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Beyond agricultural innovation systems? Exploring an agricultural innovation ecosystems approach for niche design and development in sustainability transitions

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ABSTRACT

Well-designed and supported innovation niches may facilitate transitions towards sustainable agricultural futures, which may follow different approaches and paradigms such as agroecology, local place-based food systems, vertical farming, bioeconomy, urban agriculture, and smart farming or digital farming. In this paper we consider how the existing agricultural innovation systems (AIS) approach might be opened up to better support the creation of innovation niches. We engage with Innovation Ecosystems thinking to consider the ways in which it might enhance efforts to create multi-actor, cross-sectoral innovation niches that are capable of supporting transitions to sustainable agricultural systems across multiple scales. While sharing many similarities with AIS thinking, Innovation Ecosystems thinking has the potential to broaden AIS by: emphasizing the role of power in shaping directionality in innovation platforms or innovation communities that are connected to niches and their interaction with regimes; highlighting the plurality of actors and actants and the integral role of ecological actants in innovation; and offering an umbrella concept through which to cross scalar and paradigmatic or sector boundaries in order to engage with a variety of innovation systems affecting multifunctional agricultural landscapes and systems. To this end, an *Agricultural Innovation Ecosystems* approach may help design and support development of transboundary, inter-sectoral innovation niches that can realize more collective and integrated innovation in support of sustainability transitions, and help enact mission oriented agricultural innovation policy.

1. Introduction

To sustainably meet the increasing demand for food (FAO, 2014, 2016), agricultural systems will need to transition away from the dominant industrial agriculture paradigm designed for production, self-sufficiency, efficiency and affordability (Prost et al., 2017) to one of sustainable agriculture that “conserves land, water, and plant and animal genetic resources, and is environmentally non-degrading, technically appropriate, economically viable and socially acceptable” (FAO, 1989). Recent efforts have included co-existing and co-evolving but also competing approaches that aim to develop and enact alternative forms of agriculture such as permaculture, aquaponics, vertical farming, urban agriculture, precision agriculture, social and care farming, agroecology and ‘smart’ or digital farming (Dell'Olio et al., 2017; Hassink et al., 2013, 2018; Ingram, 2018; Junge, 2017; Muller et al., 2017; Orsini et al., 2013; Wolfert et al., 2017; Wezel et al., 2011). Along with these alternative forms of agriculture comes the potential for creating bioeconomies and circular economies, or local place-based food systems (Borrello et al., 2016; Hermans, 2018; Rossi, 2017).

The diverse and complex challenges facing a transition to more sustainable agricultural systems are often related to resource competition (e.g. water, energy, biodiversity, land), socio-economic concerns (e.g. rural livelihoods, community development, emerging markets), human health and environmental integrity (e.g. ecosystem health, environmental justice, climate change) (Bennett et al., 2014; Elzen et al., 2012; FAO, 2014, 2016). These challenges inherently span multiple natural resource management systems (e.g. agriculture, fisheries, forestry, water, conservation, energy) and linked ecosystem services (i.e., regulating, provisioning, cultural and supporting services) (Bommarco et al., 2013; Tittonell, 2014; Saint Ville et al., 2015). Agriculture-related fields (e.g. agroecology and socio-ecological systems) recognize the need to better foster linkages across scales and sectors to address

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complex sustainability challenges (Berthet et al., 2016; Foran et al., 2014). Therefore more networked approaches to innovation governance are required in order to facilitate the boundary crossing (e.g. cross sector/cross-scale/cross-domain/cross-property) and co-ordination across scales necessary to support transitions towards sustainable agriculture (Elzen et al., 2012; Hermans et al., 2016). Similarly, landscape approaches (i.e. place-based frameworks that consider ecosystems and politics of scale) (Arts et al., 2017) have the potential to develop more integrated strategies for sustainable agriculture and to facilitate the required linkages between the systems, services and sectors affecting agricultural landscapes (Sayer et al., 2013).

Agricultural innovation systems (AIS) thinking has become increasingly applied to analyze the organization of combined technological, social and institutional innovations in agriculture (Kilelu et al., 2013; Turner et al., 2016). AIS thinking is broadly focused on understanding the governance of actor interactions in innovation, the role of innovation policies and of innovation support structures such as research and extension (Hall et al., 2003; Klerkx et al., 2012; World Bank, 2006, 2012) and is often applied to the level of a country, a sector, or a particular technology (Klerkx et al., 2012). However, when competing normative directions for alternative forms of agriculture emerge (competing with the dominant industrial agriculture paradigm, or competing with each other) an AIS may be in support of some of those directions, but exclude other directions, which may contribute to lock-in and stagnation in unsustainable systems (Stirling, 2011; Ingram, 2018; Plumecocq et al., 2018; Vanloqueren and Baret, 2009; Schlaile et al., 2017; Touzard et al., 2015). This may be reinforced by early AIS thinking that emphasized economic contributions and private sector engagement as opposed to sustainability transitions ambitions (Hall et al., 2016; Hall, 2017; Schlaile et al., 2017; Schot and Steinmueller, 2016). To date, AIS remains rather focused on innovation in the agricultural sector alone and often on the industrial agriculture paradigm, having yet to take a multifunctional approach to agriculture or explicitly focus on ecological aspects (Foran et al., 2014; Wigboldus et al., 2016).

