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Framing niche-regime linkage as adaptation: an analysis of learning and innovation networks for sustainable agriculture across Europe

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Abstract

This paper draws on the transition literature to examine niche-regime interaction. Specifically it aims to reveal and contribute to an understanding of the processes that link sustainable agriculture innovation networks to the agricultural regime. It analyses findings from participatory workshops with actors in 17 Learning and Innovation Networks for Sustainable Agriculture (LINSA) across Europe. Framing linkage as an adaptive process, whereby regime actors and entities adapt to incorporate LINSA, and vice versa, reveals different patterns and processes of adaptation. Five adaptation modes are distinguished and described corresponding to different levels of adaptation between LINSA and the agricultural regime. Understanding adaptive linkage processes within and across these modes as reflexive, learning and networking processes enabled and facilitated by individuals and organisations provides more insights into linkage processes than a hierarchical approach. Analysis of results from 17 LINSA from a number of different contexts across Europe allows a broad empirical analysis and an overview of the interplay of processes contributing to the agricultural regime's adaptive capacity.

1. INTRODUCTION: INCORPORATING DIVERSITY INTO AN UNDERSTANDING OF AGRICULTURAL TRANSITION

There are growing debates about the need to re-orientate the food production-centred food system towards more ecological, social and environmental lines and address the growing demands from society on agricultural systems (Marsden, 2013). It is increasingly acknowledged that meeting this sustainability challenge in the agri-food system will require system innovation (Elzen et al., 2004) and transition (Hargreaves et al., 2013; Hinrich, 2014).

From the socio-technical transition perspective a transition entails a fundamental change in co-evolving structures, cultures and practices so that the way a societal system functions is profoundly altered (de Haan and Rotmans, 2011). In agriculture the notion of transition applies to a shift from an agri-food system with the societal function of producing food, characterised by having the goal of increasing productivity, to one built around the wider principles of sustainable production and rural development (Brunori et al., 2013). A number of alternative models of agriculture have emerged which potentially can contribute to such a shift including, for example, low-input agricultural approaches, multi-functional agriculture and locally embedded production and consumption (e.g. Horling and Marsden, 2011). Within these approaches, networks of actors experimenting with innovative sustainable solutions at the local level are understood to play an important role in seeding a more sustainable form of agriculture (Wiskerke and van der Ploeg, 2004; Klerkx et al., 2010). It is known that the solutions they propose deviate from, and hence are often resisted by, the prevailing agri-food system however

the nature of their interaction with the agri-food system is still to be fully explored (van der Ploeg et al., 2004; Knickel et al., 2009).

The socio-technical transitions literature provides useful perspectives for examining this interaction. In this literature a socio-technical regime is described as "the structured complex of more established practices and associated rules that stabilise existing systems" (Geels, 2011, p26). Regimes are relatively inert and resistant to change being structured to incremental innovation following established trajectories. According to Seyfang and Smith (2007, p588) the regime's "entrenched cognitive, social, economic, institutional and technological processes lock us into trajectories and lock out sustainable alternatives". The technological, organizational and institutional arrangements which support the dominant mode of agricultural production can be thought of as a socio-technical regime. In the transitions perspective niche are important sources of ideas and practices which challenge the regime and can potentially initiate a sustainable regime transformation, if conditions are right (Kemp et al., 1998). This regime transformation is seen to occur through an accumulation of novelties in 'niche spaces' which allow, through learning and experimentation, radical innovations to develop (Schot and Geels, 2008). Regimes do not always recognise that novelties can be the key to effective innovations and as such the novelties often remain hidden (van der Ploeg et al., 2004). These novelties can be thought of as synonymous with networks proposing innovative sustainable solutions

Thus studies using this perspective have drawn attention to the interplay between the entrenched regime and innovative niche. This interplay has been conceptualised within different strands of the transitions literature. The multi-level framework proposes that radical innovation emerges from complex interactions between processes occurring at, and between, three inter-related levels (niche, regime and landscape) (Geels, 2002, 2006). Developed for technological innovations in various industries and supported by historical analysis, this provides a heuristic structure for guiding the search for patterns, causes and impacts of different phenomena during transition. A parallel set of literature sharing the same concepts considers how the transition (and niche in particular) can be managed to break into the mainstream, this has been applied to emerging innovations in sustainable development contexts (e.g. Shove and Walker, 2007). Thus the transitions perspective offers concepts for understanding how innovative networks experimenting with sustainable agricultural practices might interact with the dominant agri-food system.

However, multi level analysis has been criticised. as offering an overly functional and structural (and hierarchical) explanation of transition, and as not taking account of the heterogeneous characteristics of niche and regime and their interaction, nor of their adaptive capacity, or the dynamic nature of their interaction within sustainable agriculture contexts (Raven et al., 2011). Descriptions and analyses are seen as abstract from the messy dynamics that occur within and between networks of actors that are involved at all levels in innovation processes (Elzen et al., 2012; Farla et al., 2012). In the same way critics argue that the orientation in system innovation theory and transition management towards the niche, typically focussing on how and under what conditions a niche influences a system, neglects the *processes that link* niche and

incumbent regime entities, which can be characterised by reflexive and adaptive processes (e.g. Geels, 2002; Smith, 2007).

These criticisms are pertinent to understanding the relationship between the multiplicity of networks operating within sustainable agriculture niches and the multi-faceted agricultural regime. As Rotmans et al. (2001) notes, transitions have an inherent complexity and uncertainty due to the multiple developments in a number of spheres that are intertwined, multi-actor in nature, and to the existence of radical shifts. This is no more so than in agriculture, which is multi-dimensional and where a number of diverse and qualitatively different sustainability innovations are emerging. These differ from technological ones conceptualised as niche, as they are concerned with sustainable forms of agriculture and do not develop in predictable ways but are characterised by adaptability and flexibility (Roep et al., 2003; Veldkamp et al., 2009). Also, as Geels (2010) notes, sustainability transitions differ significantly from technological (and historic) transitions.

Furthermore the agricultural regime's adaptive capacity, which can involve drawing in and offering some protection to niches, creates a situation where multiple agricultural transitions result from push-and-pull efforts by niche actors in cooperation with regime actors or, a mix between 'top-down' induced and 'bottom-up' sprouted action (Klerlx et al., 2010). Commentators have described bottom-up networks emerging in a self-organising fashion and coordinated by rural actors (traditional and non-traditional), coalition networks with regime actors, or emanating from within the regime itself (Berkhout et al., 2004; Aarts et al., 2007; Knickel et al., 2009; Elzen et al., 2012). Thus networks of actors collectively engaged in innovation emerging in, and operating across, all levels are seen to contribute to transition in what some commentators call a Complex Adaptive System (CAS) (Klerxk et al., 2010; Rotmans and Loorbach, 2010).

This complexity highlights, not only the need for a more nuanced understanding of the relationship between niche and regime than offered by existing transition perspectives such as multi-level analysis, but also the need for closer attention to the adaptive nature of niche-regime linkage and the networks and processes involved. This leads to the main questions of the paper, namely: How can analysis of the niche-regime linkage be framed to take account of these dynamic and multiple interactions? Are the analytical concepts of regime and niche relevant to understanding the relationship between the multiple sustainable agricultural networks operating at niche and regime levels in agriculture? Is adaptive capacity a useful concept to explore this relationship? Although alternative theoretical framings (e.g. structuration theory (Giddens, 1984)) may offer insights into these phenomena the focus here is on sustainable agricultural *innovations* and their development with respect to the agricultural regime, hence the transition constructs would seem appropriate. This paper therefore aims to extend this theory to better incorporate the inconsistencies described.

This paper aims to reveal, and contribute to an understanding of niche-regime linkage specifically the processes that connect innovation networks in sustainable agriculture to elements of the agricultural regime. It draws on analysis of 17 Learning and Innovation

Networks for Sustainable Agriculture (LINSA) from across Europe. These are networks of actors with a diversity of components and ambitions which have an environmental, social or economic goal (Brunori et al., 2013). LINSA were identified within the SOLINSA[1] project as "networks of producers, customers, experts, NGOs, SMEs, local administrations, as well as official researchers and extensionists that are mutually engaged with common goals for sustainable agriculture and rural development - cooperating, sharing resources and co-producing new knowledge by creating conditions for communication." (Brunori et al., 2013, p4).

Specifically the paper aims to make theoretical and empirical contributions to niche-regime linkage in three ways. Firstly by using LINSA-regime as an analytical space for understanding linkage; secondly by conceptualising linkage as an adaptation process to account for the dynamic and heterogeneous nature of niche-regime interaction; thirdly by drawing on data from 17 LINSA across Europe to provide rich empirical insights and expand the scope of analysis beyond previous research.

The paper is structured in the following way. In the next section conceptualisations of niche and regime are explained, theories concerning their interaction are reviewed and their limitations considered with reference to the agricultural context. A discussion of reframing niche-regime linkage as adaptation follows. The LINSA concept and methods of LINSA selection and analysis are described next, and then five adaptation modes are distinguished and described corresponding to different levels of adaptation between LINSA and the agricultural regime. A discussion and conclusion complete the paper.

2. CONCEPTUALISING REGIME-NICHE LINKAGE

2.1 Regime, niche and novelty as analytical concepts

The notions of regime, niche and novelties provide analytical concepts for exploring the interplay between an embedded agri-food system and the emerging networks experimenting with sustainable innovations which challenge it. Building on evolutionary economics perspectives, regimes are understood to develop incrementally and cumulatively along entrenched trajectories (Dosi, 1982; Geels 2004), and the resulting inertia presents a number of barriers to innovations advocating transformations in a more sustainable direction (Rip and Kemp, 1998; Geels, 2004). The rules of the regime generate incremental (first order) innovations which fix problems within the regime; they maintain the status quo and do not challenge the rules about how a system operates. These contrast to radical (second order) innovations which respond to contradictions within the regime and external pressures and, crucially, seek to change it; their rules are generated outside the regime (Knickel et al., 2009; Brunori et al., 2013)[2].

[1] SOLINSA- Support of Learning and Innovation Networks for Sustainable Agriculture
[2] In reality this distinction is not so clear since it depends on context (Brunori et al., 2013)

Describing the agri-food regime in terms of the interdependence and co-evolution of technical (food production and associated inputs and processes) and social elements (prevailing attitudes and values, and policy measures) across a regime fits well with the socio-technical transition perspective. Smith (2006) notes that the mutually entrenching cognitive, material, economic and social phenomena that characterise a regime, are clearly present in the development of the agricultural socio-technical regime. This manifests itself in regimes in western agriculture through regulation, prescribed farming practices, a specific trajectory for research and development and established supply chains (van der Ploeg et al., 2004); and in institutions, such as Agricultural Knowledge Systems (AKS)[3], that are charged with fostering innovation and are often locked into generating incremental innovations (Knickel et al., 2009). Due to its stabilising features, the agricultural regime is characterised as enjoying stronger institutional support, greater economic significance, and broader political legitimacy and scientific authority than emerging alternatives, it therefore tends towards sustaining dominant frameworks and marginalising more radical sustainable alternatives (Flinterman et al., 2012; Brunori et al., 2013).

Internal niche processes of learning and experimentation allows niche to develop and build up momentum to challenge the regime (Kemp et al., 1998). Definitions for niche vary. The concept originally described niches of technological innovations, developing within commercial markets, where niche afford temporary 'protective space' to novelties against mainstream market selection (Kemp et al., 1998). As Seyfang and Smith (2007, p591) point out niches are spaces where "the rules are different" and conventionally these rules are those of the market. However niche have also been used to capture socially-oriented innovations where people's motivations for action are based upon different values from the mainstream (Smith, 2007; Seyfang and Smith, 2007) and here the 'protected space' of niche may be one of values and culture (Witkamp et al., 2011). In agricultural and associated rural development settings niche may offer some temporary 'protective space' to novelties through subsidises or policy incentives for diversification and sustainable agricultural practices, or by providing a supportive and sympathetic community in which to nurture sustainable agriculture ideals. These novelties, described as a new technology, a new technical concept or a new way of doing things (van der Ploeg et al., 2004), are often enacted by local level networks of actors (Tisenkopfs et al., 2009; Esparcia, 2014). In this paper, we refer to these local level networks as LINSA, as defined in Section 1. Thus LINSA are envisaged as synonymous with novelties experimenting with, and mutually learning about, new way of doing things in sustainable agriculture and associated rural development niche spaces (Roep et al., 2003; Geels and Schot, 2007).

[3] In agriculture the notion of the AKS describes the formal set of institutes and actors charged with fostering innovation, and the stable actor networks which support agricultural innovation and learning (Roling and Engel, 1991). The agri-food regime has developed a dedicated knowledge base and institutional arrangements to promote and sustain it. The AKS encompasses powerful actor networks (comprising agricultural scientists, extension officials, and agro-chemical suppliers and technologically innovative farmers). Co-evolving within the regime, the AKS institution confers legitimacy and scientific authority (Leeuwis, and van den Ban, 2004).

