggesting only "*shallow learning*" (Smith, 2007) or "*short-learning loop*" (van Poeck and Östman, 2021) had taken place.

Actually, although the Belgian LP network was centred on the engagement between corporate retailers and small-scale local producers, assuming it as an episode of niche-regime interaction requires some caution. As the main triggers for its establishment relates to retailers' motivations and strategies, it can be considered as a niche innovation emerging within/from the food regime itself. Moreover, this LP network emerged both as an opportunity for corporate retailers to satisfy consumers' demand, and as a solution to respond to criticisms of the retail industry (by linking LPs to their sustainability strategies), and certainly not in opposition to it. Previous studies have suggested that such type of niche has usually limited transformative potential (Ingram, 2018; Smith, 2007). As argued by Bui et al. (2016:102), incremental innovations associated with "*the internal evolution of the regime and to its adaptation to a shifting landscape (…) do not fundamentally transform the rules*".

5. Concluding remarks

This study proposes an analytical approach to niche-regime interactive learning, taking an inter-organisational network learning perspective. This approach is illustrated empirically for evaluating the transformative potential of a network-learning episode in which corporate retailers (powerful regime actors), small-scale, local, food producers (non-mainstream actors), and local governments engage with one another for the marketing of local products (LPs) in Belgian supermarkets.

This network perspective to niche-regime interactions and learning at the regime level innovates in two ways. First, it integrates the notion of learner levels into the MLP, and proposes a typology of learning *loci* that differentiates system and sub-system levels, distinguishing between *learning-in* and *learning-by* socio-technical systems. Second, it proposes a different understanding of the concepts of learning loops than usually found in learning in STs studies, by considering them as encompassing both processes and outcomes, inasmuch as, through forward and backward loops, processes affect outcomes and vice-versa, and taking into account the recursive relations between context-process-content elements.

The paper makes both conceptual and empirical contributions towards a better understanding of learning for transitions at the regime level, particularly in the context of niche-regime interactions, and hence towards a further understanding of learning in sustainability transitions in general. The proposed inter-organisational-network perspective to learning in socio-technical systems: 1) helps to elaborate and operationalise interactive, multi-stakeholder learning, and hence grasping the complexity of social learning (SL); 2) enables capturing learning dynamics within and between sub-system levels (*learning-in*), and across the system as a whole (*learning-by*); 3) elucidates knowledge-power issues SL is subjected to, particularly when regime and non-mainstream actors interact with one another, inasmuch as dominant actors can shape network-learning episodes according to their own views and priorities; moreover, 4) its application to the LP-network-learning episode elucidates the value of the network perspective, illustrating its significant descriptive and analytical power in helping to further the knowledge on *learning-in* and *-by* regime.

The empirical study of SL in extensive, inter-organisational networks (Knight and Pye, 2005), such as those composing socio-technical regimes, faces significant challenges. Transitions are likely to involve multiple NL episodes, in different locations worldwide, engaging different learner levels, probably from different socio-technical systems. This means a great deal of empirical research is necessary to understand how dominant regimes may be disrupted, how higher-order learning may (or may not) take place at the regime level, and in what conditions lock-in and path-dependence may be overcome. Furthermore, transitions are also long-term processes of structural transformations, involving various other (interconnected) phenomena (e.g. cultural, policy, power processes, disruptive developments at landscape level)[22], implying a comprehensive understanding of learning in STs requires "*taking a long-term, macro perspective of a phenomenon* [learning] *which is observable at the micro-(social, political) level*" (Knight and Pye, 2005:389).

These are critical challenges. Nevertheless the potential offered by this inter-organisational-network perspective to niche-regime interactive learning still holds, particularly by providing an integrative, systemic narrative and analysis of transition-learning episodes (and therefore greater scope for cross-case analysis), representing an original approach to *learning-in* and *-by* regimes, as well as to niche-regime interactions. In sum, this study demonstrates that a network perspective to niche-regime interactions and learning at the regime level is promising in furthering the knowledge on learning in STs, and could lay the foundations for further empirical research on *learning-in* and *-by* regime[23].

Declaration of Competing Interest

None.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

[22] We thank an anonymous reviewer for drawing attention to this point.
[23] We thank an anonymous reviewer for highlighting this point.

Acknowledgements

This work received financial support from the Belgian Science Policy Office – BELSPO (through contract BR/121/A5 and a Postdoc Research Fellowship to Non–Europeans for the leading author). Earlier versions of the paper were presented at the 8th and 9th International Sustainability Transitions Conferences – IST. The paper benefited from discussions with Tjitske Anna Zwart, Helene Joachain, Marek Hudon, and Erik Mathijs; from comments on an earlier version of the paper by Barbara van Mierlo, P.J. Beers, Joanne Vinke-de Kruijf and other participants of an authors' workshop of a special issue on Learning in Sustainability Transitions held in June 2017; and from detailed comments and suggestions by the editor and three anonymous reviewers. We take responsibility for any errors.