In order to capture and support a variety of alternative agricultural transition pathways, this paper considers how AIS might be opened up or expanded by engaging Innovation Ecosystems thinking, which has been previously identified as well suited for supporting transitions towards sustainability (Oksanen and Hautamäki, 2015). The goal of the paper is therefore to compare AIS and Innovation Ecosystems thinking to see where Innovation Ecosystem thinking may assist in conceptualizing and strengthening the creation and support of innovation niches in which alternative forms of agriculture are being developed, and to identify where Innovation Ecosystems thinking itself may be strengthened. The paper continues as follows. After defining innovation niches, we identify conceptual overlap and divergence between Innovation Ecosystems and AIS thinking in order to assess their potential contributions to sustainable agricultural systems. The paper then contemplates how Innovation Ecosystems thinking may complement AIS and assist with the creation and support of new multi-actor, multi-scale and multi-sectoral innovation niches. We conclude by reflecting on how an *Agricultural Innovation Ecosystems* approach may encourage collective and integrated innovation to better address the complex challenges facing transitions to sustainable agriculture.

2. Innovation niches, agricultural innovation systems (AIS) and innovation ecosystems

2.1. Fostering innovation niches in pursuit of transitions

Transitions to more sustainable agriculture require the formation of innovation niches (Elzen et al., 2012; Meynard et al., 2017). Innovation niches are defined as the spaces that allow actors to experiment, co-innovate and create new technologies, practices and institutions that can support transitions to sustainable agriculture by enabling interactions across boundaries (e.g. sectoral, organizational, professional, disciplinary, cultural, etc.) in agricultural systems (Elzen et al., 2012; Meynard et al., 2017; Schot and Geels, 2008). They can facilitate the collective action of diverse actors (often in new combinations) for developing new modes of production, new institutional arrangements and new organizational systems to better support systemic learning, adjusting and adapting (Elzen et al., 2012; Meynard et al., 2012; Meynard et al., 2017). In practice, innovation niches can be identified as spaces (i.e. physical, ecological, technological and virtual) where stakeholders come together to define shared objectives and engage in social learning to support an innovation process (Meynard et al., 2017).

Innovation niches are nested within larger regimes (the status quo of dominant systems they aim to change) and socio-technical landscapes (exogenous developments that influence niche development) (Grin et al., 2010; Schot and Geels, 2008; Elzen et al., 2012), but these levels should be seen as analytical constructs because in reality there is no dichotomous struggle between niche and regime, instead transition processes run across multiple scales (e.g. geographic, ecological, technological, etc.) (Ingram, 2015, 2018; Hermans et al., 2016; Svensson and Nikoleris, 2018; de Haan and Rotmans, 2018). Transitions occur when the creation and broader scaling of innovations established at the innovation niche level interact with current regimes, ideally leading to the opening of existing regimes and transforming them (Hinrichs, 2014; Wigboldus et al., 2016; Ingram, 2018). This perspective implies that agricultural innovation is a process in which co-evolution of technology, practices and institutions takes place at multiple and sometimes overlapping scales (e.g. farm, supply chain, policy system, sector, region, country) (Hermans et al., 2016; Wigboldus et al., 2016). Yet, innovation is not guaranteed, and the mere existence of a niche does not automatically transform a regime, drawing attention to the complex and heterogeneous factors that contribute to entrenched agricultural regimes and lock-in (Ingram, 2015; Wigboldus et al., 2016; Vanloqueren and Baret, 2009). Nonetheless, proponents of sustainability transitions argue that innovation niches can be built to facilitate linkages to support opportunities to innovate in radical ways to help solve complex issues (Geels, 2002; Schot and Geels, 2008), which may also take place through purposeful design (Elzen and Bos, 2016). Thus, there are ongoing questions about the architecture required to support the design and further development of successful agricultural innovation niches (Elzen et al., 2012; Meynard et al., 2017; Prost et al., 2017). We now consider how Innovation Ecosystems thinking may complement AIS and assist with conceptualizing design and support development of innovation niches.