2.2 Niche 'linking up' with tensions in the regime –hierarchical linkage

In describing linkage, commentators emphasise the dialectic nature of the relationship between niche and regime. According to the multi-level framework interaction across three levels: socio-technical regimes (the meso-level), socio-technological niches (the micro-level) and socio-technical landscapes[4] (the macro-level), can result in radical innovation. Niche actors may either wait for 'windows of opportunity' to open up in the regime, or use niche experiences to create 'cracks' in the regime to establish innovations and stimulate regime actors to transform the regime from within. Tensions in the incumbent regime created by landscape pressures offer opportunities for niche to provide solutions; niche activities break through when they successfully resolve those tensions (Geels, 2002). As described for ecological theory, a breakthrough can occur when what is new, and the condition making the new possible, originate at the same time (Haila and Dyke, 2006). Niches are described as building up internal momentum and looking for chances to exploit destablisation in the regime. Developing these ideas scholars consider that it is the shift in relative strength of selection pressures that generate opportunities for change, arguing that the competitive selection pressures that initiate change can be top-down or bottom-up (Berkhout et al., 2004).

Transformative changes depend, both on internal tensions within the regime and, on the development and adaptive processes of the niche itself. When links are successfully made between regime and niche a process of reconfiguration can then trigger changes across the regime (Geels, 2001; Berkhout et al., 2004). Although developed for understanding technological innovations, these ideas are pertinent to agricultural transitions. As noted for sustainable development, pressure within the regime through environmental policies, for example, to become more sustainable makes the diffusion into the mainstream easier. These tensions can be an opportunity for niche actors to offer solutions as well as to identify sympathetic regime actors and gain support. Drawing on critiques of the multi-level analysis and the transition management literature Smith (2006, 2007) describes how niche can stimulate transformation by 'linking up' with tensions in the incumbent regime and applied these ideas to green niches describing the relationships between the mainstream food system and organic practices that diverge radically from it. However although these views provides some insights into linkage, commentators argue that linkage relations between niche and regime requires further analytical attention (Smith, 2007; Elzen et al., 2012)..

2.3 Dealing with dynamics and heterogeneity –complex linkage

The hierarchical transition perspectives, with a focus on how niche linearly develop and influence a system, provides some insights into the nature and extent of niche-regime

[4] In addition to the niche and regime, a background sociotechnical landscape is defined which forms an exogenous environment representing longer-term influences on niche and regime actors (macroeconomic trends, deep cultural patterns, macro-political developments) (Geels and Schot, 2007). In agriculture these include the CAP, impact and regulations associated with climate change, consumer patterns and dietary preferences and concerns, cost of inputs linked to the price of oil, and demographic changes.

linkage but fails to reveal the complexity of interaction processes. It also does not take into account the processes between sub-niche networks (novelties) like LINSA and the regime. Critics argue that compartmentalising the niche and regime and envisaging them as static and homogeneous black boxes is artificial and abstract (Hekkert et al., 2007; Shove and Walker, 2010; Hargreaves et al., 2013). Instead, they assert that, both niches and regimes are dynamic heterogeneous layered entities.

Regimes are recognised as having a web of inter-linking actors across different social groups and communities and multiple components, that is, sub-regimes, layers and domains (Geels, 2002). With respect to linkage, this can create complexity as links can occur across any one of a number of the socio-technical regime dimensions (Geels, 2002; Smith, 2007, 2006). Berkhout et al. (2004) for example talk about a continuum of regimes at successively higher levels of aggregation and the interaction with niche occurring at any one of these levels. In the case of the agri-food regime, although perceived as a uniform entity and a monolithic industrialized or modern food production system, it is described as heterogeneous with multiple social and technical components (including actors, networks and rules and routines) operating in different interdependent sub-regimes (e.g. market, policy, research, technological) (Geels, 2002; Smith et al., 2005; Holtz et al., 2008). In deconstructing the monolithic regime, Diaz et al. (2013) for example, found mismatches between domains (agriculture and environment), sub-regimes (research and administration) and governance levels (administration levels) which niche could exploit. Additionally there are intermediary regimes spanning previously unrelated regimes which complicate any understanding of a 'single' regime, for example, elements of the agriculture overlap with those of health or energy regimes (Holtz et al., 2008; Geels, 2011; Flinterman et al., 2012).

Furthermore, although a regime exhibits stability and path dependency this is regarded as relative, since a regime is continually subject to competitive selection pressures as well as internal pressures, contradictions, different interpretations and operationalisations of policy, and different actor experiences and motivations (Rip and Kemp, 1998; Berkhout et al., 2004; Geels, 2004, 2011). Also, as Smith et al. (2005) point out regimes involve the active coordination of lower order agency on the part of institutions, networks and actors as regime 'members' in their own right. It is these diverse actors who reproduce the regimes but who also reproduce tension. Thus regimes are described as "semi-coherent" as there is both alignment and tension. This is evidenced in the agri-food regime by the number of organisations and individuals not adhering to the assumptions and principles of a sectoral, industrialised agriculture, with disagreement on specific issues, debate and internal conflict. These contradictory pressures lead to sub-groups in the agricultural regime which champion different transitional trajectories (van der Ploeg, 2009).

Niche are similarly multi-faceted. Their actor interests do not always align, they are the scene of negotiation and can become fragmented and re-configured by innovation processes. As such their development is characterised by non-linearity, fluidity and instability (Geels and Raven, 2006; Diaz et al., 2013). This is the case for the sustainable agriculture innovations which arguably, like social innovations, do not exhibit the consensual, streamlined progress that are

attributed to technological niches (Lovell, 2007; Seyfang and Smith, 2007; Hielscher et al., 2011). They emphasise more sustainable forms of agriculture, in a social, ecological and economic sense, than technological innovations and can take multiple forms (Klerkx et al., 2010). Indeed one of the features of sustainability transitions is that they involve multiple solutions as opposed to a single technological solution (Geels, 2010).

This heterogeneity in regime and niche presents a challenge for understanding linkage. Scholars argue that there are multiple horizontal and diagonal interactions between niche and regime layers (e.g. Klerkx et al., 2010). It has been shown that niches do not usually link up to a regime as a sort of 'coherent whole', that instead, often just specific components (technical or social) of a niche link up to a regime (Smith, 2007; Elzen et al., 2012). These linkages can be envisaged as taking place in a fuzzy and messy overlapping space between niche and regime. At the sub-niche level Elzen et al. (2012) propose that novelties interact with both niche and regime. Novelties and their actors can be part of the niche where they receive protection, however some of the actors involved are regime actors who apply the novelty in their own practices and this makes the novelty part of the regime.

Thus, the agri-food regime and niches concerned with sustainable agriculture, are not stable coherent entities with distinguishable hierarchical boundaries but dynamic and heterogeneous overlapping configurations. Networks of actors proposing sustainable innovations (LINSA) can be envisaged as synonymous with novelties which operate in this overlapping space. This underpins the approach to analysis of linkage in this paper and the notion of LINSA as developed in Section 3.

It is clear from the discussion above that no single bounded 'agri-food regime' can be defined. For the purposes of the analysis in this study the core agricultural regime is understood in terms of its key societal function of producing food. This follows a sectoral approach where sub-regimes can be identified as, for example: agricultural policy, agricultural research, AKS, agro-food industry, food production and processing technology, market and consumer preferences (Holtz et al., 2008; Geels, 2011). However it is acknowledged that these sub-regimes and their individual actors are also required to address sustainability and rural development functions (environmental, social and economic) to some extent, for example, through CAP measures and market-led initiatives. The agriculture domain thus dominates the regime but environment and rural development domains are also represented. Within the latter diversification into care farming and farm energy means that energy and health domains, which span other regimes, are also represented. Thus the boundaries are blurred with the multiple niche which offer space (to protect from market pressures or from dominant values) to sustainable agriculture or rural development novelties inside or on the margins of this regime.

2.4 Reframing niche-regime interaction and linkage as adaptation

2.4.1 Adaptive systems

As well as the heterogeneity already described, critics argue that multi-level transition approaches are quasi-static, that the dynamic nature of the niche and regime entities is neglected (Hekkert et al., 2007), and that the dynamics of transition trajectories are messy, coincidental and capricious (Elzen et al., 2012). With reference to sustainable agriculture initiatives, Roep et al. (2003, p197) accord stating that "innovation and transformation are complex and recursive processes. They are characterised by setbacks, creativity, confrontations, negotiations, uncertainty and contingency". This has led some scholars to draw on frameworks stemming from Complex Adaptive System (CAS) theory to try to capture this unpredictable behaviour (van der Brugge and van Raak, 2007; Foxon et al., 2009). A CAS is seen as constantly changing, evolving and adapting to a changing environment. This view has particular relevance to envisaging the interaction between niche and regime in terms of the regime's adaptive capacity, the regime's ability to respond to constantly changing selection pressures and maintain its stability. This, Berkhout et al. (2004) argues with reference to technological regimes, is governed by regime resources and the ability to coordinate responses. With respect to technological innovations, symbiotic niches are thought to reinforce the regime by assisting with its adaptive capacity, by reproducing regime functions in the face of prevailing selection pressures (Geels and Schot, 2007), where these competitive selection pressures can include new configurations, innovations and new visions (Berkhout et al., 2004). However, adaptive capacity is also determined by the regime's ability to open up to novel practices as alternatives to the incumbent regime. Some researchers point out that niche also exert selection pressure and generate resources to respond to this pressure, as such the greatest capacity for adaptation may lie in the innovative networks of actors emerging outside the regime (Christiansen, 1997; Kemp et al., 1998). These ideas correspond to CAS theory in which stability or resilience is regarded, not only as capacity to buffer or absorb disturbances and still maintain function, but as concerned with opportunities that disturbances open up in terms of recombination, renewal and emergence of new trajectories (Folke, 2006). This line of thinking in ecology where CAS is applied has created a spectrum between adaptability, the capacity of actors in a system to influence resilience, and transformability, the capacity to create a fundamentally new system (Walker et al., 2004; van der Brugge and van Raak, 2007). This agrees to some extent to different interactive relationships and transition pathways described under different landscape pressures and levels of regime and niche stability which are discussed next.

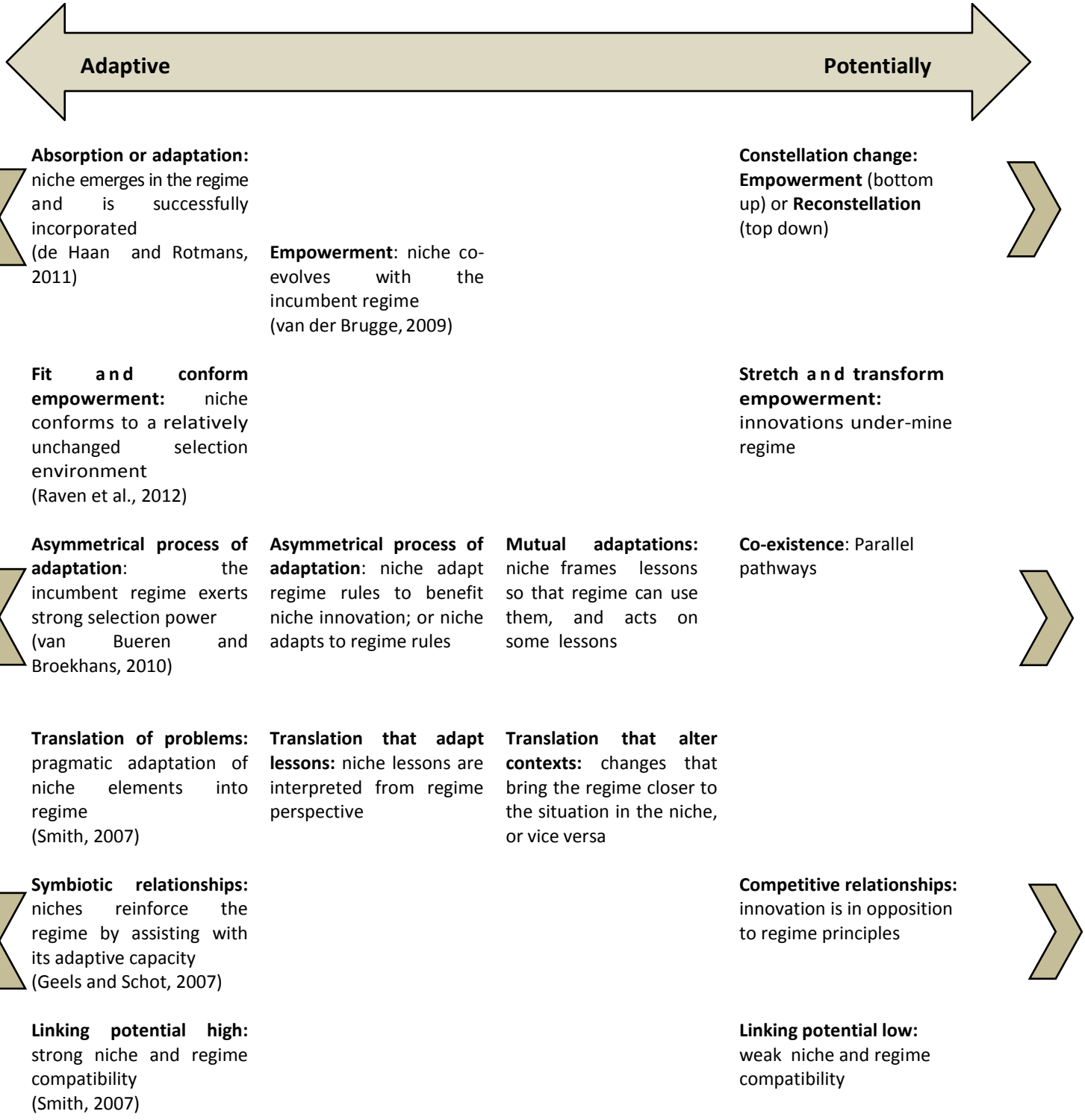


Figure 1 Niche-regime linkage modalities grouped according to the nature and extent of adaptation Adapted from Klerkx et al., 2009