Appendix A. – Interviews with corporate retailers – October 2016 and August 2017.

Interviewee	Date/ Length/Language
General Director Quality and Sustainability	07.10.2016/4h/English
Responsible for LPs (internal procedures) through an external company (consultant)	07.10.2016 (simultaneous with Retailer1HQ1)
Person in charge of the LPs area	20.12.2016/3h/English
Store director in the province of Walloon Brabant	24.03.2017/1h/French
Store director in the province of province of Antwerp	11.04.2017/1h/Dutch
Store director in the province of province of Flemish Brabant	11.04.2017 (simultaneous with Retailer2Store2)
Store director in the province of Flemish Brabant	25.04.2017/1h/Dutch
Regional coordinator for LPs covering three provinces in Flanders	20.04.2017/3h/English
Manager of Fruits and Vegetables procurement	21.04.2017/1h/English
Store director in the province of Liège	27.04.2017/45min/French
Store director in the province of Flemish Brabant	27.04.2017/2h/English (with some Dutch)
Store director in the province of Flemish Brabant, and previously Regional coordinator for LPs covering one province in Flanders	15.05.2017/1h/Dutch
Store director in the province of Antwerp	23.05.2017/1h/Dutch (with some English)
Person in charge of the LPs at a store in the province of Antwerp	23.05.2017/30m/Dutch
Regional coordinator for LPs covering two provinces in Wallonia	02.06.2017/1h50m/English
Regional coordinator for LPs covering one province in Wallonia	07.07.2017/1h30m/French
Person in charge of the LPs at a store in the province of Hainaut	07.07.2017 (simultaneous with Retailer1Reg3)
Store director assistant at a store in the province of Hainaut	07.07.2017 (simultaneous with Retailer1Reg3)
Store director at a store in the province of Hainaut, and previously Regional coordinator for LPs covering one province in Wallonia	09.08.2017/2h20m/French

Notes: (1) With only one exception, the first author conducted the visits and interviews with retailers together with a colleague, who has authored a separate paper on retailers' practices (under review). The second author participated in two interviews with retailers, and conducted all observations and interviews with local producers and local authorities, and is the leading author of another paper on ethical values, already published as Bui et al. (2019), co-authored by the authors of this paper and two other colleagues**. (2)** Interviews with Retailer1's LP regional coordinators covered 60% of its largest stores.

Appendix B. – Interviews with other actors engaged with LPs initiatives – April 2016 and January 2017.

Interviewee	Date/Length/Language
Officer in charge of short circuits in the Walloon Agence pour l'Entreprise et l'Innovation	15.04.2016/1h40m/French
Head of the GAL Culturalité who carried the initial project	28.04.2016/1h/French
Director of Promogest ASBL and Director of the Agriculture Services of the Liège Province	09.05.2016/1h/French 27.06.2016/3h45m/ French
Producer working with Promogest	24.06.2016/-/French
Responsible for logistics and customer relations at Promogest	27.06.2016/1h/French
Promotion manager at Promogest	27.06.2016/1h/French
Producer working with Promogest	15.07.2016/-/French
Provincial officer responsible for the follow-up of the partnership between big retailers and local producers	01.09.2016/2h45m/ French
Ex-Director of Promogest ASBL	19.09.2016/2h50m/French
Elected official in Liège Province, in charge of Rural life and Short circuits	19.09.2016/1h40m/French
Officer in charge of social economy in the minister's office of JC Marcourt, Walloon minister of economy	30.09.2016/1h15m/French
Officer in charge of the GoodFood Strategy in Bruxelles Environnement	13.10.2016/2h30m/French

Appendix C. – Issues addressed in interview protocols.

Interview Protocol Issues
- Actors' initial motivations and goals to engage with each other
- View on sustainability and reasons for getting involved in sustainability projects
- Definition of LP and perception of its relationship with sustainability
- View on the role of retailers and other actors of the food system
- Sets of values primed on consumers
- Share of LPs in total revenue, margins
- Hierarchical aspects (e.g. organisational chart, autonomy and control)
- How innovative were the concrete practices into which goals have (or have not) been translated
- Degree of formalisation of new practices
- Dissemination of new knowledge and information related to local procurement
- Actors and functional areas involved with local procurement
- Interactions and communication within and between organisations (frequency of meetings, events, training courses, visits; social contacts)
- Impacts of new knowledge on different levels (including individuals' personal practices)

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