2.4.2 Adaptation Modalities –higher level framing

As noted earlier, adaptation depends both on internal tensions within the regime and on the development and adaptive processes of the niche and its constituent novelties. Here regime adaptability is important but so too is the resilience and adaptability of the configurations in the niche in relation to the wider context of the regime (Berkhout et al., 2004). Researchers working with technological innovations describe numerous types of interactions and pathways of change ranging from a situation where the niche innovation conforms with regime and is successfully incorporated (adaptive), to one where niche innovations aim to transform the regime (potentially transformative) but are resisted. These have been classified into modalities using various terminologies but the relationships they describe can broadly be grouped according to the nature and extent of adaptation, as set out in Figure 1. Although these refer in the most part to technological innovations, Smith (2007), in a study of green niches, also described corresponding niche and regime interaction in terms of adaptation referring to different levels of translation.

The interactions with most pronounced adaptation, termed *absorption* or *adaptation*, are described as internally induced change where a niche emerges in the regime and is incorporated into the regime (de Haan and Rotmans, 2011). This aligns with what Smith and Raven (2012) call *fit and conform empowerment* and describes a situation in which *asymmetrical processes of adaptation* operate, where the incumbent regime exerts strong selection power over the niche and the regime incorporates lessons from the niche in a way that requires least change (van Bueren and Broekhans, 2010). The same idea is explained in Smith's (2007) modality *translation of problems*: *pragmatic adaptation of niche elements into regime*, where problems in the regime inform the guiding principles creating the niche and some niche practices are sufficiently flexible to be interpreted favourably against regime socio-technical criteria. All these modalities broadly correspond to *symbiotic* niche-regime relationship which reinforce the regime by assisting with its adaptive capacity (Geels and Schot, 2007). These ideas also align to those from ecology in the sense that disturbances or novelties are described in terms of symmetry breaking where internal differentiation arises in a system (Haila and Dyke, 2006)

The interactions with least pronounced adaptation but greater transformative potential are described as a *constellation change* which aims to transform the regime through bottom-up emergence of niche *empowerment* or brings about a transformative change top-down *reconstellation* (de Haan and Rotmans, 2011). These align with Smith and Raven's (2012) notion of *stretch and transform empowerment*, and to a situation of *co-existence* where niche evolve out of dissatisfaction with the regime, lessons fail to penetrate the regime, the regime and niche develop along parallel pathways (van Bueren and Broekhans, 2010). These modalities broadly correspond to *competitive* niches which can make the regime vulnerable and are countered by the regime (Geels and Schot, 2007). These distinctions show that transformative niche encounter strong selection pressures, so transformability can be understood here as ambition, rather than capacity, to create a fundamentally new system.

Interactions between these two extremes are described as *empowerment* were the niche grows and is able to sustain itself, co-evolving with the incumbent regime (van der Brugge, 2009 in Klerkx et al., 2009) or *mutual adaptation* where niche learns how to frame its lessons in a way that is of use to the regime and the regime acts on some of these lessons (van Bueren and Broekhans, 2010). Smith (2007) similarly identifies *translation that adapt lessons* where niche lessons are interpreted from regime perspective and inserted into regime settings or the niche is modified in the light of lessons learnt about the regime; and *translations that alter contexts*, where changes bring the regime closer to the situation that pertains in the niche, or vice versa (which can entail the mutual adaptation of niche and regime).

At the same level of analysis, but drawing on transitions management literature, a spectrum can also be described according to linking potential. In the context of sustainable development, linking potential is thought to be greatest where niche 'links up' with tensions in the incumbent regime and there is good compatibility between the assumptions, practices and rules of the niche with those of the existing regime. In the former the niche adapts to become more accessible to mainstream audiences and the regime may accommodate some niche ideas (Seyfang, 2009), in the latter, although the niche are potentially transformative, linking potential is limited as niche actors expectations and values are very different to those in the incumbent regime.

These modalities give a sense of the nature and extent of niche-regime linkage as adaptation at a higher level of analysis where niche and regime dichotomy is emphasised. However, as revealed above, the heterogeneity and blurred boundaries of niche and regime, and the dynamic nature and complexity of interaction means that a more refined analysis is needed to complement such modal classifications.

2.4.3 Adaptive linkage processes – more refined framing

Scholars have introduced several concepts to analyse linkage processes that emphasise the adaptive, dialectic and reflexive relationship between niche and regime actors and entities. In a critique of Strategic Niche Management Smith (2007, p430) arguing that, as well as a niche influencing the regime (through one way transfer of lessons to regime actors), a regime also influences niches, stated "the incumbent regime inevitably influences lesson drawing, as actor preferences and meanings are informed by experiences and norms from the regime, and this prior perspective is the starting point for actor engagement with the niche". In this sense, he argues, sustainability problems in a regime have an important constituting effect upon niche creation.

Klerkx et al. (2010) in highlighting the significance of networks to innovation, describes the reflexive relationships between network actors and their institutional environment in which they are embedded. They refer to 'adaptive innovation', which involves continuous adaptation to changing circumstances, with 'circular causality' in which niches are conditioned by regimes, but themselves (try to) influence regimes, which hence may exercise a different kind of conditioning on niches. In innovations systems studies such a reflexive

relationship between actors and their institutional environment which actors may adapt, change, or complement has been called 'mutual embeddedness' (Markard and Truffer, 2008). This view is set against the debates about the relative importance of agency and structure in explaining change. Many networks, particularly those concerned with sustainable agriculture, have visions and expectations for changing the regime and might include entrepreneurs and advocates. Changes brought about by such networks are purposeful and hence can be attributed to agency. These confront or align with the agency of regime members.

Developing the case for linkage as a reflexive process, Smith (2007) considers niche practices and regime contexts as translating back and forth. He asserts that they are in a dynamic and direct relationship with one another, in which ideas, practices and events in one are translated into ideas and practices in the other. Thus linking rarely means that socio-technical practices from a niche are simply adopted in a regime (or vice versa), but that some form of translation, i.e. changes of these practices takes place to make this possible. Research has shown that socio-technical components, rather than entire alternative practices, translate from niches into regimes and components of each appear in the other, also that elements of niches link to elements of regimes through a process of progressive anchoring (Elzen et al., 2012).

The continuous and evolving adaptive interplay between the regime and niche actors, described here in terms of adaptation modalities and the adaptive linkage processes operating within and across them, provides the backdrop for understanding niche-regime linkage. Although these ideas refer to the niche level, they are equally relevant to understanding the interactive processes between sub-niche novelties and the regime. They can contribute to a hypothesis that linkage is an adaptation process operating across the niche-regime overlapping space and involving multiple entities and actors in both in network configurations, described here as LINSA.

2.4.4. Framing the analysis

At one level the notion of a spectrum between Adaptive and Potentially transformative modes of adaptation (in Figure 1) provides a useful framing for analysis of the niche-regime linkage. According to the above discussion the following properties influence such a pattern of adaptation:

- The origin of niche (emergence within or outside the regime)
- The extent to which niche has transformative ambitions; the level of innovation
- Niche-regime compatibility (alignment of assumptions, practices and rule)
- Tension in regime and the potential for niche to link up with these tensions
- Balance of adaptation (extent of asymmetry of adaptation processes)
- Niche adaptation -level of assimilation and lesson penetration -(flexibility, potential for addressing regime problems and nature of translation, extent to which the niche reinforces regime functions and enhances adaptive capacity)

- Regime adaptation and its level of cooperation and accommodation with niche (the extent of support or resistance from regime actors, structures and value systems rules, practice etc)
- Linkage potential (potential to address regime problems- nature and extent of linkage

These properties are known to combine to create different patterns and levels of interplay and adaptation between niche and regime and will be applied to examine LINSA linkage with regime entities. However, acknowledging the complexity of niche and regime interaction, adaptive linkage processes need to be considered at a more in-depth level. These are the reflexive processes in which niche and regime actors and networks continuously adapt, react to, and modify each other.

3. SELECTION AND ANALYSIS OF LINSA

3.1 LINSA

As defined in Section 1 LINSA are networks of actors with a diversity of components and ambitions which have an environmental, social or economic goal (Brunori et al., 2013). The notion of LINSA is used to capture the multiple and diverse networks of actors learning together and experimenting with sustainable solutions and innovative practices in agriculture and rural development. LINSA provide a useful device for understanding the patterns and processes of adaptation beyond the tight constructs of niche and regime.

The concept builds on a body of work showing that innovation is often enacted by local level networks of actors (Tisenkopfs et al., 2009; Klerkx et al., 2010; Esparcia, 2014). The network form is considered well-suited to illustrate the increasing diversity of agents, sources of knowledge and their social distribution involved in transition processes. Innovation occurs when resources flow through a network and actors strategically use the potential a network provides (Brunori et al., 2013). As Klerkx et al. (2010) notes in self-organising CAS innovation agency is distributed across networks since actors cannot pursue their innovation goals without taking into account other actors. As relational forms, LINSA also account for changing network composition, aim and scope over time (Wiskereke and Roep, 2007). With respect to CAS, LINSA correspond to 'disturbances' which can occur in niche or regime and can be absorbed or open up new opportunities (Folke, 2006).

The definition of LINSA is not fixed. LINSA can be regarded as novelties operating in established sustainable agriculture and rural development niche spaces (e.g. farm energy, care farming, low-input farming). They have yet to demonstrate their scalability to a level at which they are seen as true competitors to the regime. However as noted in Section 2 such innovation networks do not always come from outside the regime but can come, or be supported, from within the regime by actors who are sympathetic to radical change (Elzen et al., 2012). So LINSA and their constituent actors can be part of the niche, or part of the regime if some of the

actors involved are regime actors who apply the innovative practices. As all have a sustainability goal of some form they can be described as purposeful.

The theoretical ambiguity of niche and regime and the associated absence of definitive boundaries and criteria for analysis, as discussed above, are widely acknowledged, particularly the difficulty of applying the conceptual levels of niche and regime to empirical levels (e.g. Smith et al., 2010; Lawhon and Murphy, 2012). A regime for example can be defined at one of several empirical levels (Berkhout et al., 2004). In this study the regime entities for analysis, were identified and described relative to the topic of interest in each particular LINSA. LINSA were expected to interact with different domains, sub-regimes and actors (e.g. sector representatives; environmental, rural development, care farm and farm energy organisations, farmer/citizen associations, AKS representatives, researchers, technologists, supply chain actors, consumers, policy makers, etc) at different tiers of regime governance and at different spatial scales. It was anticipated that the relevant regime actors and entities would be revealed in the analysis through these LINSA relations, rather than by using any prescribed units of analysis or definition of sub-regimes in advance in each case. However particular attention was paid to LINSA links with the AKS component and actors since this regime sub-system is significant to innovation.

3.2 Selection

LINSA are not tightly defined configurations which the proposed networks had to adhere to, however the project partners agreed that they should: have to engage in common activities, share a goal of innovation for sustainability[5], and demonstrate a minimum level of governance and organisation (Moschitz et al., 2015). Seventeen LINSA were selected for analysis from an original list of 35 networks, that met this standard, proposed by project partners.

Selection aimed to ensure that a wide range of networks in the sustainable agriculture and rural development context (encompassing three broad themes agriculture, energy, consumer-oriented networks[6]) across Europe was analysed. These themes were deliberately broad to capture agricultural and rural development activities that might be described as having a sustainability goal. A selection framework was applied based on the three themes and the following criteria derived from the project's conceptual review: origin (top down or bottom up), function (goals and ambitions) and scale; level of network integration (loose, tight Communities or Networks of Practice); level of innovation (radical or incremental); governance; and level of learning (Brunori et al., 2013; Ingram et al., 2013a, 2013b; Ingram et al 2014). This ensured that a range of networks types, organisational arrangements, origins, ambitions and network actors, and of linkage situations, were represented.

[5] It is acknowledged that sustainability is a diffuse term but at the stage of selection this was determined by LINSA expectations as articulated in formal documents.

[6] These themes were identified at the project conception, they do not relate to separate regimes, sub-regime or niche.

LINSA selected look for short-term innovations related to pathways already undertaken or to new pathways. The innovations they develop range from innovative production techniques to advocating changes in operational arrangements and governance in the wider agri-food system (and associated technical, economic, social and institutional changes). In this respect they represent both incremental (first order) and radical (second order) innovations (Brunori et al., 2013). All LINSA are value-led to some extent, in that they are mutually engaged with common sustainability goals. Economic motivations underpin LINSA development to different extents. These are emphasised most in LINSA developing new technologies and practices in response to changing demands in existing market arrangements, for those concerned with social innovation alternative marketing channels and arrangements are evolving or yet to emerge. As such all LINSA actors operate as economic agents but their expectations are moderated by value considerations. The niche spaces they operate in are protected, in some cases explicitly through subsidies, in other cases implicitly through shared values and cultures. For some LINSA economic subsidies were the trigger for LINSA development, in other cases LINSA emerged through shared sustainable ambitions prior to any financial support however they later tapped into support opportunistically.

3.3 Analysis

In line with the transdisciplinary approach underpinning the SOLINSA project (see Home and Rump, 2105) data were collected in a series of participatory workshops with each LINSA. These were supplemented by face to face interviews, focus groups, observation and document analysis. Five adaptation modes were distinguished using the spectrum of adaptation (Adaptive to Potentially transformative) set out in Figure 1 as a guiding principle and developing this with empirical data from the 17 LINSA. The empirical data and analysis was framed by the adaptation properties identified as significant to niche-regime linkage in Section 2. Thus the adaptation modes, distinguished according to nature and extent of adaptation, are: Pragmatic adaptation, Progressive adaptation, Adaptation in intermediary regimes, Partial adaptation and Parallel adaptation. These modes are not discrete, but this structure can be used to capture adaptive tendencies and to provide a framework for a more refined analysis of adaptive linkage processes, also highlighted in Section as being significant to linkage.

For the LINSA being studied this clustering corresponds to a progression from LINSA with ‘single issue’, first order innovations (agricultural practices) emerging in or close to the regime; towards ‘multiple issue’, second order innovations with transformative ambitions and socially-oriented goals emerging outside the agricultural regime. The modes exhibit increasing divergence from the mainstream regime with respect to assumptions, practices and rules, from compatible to oppositional (Ingram et al., 2015). The latter as social innovations demonstrate diverse organisational forms, pluralistic actors and resource base and varying degrees of formalisation (Seyfang and Smith, 2007). However, it is acknowledged that this is somewhat simplistic distinction since changes in values cannot be separated from changes in technologies and practices and actors relations which occurs sin all LINSA.

4. RESULTS

The five Modes are characterised in each of the sections below and exemplified with details of one or two LINSA. For full details of all 17 LINSA see Moschitz et al. (2015). The mode characteristics are summarised in Table 1. The terms LINSA and regime are used in the following analysis as shorthand, as there is insufficient space here to provide full details of the diversity of actors and entities involved in each.

4.1 Mode: Pragmatic adaptation

LINSA emerge within or very close to the agricultural regime and are successfully incorporated, as such linkage is well defined. The process of adaptation is asymmetrical as the regime exerts a strong selection power over the LINSA (where this selection power represents the economic drivers of agricultural production); it corresponds to streamlining of current regime processes rather than generating radical system change. With respect to translation, problems in the regime inform the guiding principles creating the niche, and LINSA practices are sufficiently flexible to be interpreted favourably against regime socio-technical criteria. LINSA guiding principles (assumptions, practices and rules) are commensurate with many of those of the incumbent regime, so compatibility is high. LINSA aim to achieve sustainable food production according to the rules of the regime's farming sectors (fruit, dairy, livestock); and help their respective sub-regimes adapt. LINSA actors achieve linkage with regime entities by being flexible and opportunistic. They develop and grow incrementally utilising existing AKS structures and linking with traditional actors and organisations. Policy intervention and regulations articulate the food production tensions (food quality and environmental concerns) and these create channels for translation of LINSA practices and ideas. The nature of the LINSA and the regime tensions means that some discrete solutions are available and can be easily extracted and accommodated by the regime entities concerned through technical farming practices, standards, regulations and policies. They use internal resources and deploys regime actors in collaborations and partnerships with LINSA actors, in response to internal regime pressures.

EXAMPLE: The Charter for Good Agricultural Practices in Livestock production in France

The Charter is a network of beef and dairy farmers, farmers' organisations, research and extension organisations created within the agricultural regime in response to consumer mistrust following mad cow disease. Original plans to build around farmers evaluating their own practices and committing to the Charter proved ineffective. Leaders of the scheme (including National Livestock Confederation and the Livestock Institute) decided to involve the AKS actors (agricultural chambers, cooperatives) and regional facilitators and trained local advisers were organised to support farmers and roll out the initiative. The Charter aims at progressively supporting French cattle farmers to improve their practices by the use of 41 Standards that farmers commit to. The standards are not too demanding, the intention is for every farmer to follow the standards, and not only an elite or motivated few. Thus the regime succeeds in incorporating lessons from the LINSA in a way that requires least change. The approach has been criticised by founding actors as remaining within the production oriented regime (thus there are internal LINSA tensions), but it has been a quantitative success.

Table 1 LINSA-regime adaptation modes

	Pragmatic adaptation	**Progressive adaptation**	**Adaptation in intermediary regimes**	**Partial adaptation**	**Parallel adaptation**
Origin	Within agri-food regime	Emerge on fringes of agri-food regime	Emerged within agri-food/ energy/health regimes	Marginal to agri-food regime	Outside mainstream agri-food regime
Ambition and Level of Innovation	No ambitions to change regime. 1st order	Ambitions to make a difference in a regime sector. 1st and 2nd order	Originally sustainable development goals. 1st and 2nd order	Ambitions to change consumer-producer patterns. 2nd order	Ambitions to change food system and societal norms. 2nd order
Compatibility	Compatible assumptions, rules, practices	Complementary assumptions, rules, practices	Emergent, limited sharing of guiding principles	Divergent, limited sharing of guiding principles	Oppositional, no shared guiding principles; different value system
Tension in regime	Agri-food regime tensions food quality, env., policies, farm livelihoods	Agri-food regime tensions env. policies , farm livelihoods	Energy/health regime tensions supplant agri-food regime tensions	Tensions beyond agri-food regime – consumer and civic concerns about food	Tensions beyond agri-food regime, food justice, health, community
Balance of adaptation	Asymmetrical process of adaptation with minimal regime adaptation Reinforces regime functions and adaptive capacity	Asymmetrical process of adaptation with some regime adaptation Reinforces regime functions and adaptive capacity	Complex adaptation of LINSA and regime	Partial adaptation as LINSA and regime tend to develop along own paths High transformative potential	LINSA and regime coexist and develop along own paths High transformative potential
LINSA adaptation	Flexible LINSA practices assimilated into regime Pragmatic adaptation of elements into regime	LINSA actors adaptation to regime problems and rules	LINSA adapt daily farming routines to new int. regime rules and align new regime practices with agri-food regime	Few discrete practices integrated into the regime LINSA actors might exchange lessons with regime	Very few discrete practices integrated into the regime. LINSA lessons fail to penetrate the system, and vice versa
Regime adaptation	Regime actors, structures and value systems support LINSA adaptation	Regime actors, structures and value systems support some LINSA adaptation	Energy / health regimes address their own tensions by co-opting agri-food resources	Regime actors, structures and value systems give partial support to LINSA adaptation	Regime actors, structures and value systems do not support LINSA adaptation
Nature and extent of linkage and linkage potential	Well defined 'vertical' linkage. Strong potential to address regime problems	Well defined 'vertical' linkage, Good potential to address regime problems.	Complex linkage, some potential to address problems in both regimes	Partial linkage. Relatively weak potential to address regime problems 'Lateral' networking reinforces niche	Diffuse linkage. Weak potential to address regime problems 'Lateral' networking reinforces niche
Example LINSA	**Charter of Good Agricultural Practices in Livestock production, France**	**Sustainable Dairy Farming, Netherlands; Réseau Agriculture Durable, France**	**Biogas Latvia**	**Association for Solidary Economy Crisoperla, Italy**	**Permaculture Community, England**

Linkage is achieved by adaptation of LINSA actors and livestock sector actors and sub-regimes, albeit asymmetrically. The standards are continuously reviewed, translated and re-negotiated by actors as they move into the mainstream arena. In an attempt to continually improve practice, the Charter network reassesses and redefines standards every 3 or 4 years. Legislation and new expectations from the society can trigger off these evolutions. The content is defined by the farmers, but each evolution of the scheme is an opportunity to collect the views and expectation of in the food chain partners and of consumer and citizen associations. Thus an dialogue between LINSA and regime actors has been established to enable both future strengthening of the standards and integration into the regime. This reflexive relationship brings about incremental change in the LINSA and the livestock sector it interacts with. The LINSA and the regime both adapt and are re-configured.

4.2 Mode: Progressive adaptation

LINSA are emerging on the fringes of the agricultural industry in response to sustainability issues such as resource efficiency, soil and water quality. Links between LINSA actors and conventional farming networks are enhanced by shared guiding principles to some extent (assumptions, routines) with respect to making farming businesses economically sustainable, although the values, practices and rules are being challenged. Although innovations are conceived as second order, there is some flexibility to allow practices to be detached and inserted into mainstream routines, especially as in some cases these represent cost efficiency savings for businesses. The relationship is characterised by progressive adaptation as LINSA actors adapt usually by re-interpreting and modifying practices, and the farming industry adapts to incorporate some LINSA solutions to meet their particular problems. Although still an asymmetric process of adaptation the incorporation of lessons from the LINSA requires some adjustment in the regime. The LINSA co-evolve with the mainstream but come together through projects and partnerships and by recruiting and mobilising traditional actors. The two examples that follow demonstrate the different nature of linkage observed in the Mode.

EXAMPLE: Sustainable Dairy Farming, Netherlands

This LINSA is a regional network of dairy farmers who want to improve the environmental and economic situation. They are challenging the existing rules of dairy farming by advocating a low external input approach (LEIA). This has attracted the interest of farmers, researchers, consultants and politicians as a means of making the dairy sector more sustainable (economically and environmentally). Actors in several large scientific research programmes supported the development of LEIA. Tensions in the sector (water quality concerns with high input dairying and demands for cost efficiencies) have framed LINSA development and provided opportunities for integration. This LEIA concept has become progressively incorporated into the sector at the provincial level through a succession of projects over a period of 10 years. The projects each with 50-100 farmers from existing farmer study clubs were aligned to provincial policy and contingent on funding. LINSA actors utilise selected mainstream practices and rules to formalise or legitimise their working practices to gain acceptability by policy makers. In calculating the mineral flows through the farm and the certification of the LEIA, actors in the network have tried to formalise their working methods. They have reinterpreted elements of

the practice so that they can be inserted into regime settings. In this sense the second order LEIA concept becomes fragmented into detachable practices.

Successive positive project monitoring and evaluation (meeting criteria of both farmers and the authority) has led to repeated funding, in a cycle of positive feedback and raised ambition. In the latest project newcomers implement the approach while a core of farmers set up a new experiment advancing the concept. Consequently LINSA practices are adapted for more widespread usage but also strengthened by committed actors. The exemption some experimental groups have secured for surface spreading (the most contested element of the approach instead of the legally required manure injection) has meant that it has been able to survive outside the official regulations; thus, the dairy sector actors have adapted to provide a protected space for learning and experimentation. The regime still exerts a strong selection power but the LINSA actors are learning how to frame lessons in a way that is useful to it, there is, therefore, some evidence of mutual adaptation. Mobilising scientific expertise to legitimise these LINSA practices through networking and enrolment of researchers has been a key adaptation device, particularly in persuading policy makers to fund projects and exempt practices. Reliance on project funding however means some uncertainty about the durability of the LINSA links to the mainstream networks and institutions.

EXAMPLE: Réseau Agriculture Durable (RAD)

RAD is a network of small groups of farmers in France sharing ideas, experimenting with, and promoting sustainable ways of farming. RAD helps farmers and advisors build their own pathway towards sustainable agriculture through a reflexive process. The RAD was created in a bottom up way on the fringes of the main agricultural sectors and has co-evolved, receiving little support, although AKS agents initially provided technical advice and facilitation tools. Linkage is constrained by the diffuse nature of the LINSA ideas and practices and tends to be ad hoc. RAD actors have reinterpreted and codified some LINSA components adapting them to regime rules, for example, agri-environment measures (AEM) and premiums within CAP. Thus they have learnt how to frame some LINSA lessons in ways that can be useful to the national policy and situate the practices within mainstream settings and financial incentives. Opportunities for joint project work between research organisations and some groups in the LINSA have emerged as the industry responds to sustainability concerns. The LINSA actors regard these hybrid projects as important in gaining some political recognition and support, whilst the mainstream actors regard them as enhancing their sustainability credentials. The intermittent nature of this interaction, reflects LINSA members' reluctance to fully embed the LINSA in the mainstream. The LINSA has been more active in linking with advisory and knowledge system of alternative farmers and rural actors. These strong lateral links within this alternative niche enable them to have a bigger impact at the national level.

4.3 Mode: Adaptation in intermediary regimes

In this mode LINSA are founded on the basis of agricultural sustainability but operate at the intersection of agriculture with the health (Dutch care farming) and energy (Latvian farm biogas) sectors, respectively. They contribute to emerging 'intermediary regimes' that

incorporate elements from both regimes. These networks draw on some elements of the existing regimes, bypass other elements and create new regime elements (regulations, language and institutional setting) themselves. Tensions at the regime level have provided openings for individual entrepreneurs to diversify and create novelties. For example, liberalisation of Dutch health care sector has made it more attractive for entrepreneurs to operate in the health care market. Originally LINSA actor values were aligned to sustainable principles, anthroposophy in the case of care farming, and sustainable on-farm energy production in the case of biogas. However, new non-farm actors, guided by profit rather than values, have exploited these new niches and become key players in LINSA. Sustainability was a linking concept for LINSA and regime; once this was eroded, opportunities for linkage through exploitation of regime tensions declined.

EXAMPLE: Biogas Production Network, Latvia

The LINSA includes about 100 members who deal with production of electricity and heat energy from processing agricultural biomass; structurally it is a network of networks which lacks coherence. Actors are biogas producers, scientists, service providers, suppliers, policy makers, investors, consultants, municipalities, banks, environmental agencies, and NGOs. The expansion of biogas sector since 2009 was fostered by a political decision to support biogas production, within the context of broader agricultural, rural and energy sector developments. Quotas were distributed to biogas producers and this created a secure and exclusive niche market.

Throughout the network development, business interests and sustainability issues have clashed. Although the original idea of biogas production was associated with making farming more sustainable (the use of agricultural residues, processing of manure, reduction of greenhouse gas emissions, introduction of localised heat supply systems and side production of fertilisers) in reality permissions to open biogas stations were issued mostly to operators outside agriculture. In this sense there has been a shift towards the energy regime addressing their own regime tensions by co-opting agricultural resources. There is little interaction across the two main kinds of biogas producers (landless investors and agricultural producers).

This division has hampered linkage. The links between AKS and producers are not well institutionalised. The barriers between LINSA and the AKS include: differing foci of interest (the researchers are interested in experiments in laboratory conditions, while practitioners need fast solutions to practical problems in real conditions of production); different value systems (the researchers being more concerned with biodiversity, sustainability, promotion of scientific knowledge, while producers are more concerned with economic performance); organisational barriers (some producers blame researchers for passivity in responding to their proposals to carry out joint research in real production situations). Thus AKS actors, by maintaining interest in the sustainability agenda, have not adapted sufficiently to new actors' demands concerning more efficient and commercial performance. In this sense the sheltered mode of production (quotas, guaranteed procurement, subsidised price) has not been conducive to linkage with traditional supporting regime actors and adaptation is a conflictual process. However, new actors and organisations are independent, flexible and responsive, and promote interaction and learning (Tisenkopfs et al. 2015). One of the most central actors and drivers for the whole

network development is the Vecauce study farm, a pioneering biogas producer and research station, which acts as co-learner together with interested producers and promoters of sustainable biogas production at a political level. Experienced biogas producers and researchers and consultants from small private institutes or demonstration farms become important as knowledge brokers. Thus demand for technical learning stimulates linkage and unites many of the stakeholders on both knowledge demand and supply sides.

4.4 Mode: Partial adaptation

LINSA have emerged on the margins of mainstream agriculture out of dissatisfaction with the incumbent food system and developed along separate pathways with only limited interaction. They are responding to tensions which go beyond those of the agricultural regime incorporating wider civic concerns and represent a break with the dominant economic, political, technical, organisational and cultural patterns. In this sense they have transformative ambitions. They build up specific new socio-economic space with new actors, rules and artefacts, and new interactions. Networks have emerged with a diversified composition including actors working together who otherwise would not have collaborated: such as those in the supply chain, marketing, technology industries, municipal and community organisations and citizens. They develop and build alternative marketing channels outside those associated with mainstream food system. Practices have marginal flexibility to be integrated into the regime although there is some reinterpretation of LINSA elements through food certification. These direct short 'vertical' linkages however are in tension with lateral linkages which are used to reinforce the niche. The importance of associations and individual actors in connecting LINSA and regime networks is apparent.

EXAMPLE: Association for Solidary Economy Crisoperla in Italy

Crisoperla, originally created by the interaction between organic farmers and technicians, has gradually evolved into an organised structure including consumer groups and civil society organisations, integrating cultural and political functions The LINSA aims to create an alternative system of knowledge and practices around sustainable production and consumption of food. The Association emerged and developed with the intention of placing itself in a position of autonomy with respect to the regime and the official AKS. However, they do seek to establish collaborations and may receive occasional funds from the Regional Government and municipality. Interaction is achieved through a number of events which intend to engage external stakeholders including regime members. Crisoperla and regime actors can be seen to adapt and link in three ways. Agronomists from the AKS are involved but in non-traditional roles. They acted as facilitators, not as technicians, when initially enabling knowledge exchange between farmers. They now act as brokers, exploiting their links with, for example, the Regional Government to find support, and are engaged in co-ordination of the activities within the Cooperative that has emerged. Secondly, the Crisoperla Association, through the figure of its President, has joined the steering committee of an organisation representing organic farmers nationwide. This is both to strengthen the organic farming institutional framework and to reinforce the position of the Association in relation to the local policies of territorial development. Thirdly, non-conventional marketing channels have developed. Some of the

network members have created a new cooperative of farmers and fishermen to enhance the commercialisation of products using a certified brand, thus there is modification of some LINSA elements to adapt to, and exploit tensions within, the regime. Those engaged in these commercial activities have different expectations from those who focus on increasing cultural and political engagement of the Association, and some tensions have arisen, leading to internal divisions; in this situation linkage becomes a fragmented process. Overall the LINSA in addressing social and ethical issues, is aiming to link diverse actors who subscribe to similar values, although there is some negotiation of specific technical issues.

4.5 Mode: Parallel adaptation

LINSA can be characterised as grassroots and social innovations, they include non-regime actors and hybrid, diffuse networks (municipalities, NGOs, activists, volunteers etc) who are concerned with food but in a wider setting than agriculture. They are responding to tensions in and beyond the agricultural regime, with respect to food quality, food justice and health concerns. Actors' motivations are mostly ideological, in that they have aspirations for systemic transformative change in the incumbent regime's food system and a very distinct set of design principles aligned to values and beliefs which are characterised as being in opposition to those of the agricultural regime. Individually their economic motivations are strongly shaped by their values. The LINSA start from a second-order position in that they reframe the whole system of food production and consumption around alternative assumptions practice and values. In this sense they could be described as radical within the mainstream context in producing artefacts, rules and actors that seek significantly to influence or change the regime. There is minimal linkage and they exist independently to the regime and follow parallel pathways.

There is little evidence of LINSA adaptation or of the regime accommodating the LINSA. The characteristics of the LINSA are diffuse (social and community concerns) and do not align with particular mainstream tensions. Although LINSA develop some technical practices in food production for example, these are not easily detached from the LINSA to provide solutions to regime tensions. LINSA are also at a structural disadvantage, there are no historical ties with the AKS and limited opportunities or resources to link with it. Some LINSA and regime actors might learn some lessons from each other mostly at the individual level but these lessons fail to penetrate or make any difference. Administrative and governance components of the wider food system regime responding to tensions have opened up some opportunities for linkage through charities which through project based initiatives attempt to create some pressure at municipal levels in the regime. Interest in community and local food initiatives has provided opportunities for these LINSA to initiate and grow using networking and advocacy. These modes tend to focus their efforts on lateral networking with actors and organisations in the same value niche outside the traditional regime. They are largely invisible to regime actors.

EXAMPLE: Permaculture Community, England

The Permaculture network in England advocates a radical shift in patterns of thinking and action towards new agri-food systems framed around agro-ecological principles and community. It is a diffuse network of diverse individuals and represented by the Permaculture

Association (PA) which coordinates the externally funded 'Learning And Network Demonstration' (LAND) project, and the new FarmLAND initiative which aim to promote and educate, the public and farmers respectively, about Permaculture design. Permaculture as a world movement has a global vision which actors are trying to translate to, and interpret for, local situations. Although actors share the same vision, they have diverse practical, philosophical and spiritual interpretations of Permaculture. Most aim for self-sufficiency and operate outside of conventional food supply chains or markets.

Linkage to mainstream agriculture is weak, any interaction is limited to individual networking and boundary spanning. The Permaculture ethos of shared values and beliefs in the system gives the networks a strong community identity and a resistance to activities that will compromise Permaculture principles. Most actors reject, for example, the notion of food certification, a device used by other LINSA to link to the regime food marketing channels. Furthermore, as Permaculture operate on the basis of design principles, it does not prescribe specific practice of food production, it cannot offer precise standards that marketing channels, or consumers, would recognise. Although the techniques and science of agro-ecology provides some common ground, Permaculture actors interpretation encompasses a much broader canvas framed around 'sustainable living', making the concept less accessible to regime actors. Attempts to translate Permaculture ideas through LAND and FarmLAND have had limited success in linking with mainstream actors who remain largely indifferent or even sceptical. Furthermore there are few regime structures or resources to offer linkage opportunities. As a result the LINSA remains largely unknown in conventional circles.

The PA plays a key role in trying to position the network more towards mainstream structures. It tries to access sustainable farming programme funding through partnerships with academics and other organisations. In doing this, it translates mainstream concepts, such as sustainable intensification or catchment based approaches, to Permaculture frames. There have also been attempts to link through accreditation of some of the PA training course modules with formal regime networks. With respect to linking to regime research components, the PA want to prove that Permaculture works and is seeking credibility through peer reviewed publications. However, by using small scale participatory trials, they are taking regime research rules but adapting them to their value sets. In terms of regime adaptation, the PA accuse certain regime actors of 'cherry picking' aspects of agro-ecological production to slot into conventional systems. Although this translates selected Permaculture ideas into the regime, it is an anathema to many Permaculturalists who regard the approach as indivisible and holistic.

Overall it is individual actors in the PA who play an important role in linking with other individual actors within regime entities (agricultural and environmental domains, regional and national policy). In the most part lateral linkage is strong with alternative networks in the niche operating on the regime fringes who share similar value systems and aspirations to change the food system (e.g. the Transition movement, local Community Supported Agriculture groups). The hope is that this consolidation will help to create pressure at the niche level and lead to reorientation of some regime actors.

5. DISCUSSION

These results reveal that LINSA-regime linkage involves a dynamic and complex set of adaptation patterns and processes. They make contributions to debates and theories about linkage in four broad ways: firstly, by demonstrating the importance of adaptation as an overarching concept for understanding linkage and for distinguishing adaptation modes; secondly by revealing the adaptive nature of linkage processes; thirdly by exploring how agricultural regime's adaptive capacity is achieved through a complex array of these adaptive linkage processes; and fourthly by questioning the applicability of niche and regime as analytical constructs in the agricultural transition context.

5.1 Adaptation modes

The results provide insights into the nature and extent of linkage framed around modes of adaptation. Modes capture Pragmatic and Progressive adaptation characterised by asymmetric processes of assimilation and incorporation, as distinct from modes of Partial adaptation and Parallel adaptation, where there is less evidence of adaptation and LINSA and regime coexist and develop along their own paths. They are respectively supported or confined by mainstream structures, conventional actors configurations and value systems (rules, practice etc). In the former LINSA can potentially help to address, or exploit, regime contradictions; in the latter LINSA have transformative ambitions and do not offer direct solutions to regime tensions. The mode in between describes the special case of Adaptation in intermediary regimes.

These modes only capture adaptation propensities, they do not distinguish discrete types since processes, forms and configurations, both within individual LINSA and within modes, can be irregular and heterogeneous. Furthermore, some processes occur simultaneously, for example, in the Dairy LINSA mutual adaptations enabled in individual projects might occur at the same time as more pragmatic adaptations. Nevertheless, some general observations can be made about adaptation at mode level. These are set out below and depicted in Figure 2 which shows the five modes operating in the overlapping space between the agri-food regime and niche concerned with sustainable agriculture and rural development. Pragmatic and Parallel modes are shown respectively as closest to (most adaptation), and furthest from (least adaptation), the regme. LINSA within the modes are depicted as star shapes to suggest dynamic networks.

In Pragmatic and Progressive adaptation modes the nature of the LINNSA means that discrete solutions are available and can be easily incorporated, as a whole or as detached practices, into mainstream settings. Thus linkage is well defined. For example, RAD and the Dairy LINSA can adapt some of their lessons to fit into regime policies (rules) such as AES measures and cross compliance, and the policy makers at regime level can adjust the rules accordingly. In some cases, as with the introduction of a premium payment into CAP rules in the RAD, LINSA actors work towards adapting prevailing regime rules to the benefit of their innovation, as described elsewhere (e.g. Raven et al., 2011). Thus they can modify the LINSA practices to make them compatible with the way the regime frames and addresses sustainability challenges, that is

from a first order innovation perspective, which articulates rules through technical and policy measures (Kemp et al., 1998; Seyfang and Smith, 2007; Knickel et al., 2009). However, LINSA inevitably have to compromise or dilute their sustainability goals, especially in Progressive adaptation mode Dairy and RAD LINSA which have second order ambitions. This results in some internal tensions in the LINSA as actors have differing expectations. As Smith and Raven (2012) note with reference to technical innovations, 'fit and conform' empowerment, where there is improved alignment with existing regime norms or structures, can actually by quite disempowering in terms of sustainability.

In Partial and Parallel adaptation modes, linkage is less easy to determine and for the most part LINSA and regime actors and entities co-exist independently. LINSA propose changes in practices and actor configurations, and governance. They also propose economic practices which deviate from established rules, but above all they question the regime's belief system, a defining characteristic of a regime (van der Brugge and van Raak, 2007). Thus these modes are characterised by LINSA proposing shifts which require second order innovation, that is learning through raising the levels of awareness, empowerment and capacity building (Knickel et al.,2009) and changing attitudes, behaviour and perceptions (Neumeier, 2012). As noted elsewhere, the translation of ideas is more difficult than the translation of technical solutions (Seyfang and Smith, 2007). The set of principles these LINSA propose are so different from those of the mainstream agriculture, that they are largely inaccessible and do not help address regime tension in any defined or immediate way, save some limited practices which might be instructive for the regime (e.g. the 'cherry picking' of certain practices from Permaculture). There is also resistance within the LINSA themselves to the extraction, and separation, of ideas and practices from their value settings, this is demonstrated in the Permaculture LINSA where some actors oppose, or regard as irrelevant, the notion of food certification. In the cases where some linkage is achieved, for example, the certification of food for marketing channels in Crisoperla, tension and fragmentation in the LINSA can result, leading to internal adaptation and reconfiguration. This has been explored in other settings, Smith (2007) described the fragmentation in the organic system following the appropriation of some food practices.

In the intermediary regimes mode Biogas example LINSA producers adapt daily farming routines and practices to new energy rules, they also align practices within energy regimes with the rules and routines of agriculture. The LINSA use agricultural resources to address energy demands, there is a need therefore for actors in both regimes, as well as within the LINSA, to adapt; this occurs through negotiation as well as establishing legitimacy through projects and research (Tisenkopfs et al., 2015). Linking is characterised as responding to specific issues. In the Intermediary regimes the quest for new technical knowledge has been a key driver for linkage, bringing together LINSA and relevant regime actors in new networks. Sustainability has also provided the key justification (and selection pressure) for the agricultural regime to support the LINSA and in turn the linking concept for the LINSA; once this was supplanted by other regime pressures, opportunities for linkage (and exploiting agricultural regime tensions) declined. Indeed the continued pursuit of the sustainability agenda by the AKS actors in the regime prevented effective linkage, since they failed to answer the needs of the LINSA actors taking a more commercially oriented route. As Smith and Raven (2012) note protective

measures can be captured by actors who are neither interested in making the niche more competitive nor empowering it to be part of a wider regime transformation.

For different LINSA actors the 'regime' represents something very different. LINSA actors in Pragmatic and Progressive modes tend to encounter actors and organisations from specialist sectors and sub-systems of the core agri-food regime. In this respect, as some are regime actors themselves, they can identify, adapt to, and draw on distinct institutional, political, economic and scientific selection pressures. They can exploit internal tensions and different regime member interpretations within these sectors but at the same time utilise the common ground between LINSA and regime entities to allow negotiations and reconfigurations to occur and in doing this reinforce the regime. For LINSA actors in Partial and Parallel modes, the regime represents a more unified and coherent agri-food system, the individual agriculture sector sub-systems and their associated tensions are irrelevant and inaccessible to them. LINSA actors perceive and encounter the mutually reinforcing cognitive, material, economic and social phenomena of the regime whose primary function of food production is not considered relevant to their goals. They do however identify with, and link to, similar LINSA in the niche.

These results confirm the importance of the extent of adaptation as an overarching framework in which to examine linkage processes. As noted above these modes suggest tendencies rather than definitive types, with different sorts of adaptations co-existing. Furthermore adaptive linkage processes are diverse and operate across all modes and across niche and regime as discussed next.

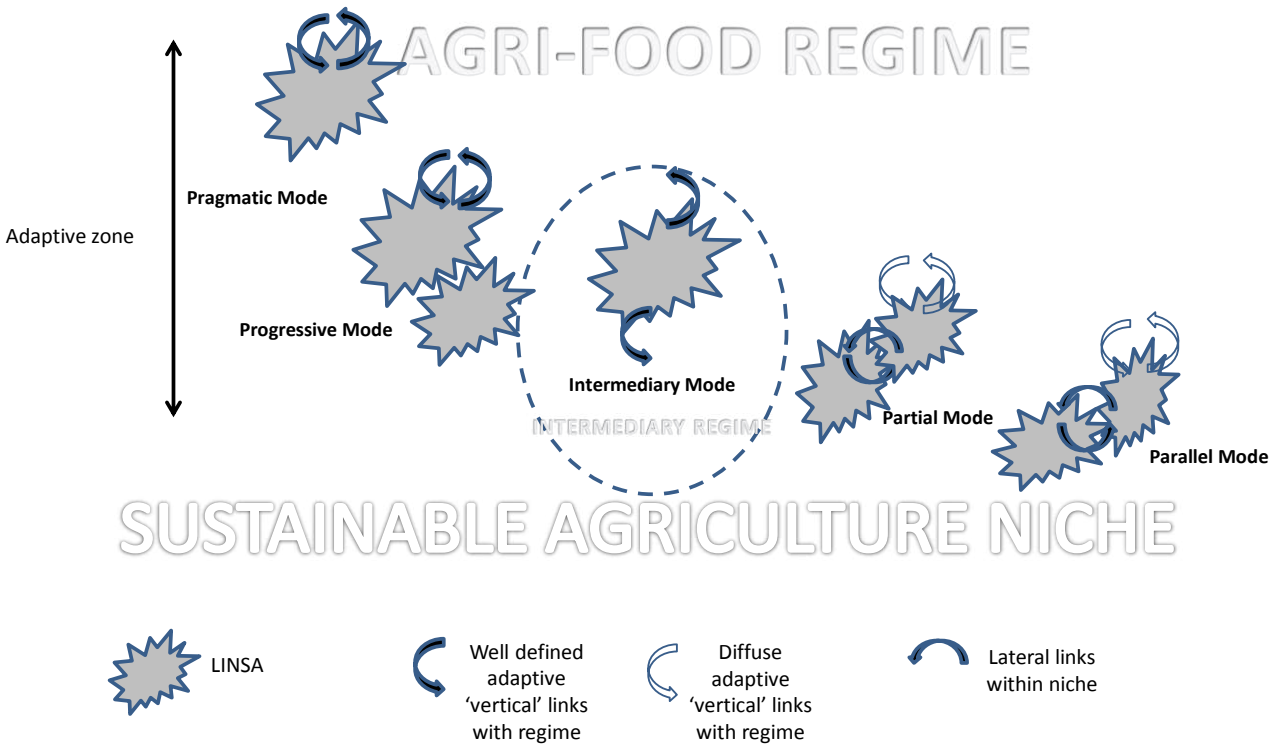
5.2 Adaptive linkage processes

A more in-depth analysis shows that linkage processes can be adaptive and reflexive in nature, that is, LINSA influence the niche and regime but also the regime and niche can influence the trajectory of the LINSA. These processes are associated with all the modes to different extents. The role of individuals and organisations as active agents in this dialogue is revealed for all LINSA.

Reflexive processes occur in all modes. They are evident in asymmetric adaptation modes where LINSA adapt pragmatically and slot into the regime. In the Charter, for example, the standards are periodically reviewed and re-negotiated as they move into, and are tested by, the regime. Thus a dialogue between LINSA and regime actors has been established to enable future strengthening of the standards. Although criticised as having diluted its ambitions by being assimilated into the livestock sector, this example shows that incremental adaptation can entail recursive processes which build on experiences and respond to regime tensions. In this way LINSA and regime actors react constantly to their environment, which in turn they actively try to modify. This suggests that on-going adaptations of the regime do not simply entail adoption or absorption of LINSA idea and practices.

This reflexivity, or translating back and forth, enables joint learning through exchange and experimentation. This was evident in the Progessive mode Dairy LINSA where projects provide spaces in which the practicability of LEIA can be explored by farmers and researchers experimenting and learning together. This also allows practices to be jointly validated and has brought actors together in a process of legitimisation. This not only entails technical learning but also a wider learning about new approaches. Other scholars have highlighted the importance to linkage of such mixtures of niche experiments and regime practices established in hybrid fora (Elzen et al., 2012), or intermediate projects (Smith, 2007), in which niche and regime actors come together to consider the full extent of their respective socio-technical situations, leading to mutual adaptation. Reflexive processes are also observed in Partial and Parallel modes, for example in the Permaculture LINSA the PA is seeking credibility for Permaculture design through scientific publication but at the same time adapting and re-interpreting regime research rules and reframing regime sustainability discourses to their own. This ongoing dialogue and reformulation of agro-ecology concepts leads to some translation of ideas and practices in each direction.

Figure 2 Linkage between LINSA and regime in five adaptation modes



Individual actors are important in enabling adaptive processes and linking LINSA to other LINSA, niche and regime actors who can support them. The extent to which they can help the adaptation process however depends on actors' interests and ideas, the functions they perform, strategies and resources, tier commitment to the LINSA goals and the influence they can wield. LINSA members can interactively shape and mobilise a network in view of achieving individual and collective goals. Klerkx et al. (2010) similarly demonstrated how rural actors employ their 'innovation agency' to influence the institutional environment of the regime. In the Dairy LINSA for example interested scientists, in verifying LEIA practices, act as a conduit to policy makers and legitimise the concepts. This mobilisation of expertise from within the regime to verify and legitimise the LINSA story has been described in different contexts. Actors contribute to the collective action of the LINSA networks by fulfilling specific strategic roles. Entrepreneurs in the Biogas LINSA behave as, and support, economic agents in the network, they have the flexibility and mobility to adapt and respond to different problems. They are specially attuned to markets and commercial imperatives in the energy and health regimes and assist in steering and consolidating the LINSA activities. Extension actors recruited from the regime in Crisoperla LINSA, have taken on new non-traditional facilitatory roles and become key members of the innovation network, now active as supporting and steering agents. In the Biogas LINSA individual brokers have emerged in response to the need for technical information and expertise, both in the LINSA and the energy and agricultural regimes, and have played an important linkage role in the network. These activities show that LINSA actors play an active and mediating role as agents in linking LINSA to regime structures. However, as well as this coordinated agency of networks which support linkage to regime, there is also evidence of the tension within LINSA with member disagreement, and divergence and fragmentation. Arguably this in itself can reinforce LINSA adaptation in that it ensures the LINSA survives albeit in a reconfigured form.

Organisations play a key role in translating practices and ideas through facilitating dialogue, learning, exchanging ideas, coordinating and linking different actors. This was demonstrated by formalised associations in the case of Biogas, Permaculture and Crisoperla LINSA which provided a focus to articulate ideas, and a channel for communication between regime and non-regime actors. Such associations and individuals are particularly significant as 'spokespersons' in internally complex LINSA, typical of Partial and Parallel modes, since actor goals are diffuse and advocates will not all be addressing sustainability in the same way, as noted by other researchers (e.g. Shove and Walker, 2007; Seyfang and Haxeltine, 2012). Staff within the PA, for example, play a key role in consolidating and articulating the goals of the LINSA and in doing so repositioning the association in response to regime research funding opportunities. As noted elsewhere, such dedicated intermediary or boundary work is necessary for interactive learning to take place, expectations to develop, and supportive networks to build (Elzen et al., 2012; Smith and Raven, 2012; Tisenkopfs et al., 2015).

In conclusion it is possible to distinguish modes typifying patterns of LINSA linkage to regime entities. This classification to some extent reinforces the notion of regime and niche as separate, uniform entities. However, in-depth analysis shows multiple adaptive linkage

processes building and sustaining networks across all modes and operating across the niche and regime suggesting that linkage is more complex than a linear interactive process between hierarchical levels, proposed by multi-level analysis. Furthermore this shows that any model or classification of adaptation modes will inevitably be an abstraction of the local and context specific processes of change and linkage where collective agency plays a significant role in shaping networks.

5.3 Adaptive capacity

By synthesising empirical data from 17 LINSA this study broadens the scope of analysis and provides an outline of the range of adaptation modes and adaptive linkage processes in operation in a number of different contexts. It also allows an overview of the agricultural regime's adaptive capacity, which is demonstrated, not only through the ability of its actors and institutions to coordinate responses and resources and adapt rules, but also by the drawing in of LINSA (or components of) from inside and outside the regime to help respond to internal regime tensions. This adaptive capacity is achieved through a complex array of adaptive linkage processes which lead to LINSA ideas, practices and lessons being absorbed, translated, validated, reinterpreted, exempted, protected or marginalised by elements of the regime to varying extents. As the regime entities draw in LINSA, they similarly adapt. LINSA, like other networks studied, are resilient and adaptable; they are dynamic with internal tensions and are constantly interactively redefined (Berkhout et al., 2004. Wiskerke and Roep, 2007). The capacity of LINSA to adapt is a function of the nature of the innovation as well as resources, network configuration and coherence and formality, and actor strategies, competences, motivations and willingness, all of which influence collective network agency (Klerkx et al., 2010; Farla et al., 2012).

Arguably the cases presented in Pragmatic and Progressive modes are not really radical or niche just part of the incremental regime adaptation while the Partial and Parallel modes raises question about the nature and character of a regime. However, exploring niche-regime linkage in terms of adaptive capacity allows a shift in perspectives away from these constraining constructs. Both niche and regime can be regarded as sources of innovation where adaptive linkage processes operate and can potentially contribute to the process of transformation.

These processes can be envisaged as operating in an overlapping niche-regime interactive space, or an adaptive zone, to borrow an ecological concept used to explain the origin of new adaptive kinds of organisms. An assemblage of interacting regime, niche and LINSA entities and actors continuously adapt to each other in this zone which is characteristically dynamic and multi-faceted in nature (Figure 2).

Learning, experimentation and feedback within the adaptive zone contributes to and enhances the regime's and the LINSA's ability to respond to pressures. For example in the Charter LINSA regular improvement has incrementally enhanced the capacity of the livestock sector to adapt to food quality tensions. In the case of the Dairy LINSA the projects have opened the dairy industry up to a greater range of learning than regulations alone. Successive project funding and

rule exemptions have allowed this network's ambition to be raised with the possibly for future translation into the regime. Thus there is continuous adaptation to environmental and economic pressures. Here the emerging networks provide capacity for regime adaptation.

LINSA in intermediary regimes assist mainstream agriculture's adaptive capacity by providing a space for developing practices which address regime tensions (use of agricultural waste and low farm incomes), but also draw in new actors, albeit with their orientation towards co-opting agricultural resources to assist the energy regime adaptive capacity. All these processes involve interactions and resource flows between LINSA, niche and regime actors, through networks, partnerships or other forms of coalitions. As mentioned already, and noted elsewhere, the role of individual actors in such networks can be key as they can articulate pressures and mobilise interests. Furthermore with respect to envisaging the processes within a CAS new approaches such as participatory research methodologies used in Permaculture or the inclusion of civic actors in Crisoperla networks, may represent disturbances which open up opportunities for the emergence of new trajectories (Folke, 2006).

LINSA in Pragmatic and Progressive adaptation modes contribute directly by providing practices that offer simple solutions and slot in easily through short 'vertical' links (albeit adaptive ones) to support the regime's adaptive capacity. Arguably these LINSA whose networks originate, or extend into, the regime may have a greater transformative potential than the LINSA emerging outside the regime; whilst at the same time establishing the regime's capacity to 'stay in power'. LINSA in Partial and Parallel adaptation modes, hinge more on ideas rather than discrete practices, and have less potential for contributing to adaptive capacity. There is some insertion of more defined LINSA elements into the regime, however, there is a simultaneous adaptation process of lateral linking with other novelties to reinforce and build the niche. This is a form of lateral anchoring novelties can work together and share ideas, and anchor more firmly in its initial niche as described by Elzen et al. (2012). In Crisoperla and Permaculture LINSA (also RAD), lateral linkage strengthens the respective niches, the niches in turn can exert more influence on regime actors with a view to them reorienting and responding to more challenging regime tensions over a longer time period. This lateral linkage becomes more important in LINSA more opposed to the incumbent regime and arguably enhances both the niche's adaptive capacity and its transformative potential. In Figure 2 three types of arrows depict linkage corresponding to well defined adaptive 'vertical' links with regime, diffuse adaptive 'vertical' links with regime and' lateral' links within niche.

The suggestion from the literature concerning technological niches, is that symbiotic niches reinforce the regime by assisting with its adaptive capacity, by reproducing regime functions in the face of prevailing selection pressures, while competitive niches which could make the regime vulnerable need to be countered. Superficially this appears to be the case with LINSA, as the regime draws in LINSA that reinforce regime functions and marginalises those that do not. However, arguably a more subtle set of processes are operating in which the former contribute to the regime's adaptive capacity with respect to sustainability challenges only in a shallow ad hoc manner, whilst the latter contribute through more insidious niche building and

consolidation processes which might potentially lead to a deeper and more enduring change. This in turn highlights the need to consider the temporal aspects of linkage and their durability. Some LINSA (Pragmatic and Progressive modes) linkage channels (projects, partnerships, subsidies, policy measures) are subject to the vagaries of regime funding, policy change and network composition, and as such can be periodic, fragile or short lived. Equally gaining and maintaining a foothold in the regime can be an irregular and tentative process for some LINSA, as elaborated by Elzen et al. (2012) in their concept of anchoring. Although linkage to the regime is less immediate and weaker in Partial and Parallel mode LINSA, they might be thought of as playing the long game, using lateral linkage and niche reinforcement to consolidate ideas and strengthen the niche with a view to a more durable and transformative relationship with mainstream agriculture. As scholars have noted, even if novelties cannot directly change the system, they can play a role as emblems for more sustainable alternatives (Smith and Raven, 2012).

6. CONCLUSION

This research enhances understanding of the niche-regime linkage in the context of sustainable agriculture. In contrast to previous studies which have been detailed analysis of evolutionary processes in a small numbers of case studies this research draws on empirical data from 17 LINSA studies. It contributes to the development of linkage theory by using the notion of adaptation to account for the complexity of linkage processes and the dynamic and heterogeneous nature of interaction across the niche-regime interface. The research confirms that the transition from an agricultural regime to a regime built around the principles of sustainable production is inherently complex. A diversity of innovative networks, and a correspondingly diverse number of linkages, are operating in an overlapping adaptive zone between LINSA and regime entities. Framing interaction as an adaptive process, whereby regime actors and entities adapt to incorporate LINSA, and vice versa, reveals a number of adaptation tendencies, or modes. Understanding linkage processes within and across these modes as reflexive and networking processes facilitated by individuals and organisations provides more insights into linkage processes than a hierarchical approach. Furthermore the analysis allows an overview of the interplay of processes contributing to the agricultural regime's adaptive capacity.

The results raise questions about the analytical premises of niche and regime and their relevance for analysis of interactions between local level innovations and the agricultural regime. They suggest that analysis needs to be framed differently to account for the complex, dynamic and diverse circumstances revealed. Rather than envisaging linkage between a hierarchy of levels analysis needs to look at the connections between a novelty and its setting, whether this setting is niche or a regime. In this respect LINSA are a useful device for representing configurations of niche and regime actors actively engaged in adaptive linkage processes in the overlapping niche-regime space. The notion of adaptive capacity can be used for understanding the complex evolving set of relations within this space. However rather than understanding adaptive capacity solely as the regimes' capacity to absorb disturbances and maintain function, it can also be seen as the capacity to adapt by utilising the opportunities that

these disturbances open up. Thus rather than fixed, regime and niche can be thought of as in a state of adaptive flux with networks like LINSA creating ‘disturbances’ in this space.

REFERENCES

Aarts, N., Van Woerkum, C. and Vermunt, B. (2007). Policy and planning in the Dutch countryside: The role of regional innovation networks. *Journal of Environmental Planning and Management*, 50(6), 727-744.

Berkhout, F., Smith, A. and Stirling, A. (2004). Socio-technical regimes and transition contexts. In: Elzen, B., Geels, F. W., Green, K. (Eds.), *System Innovation and the Transition to Sustainability*. Edward Elgar, Cheltenham.

Biggs, S., and Smith, G. (1998). Beyond methodologies: coalition-building for participatory technology development. *World Development* 26, 239–248.

Brunori, G. , Barjolle, D ., Dockes, A., Helmle, S. Ingram, J., Klerkx, L., Moschitz, H., Nemes, G. and Tisenkopfs, T. (2013). CAP Reform and Innovation: The Role of Learning and Innovation Networks. *Eurochoices* 12 (2), 27–33.

Christensen, C. M. (1997). *The innovator's dilemma: when new technologies cause great firms to fail*. Harvard Business School Press, Boston, MA.

Curry, N. and Kirwan, J. (2014). The role of tacit knowledge in developing networks in sustainable agriculture. *Sociologia Ruralis* 54 (3): 341–361.

de Haan, J. and Rotmans, J. (2011). Patterns in transitions: Understanding complex chains of change. *Technological Forecasting and Social Change* 78 (1), 90–102.

Diaz, M., Darnhofer, I., Darrot, C. and Beurel, J. (2013). Green tides in Brittany: What can we learn about niche–regime interactions? *Environmental Innovation and Societal Transitions* 8, 62–75.

Dosi, G. (1982).Technological paradigms and technological trajectories. *Research Policy* 11, 147 - 162

Elzen, B., Geels, F. W. and Green, K. (2004). *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy*. Cheltenham, UK, Edward Elgar.

Elzen, B. van Mierlo, B. and Leeuwis, C. (2012). Achoring of innovations; Assessing Dutch efforts to harvest energy from glasshouses. *Environmental Innovations and Societal Transitions* 5, 1-8.

Esparcia, J. (2014). Innovation and networks in rural areas. An analysis from European innovative projects. *Journal of Rural Studies* 34, 1–14

Farla, J., Markard, J., Raven, R. and Coenen, L. (2012). Sustainability transitions in the making: A closer look at actors, strategies and resources. *Technological Forecasting and Social Change* 79, 991-998.

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change* 16 (3) 253-267.

Flinterman, F. J., Roep, D. and Luijer, A. (2012). Bridging incompatible regimes: how the formation of intermediary regimes drives system innovation. In: Barbier, M. and Elzen, B. (Eds), *System Innovations, Knowledge Regimes, and Design Practices towards Transitions for Sustainable Agriculture. INRA - Science for Action and Development*, E-book, Paris, 86-100. Accessible at: http://www.inra-ifris.org/activites/open-science/system-innovations-knowledge-regimes-and-design-practices-towards-transitions-for-sustainable.html

Foxon, T. J., Reed, M. S. and Stringer, L. C. (2009). Governing long-term social-ecological change: what can the resilience and transitions approaches learn from each other? *Environmental Policy and Governance* 19 (1), 3-20.

Geels, F. W. (2001). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and case study. Nelson and Winter DRUID Conference, Aalborg, Denmark, June.

Geels, F. W. (2002). Technological Transitions as evolutionary reconfiguration processes: a multi-level perspective and case study. *Research Policy*, 31 (8-9), 1257-1274.

Geels, F.W. (2004). From sectoral systems of innovation to sociotechnical systems. Insights about dynamics and change from sociology and institutional theory. *Research Policy* 33, 897–920.

Geels, F. (2010). Ontolgies, socio-technical transtions (to sustainability) and the multi-level perspective. *Research Policy* 39 (4), 495-510.
Geels, F. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticism. *Environmental Innovation and Societal Transitions* 1(1), 24-40.

Geels, F. and Raven, R. (2006). Non-linearity and expectations in niche-development trajectories: ups and downs in Dutch biogas development (1973–2003). *Technology Analysis and Strategic Management* 18, 375–392.

Geels, F. W. and Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy* 36, 399-417.

Giddens, A. (1984). *The Constitution of Society: Outline of the Theory of Structuration*. Polity Press, Cambridge.

Haila, Y and Dyke, C. (2006). Introduction: What to say about nature's 'speech'. In: Haila, Y. and Dyke, C. (Eds.) How nature speaks. The dynamics of the human ecological condition. Duke University Press. Durham and London.

Hargreaves, T., Longhurst, N. and Seyfang, G. (2013). Up, down, round and round: connecting regimes and practices in innovation for sustainability. *Environment and Planning* A 45, 402-420.

Hekkert, M., Suurs, R., Negro, S., Kuhlmann, S. and Smits, R. (2007). Functions of Innovation Systems: A new approach for analyzing technological change. *Technological Forecasting and Social Change* 74 (4), 413-432.

Hielscher, S., Seyfang, G. and Smith, A. (2011). Community innovation for sustainable energy. WP 2011-3, Centre for Social and Economic Research on the Global Environment, Norwich.

Hinrichs, C. C. (2014). Transitions to sustainability: a change in thinking about food systems change? *Agriculture and Human Values* 31 (1), 143—155.

Holtz, G., Brugnach, M., and Pahl-Wostl, C. (2008). Specifying "regime"—A framework for defining and describing regimes in transition research. *Technological Forecasting and Social Change*, *75*(5), 623-643.

Home, R. and Rump, N. (in press) Evaluation of a multi-case participatory action research project: The case of SOLINSA. *Journal of Agricultural Education and Extension.*

Hoogma, R., Kemp, R., Schot, J. and Truffer, B. (2002). *Experimenting for sustainable transport: the approach of strategic niche management*. Spon Press, London, UK.

Horling, L. G. and Marsden, T. K. (2011). Towards the real green revolution? Exploring the conceptual dimensions of a new ecological modernisation of agriculture that could 'feed the world'. *Global Environmental Change* 21 (2), 441–452.

Hermans, F., Favilli, E., Home, R., Anh Joly, K., Kubinakova, K., Kunda, I., Nemes, G., Neumeister, D., Rossi, A., Sorg, L. and Varga, A. (2013). WP4 Analytical Characteristics Report: Perspectives of Sustainable Agriculture. SOLINSA project Deliverable 4.2c, October 2013. Available at www.solinsa.net

Ingram, J., Curry, N., Kirwan, J., Maye, D. and Kubinakova, K. (2013a). WP4 Synthesis Report. SOLINSA project Deliverable 4.2a, October 2013. Available at www.solinsa.net

Ingram, J., Curry, N., Kirwan, J., Maye, D. and Kubinakova, K (2013b). WP4 Analytical Characteristics Report. SOLINSA project Deliverable 4.2b, October 2013. Available at www.solinsa.net

Ingram, J., Curry, N., Kirwan, J., Maye, D. and Kubinakova, K. (2014). Learning in the Permaculture Community of Practice in England: An Analysis of the Relationship between Core Practices and Boundary Processes. *Journal of Agricultural Education and Extension* 20 (3), 1-16

Ingram, J., Curry, N., Kirwan, J., Maye, D. and Kubinakova, K. (in press). Interactions between niche and regime: an analysis of learning and innovation networks for sustainable agriculture across Europe. *Journal of Agricultural Education and Extension.*

Kemp, R., Schot, J. and Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: the approach of Strategic Niche Management. *Technology Analysis and Strategic Management* 10 (2), 175–195.

Klerkx, L., Aarts, N. and Leeuwis, C. (2009). Dealing with incumbent regimes: deliberateness and serendipity of agency in rural innovation networks. ESRC Congress 2009, Vaasa, Finland.

Klerkx, L., Aarts,N. and Leeuwis, C. (2010). Adaptive management in agricultural innovation systems: The interactions between innovation networks and their environment. *Agricultural Systems* 103 (6), 390-400.

Knickel, K., Brunori, G., Rand, S. and Proost, J. (2009). Towards a Better Conceptual Framework for Innovation Processes in Agriculture and Rural Development: From Linear Models to Systemic Approaches. *Journal of Agricultural Education and Extension* 15 (2), 131-146.

Lachman, D. A. (2013). A survey and review of approaches to study transitions. *Energy Policy* 58, 269-276.

Lawhon, M. and Murphy, J. T. (2012). Socio-technical regimes and sustainability transitions. Insights from political ecology Progress in Human Geography 36(3), 354-378.

Leeuwis, C. and van den Ban, A. (2004). Communication for Rural Innovation: Rethinking Agricultural Extension. Oxford: Blackwell Science.

Lovell H, (2007). The governance of innovation in socio-technical systems: The difficulties of strategic niche management in practice *Science and Public Policy* 34, 35-44.

Marsden, T. (2013). From post-productionism to reflexive governance: contested transitions in securing more sustainable food futures. *Journal of Rural Studies* 29, 123—134.

Markard, J. and Truffer, B. (2008). Technological innovation systems and the multi-level perspective: towards an integrated framework. *Research Policy* 37, 596–615.

Moschitz,H., Roep, D., Brunori, G. and Tisenkopfs, T. (2015) Learning and Innovation Networks for Sustainable Agriculture: Processes of Co-evolution, Joint Reflection and Facilitation. *Journal of Agricultural Education and Extension* 21 (1), 1-11

Neumeier, S. (2012). Why do Social Innovations in Rural Development Matter and Should They be Considered More Seriously in Rural Development Research? – Proposal for a Stronger Focus on Social Innovations in Rural Development Research. *Sociologia Ruralis* 52 (1), 48-69.

Raven, R. P. J. M., Verbong G. P. J., Schilpzand, W. F. and Witkamp, M. J. (2011). Translation mechanisms in socio-technical niches: a case study of Dutch river management, Technology Analysis and Strategic Management, 23 (10), 1063-1078.

Rip, A. and Kemp, R. (1998). Technological change. In: Rayner, S. and Malone, E. (Eds.), *Human Choice and Climate Change* vol. 2. Battelle: Columbus, Ohio.

Roep, D., van der Ploeg, J. D. and Wiskerke, J. S. C. (2003). Managing technical institutional design processes: Some strategic lessons from environmental cooperatives in the Netherlands. *Wageningen Journal of Life Sciences* 51, 195–217.

Roling, N. and Engel, P. (1991). The development of the concept of agricultural knowledge and information systems. In: Rivera, W. and Gustafson, M. (eds), Agricultural Extension: Worldwide Institutional Evolution and Forces for Change. Elsevier, Amsterdam, 125-137.

Rotmans, J., Kemp., R. and van Asselt, M. (2001). More evolution than revolution: Transition management in public policy. *Foresight* 3 (1), 15-31.

Rotmans, J. and Loorbach, D. (2010). Towards a better understanding of transitions and their governance. A systemic and reflexive approach. Transitions to sustainable development–new directions in the study of long term transformation change. Routledge, New York , 105-220.

Seyfang, G. (2009). *The New Economics of Sustainable Consumption: Seeds of Change*. Palgrave Macmillan, Basingstoke, Hants.

Seyfang, G. and Haxeltine, T. (2012). Growing grassroots innovations: exploring the role of community-based initiatives in governing sustainable energy transitions. *Environment and Planning C: Government and Policy* 30, 381-400.

Seyfang, G. and Smith, A. (2007). Grassroots innovations for sustainable development: towards a new research and policy agenda. *Environmental Politics* 16, 584–603.

Schot, J. and Geels F.W. (2008). Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. *Technology Analysis and Strategic Management* 20 (5), 537-554.

Shove, E. and Walker, G, (2007). CAUTION! Transitions ahead: Politics, practice, and sustainable transition management. *Environment and Planning* A 39, 763-770.

Shove E, and Walker, G. (2010). Governing transitions in the sustainability of everyday life. *Research Policy* 39, 471–476.

Smith, A., Stirling, A. and Berkhout, F. (2005). The governance of sustainable sociotechnical transitions, *Research Policy*, 34, 1491–1510.

Smith, A. (2006). Green niches in sustainable development: the case of organic food in the United Kingdom. *Environment and Planning C: Government and Policy* 24, 439-458.

Smith, A. (2007). Translating Sustainabilities between Green Niches and Socio-Technical Regimes. *Technology Analysis and Strategic Management* 19 (4), 427–450.

Smith, A., Stirling, A. and Berkhout, F. (2005). The governance of sustainable socio-technical transitions. *Research Policy* 34, 1491–1510.

Smith, A., Voß, J. P. and Grin, J. (2010). Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. Research Policy, 39(4), 435-448.

Smith, A. and Raven, R. (2012). What is protective space? Reconsidering niches in transitions to sustainability. *Research Policy* 41, 1025-1036.

Tisenkopfs, T., Brunori, G., Knickel, K. and Šūmane, S. (2009). Co-production of rural innovation: towards an enriched theoretical model. In: Knickel, K., Tisenkopfs, T. and Peter, S. (Eds.). Innovation processes in agriculture and rural development. Results of a cross-national analysis of the situation in seven countries, research gaps and recommendations. Report of the IN-SIGHT project. www.insightproject.net

Tisenkopfs, T., Kunda, I. and Šūmane, S. (2014). Learning as Issue Framing in Agricultural Innovation Networks. *The Journal of Agricultural Education and Extension* 20 (3), 1 – 18.

Tisenkopfs, T., Kunda, I. and Šūmane, S., Brunori, G., Klerkx, L., Moschitz, H. and Berti, G. (in press). Learning and innovation in agriculture and rural development: the use of the concepts of boundary work and boundary objects. *The Journal of Agricultural Education and Extension.*

Van der Brugge, R. (2009). Transition dynamics in social-ecological systems: the case of Dutch water management PhD thesis, DRIFT, Erasmus University, Rotterdam.

van der Brugge, R. and van Raak, R. (2007). Facing the adaptive management challenge: insights from transition management. Ecology and Society 12 (2), 33.

van Bueren, E. and Broekhans, B. (2010). The nitty gritty of going green: Lessons from the design process of a Dutch greentown hall on niche-regime interaction. Michigan, Constructing Green Conference. www.bus.umich.edu/Conferences/ConstructingGreen.../GetFile.aspx

van der Ploeg, J.D., Bouma, J., Rip, A., Rijenberg, F., Ventura, F. and Wiskerke, J. (2004). On regimes, novelties, niches and co-production. In: Wiskerke, J and van der Ploeg, J.D. (Eds). Seeds of transition. Essays on novelty production, niches and regimes in agriculture. Assen: van Gorcum, pp. 1-30.

van der Ploeg, J.D. (2009). Transition: Contradictory but interacting processes of change in Dutch agriculture. In: Poppe, K., Termeer C., and Slingerland, M. (Eds). Transitions towards sustainable agriculture and food chains in peri-urban areas. Wageningen: Wageningen Academic Publishers, pp. 293-307.

Veldkamp, A., Van Altvorst, A. C., Eweg, R., Jacobsen, E., Van Kleef, A., Van Latesteijn, H., Mager, S., Mommas, H., Smeets, P.J.A.M., Spaans,L. .and Van Trijp, J. C. M. (20009). Triggering Transitions Towards Sustainable Development of the Dutch Agricultural Sector: Trans Forum's Approach, Agron. Sustain. Dev. 29, 87-96.

Walker, B., Holling C. S., Carpenter S. R. and Kinzig, A. (2005) A. Resilience, adaptability and transformability in social–ecological systems. Ecology and Society **9** (2), 5. [online] URL: http://www.ecologyandsociety.org/vol9/iss2/art5/ [viewed 2 January 2015]

Wiskerke J.S.C., Van der Ploeg J.D. (Eds.) (2004). Seeds of transition: essays on novelty production, niches and regimes in agriculture, Van Gorcum, Assen.

Wiskerke, J. S. C. and Roep, D. (2007). Constructing a sustainable pork supply chain: A case of techno-institutional innovation. Journal of Environmental Policy and Planning 9, 53-74.

Witkamp, M. J., Raven R. P., Royakkers L, M. (2011). Strategic niche management of social innovations: the case of social entrepreneurship, *Technology Analysis and Strategic Management* 23**,** 667–681