2.2. Expanding AIS thinking to better understand and support innovation niches for sustainable agriculture

Both AIS and Innovation Ecosystems thinking emerged in parallel from national systems of innovation thinking in the 2000s. While Innovation Ecosystems thinking has largely been applied to business contexts, it has been applied to the agri-food industry (van Lohuizen, 2016). Table 1 contrasts the key characteristics of AIS (Hall, 2007; Klerkx et al., 2012; World Bank, 2012) and Innovation Ecosystems (de Vasconcelos Gomes et al., 2016; Jackson, 2011; Oksanen and Hautamäki, 2015). This table shows they share some theoretical foundations and converge on the notion that there is a need to foster innovation environments where scientists, policymakers, producers, end-users and entrepreneurs can mobilize their collective knowledge to innovate (Klerkx et al., 2010; Oksanen and Hautamäki, 2015). For example, a well-functioning AIS supports the construction of multi-actor innovation networks, often referred to as innovation platforms (Kilelu et al., 2013; Schut et al., 2016), with the aim of fostering interactions between actors for jointly solving agriculture-related challenges (Hall, 2007; Klerkx et al., 2012). Constructing innovation platforms generally involves attracting entrepreneurial members that act as champions, fostering linkages and cooperation, stimulating learning and mobilizing

Table 1
Characteristics of agricultural innovation systems and innovation ecosystems.

	Agricultural innovation systems[a]	Innovation ecosystems[b]
Historic emergence	2000s	2000s
Disciplinary focus	Agriculture	Business and management
Theoretical foundations	National systems of innovation; Technology transfer; Farming systems; Capacity building; Extension	National systems of innovation; Business ecosystems; Entrepreneurship
Types of issues	Economic; Socio-technological; Value chains	Economic; Value creation; Sustainable development
System conceptualization	One (sub)sectoral system with embedded systems	System of systems each with embedded systems
Focus	Multi-stakeholder processes for problem solving	Multi-stakeholder processes for value co-creation
Actors	Farm-centered: universities, firms, non-profits, decision makers, government institutions, financial markets, farmers; public sector bias	Firm-centered: entrepreneurs, universities, firms, non-profits, decision makers, government institutions, financial markets, end-users, venture capitalists
Groups of actors	Multiple actors; Innovation platforms (also known as hubs and clusters); Communities of practice; Co-innovation	Multiple actors in co-operation and competition; Innovation communities (also known as platforms, hubs and clusters); Co-evolution
Scale (system boundaries)	Crop; Sector; Region; Country	Local to global; Cut across multiple organizations, functions and industries
Level of analysis	Institutional: Actors and networks and the rules that govern their interaction. Infrastructural: the physical and knowledge infrastructure involved in innovation	Ecosystem: Integrated system of systems (no actor or system is greater than another)
Role of policy	To strengthen enabling environments and counteract disabling environments	To create enabling environments and foster innovation communities

[a] Adapted from Foran et al., 2014; Hall, 2007; Klerkx et al., 2012; World Bank, 2012; Schut et al., 2016.
[b] Adapted from de Vasconcelos Gomes et al., 2016, Jackson, 2011; Oh et al., 2016, Oksanen and Hautamäki, 2015.

adequate resources (Klerkx et al., 2012; Kilelu et al., 2013). Innovation Ecosystems thinking similarly seeks to co-create value and explicitly consider the interdependent, nested, transitional and interconnected networks of actors involved in innovation processes (de Vasconcelos Gomes et al., 2016; Jackson, 2011; Oksanen and Hautamäki, 2015). In the case of Innovation Ecosystems, such networks are referred to as innovation communities and consist of a dynamic collection of actors (e.g. governments, universities, industry, supporting institutions, specialized people, entrepreneurs, the financial system, consumers, civil society, cultural groups) that evolve as people and organizations come together to produce and/or use a specific innovation (Wang, 2009). Both innovation platforms and innovation communities can be likened to groups of change agents that come from different spheres, which is crucial for developing innovation niches and transforming regimes (de Haan and Rotmans, 2018; Klerkx et al., 2013; Wittmayer et al., 2017). However, despite some similarities between innovation platforms and innovation communities, in what follows we consider the ways in which AIS thinking might be complemented and enhanced by Innovation Ecosystems thinking to expand how we conceptualize the creation of and support for innovation niches via innovation platforms or innovation communities.

2.2.1. Increased attention to power dynamics in niches

While innovation platforms (in AIS thinking) and innovation communities (in Innovation Ecosystems thinking) function at different scales (i.e. agricultural sector versus multi-sectoral, respectively – see Table 1), they both have the potential to contribute to the creation and growth of innovation niches in support of transitions to more sustainable systems. However, innovation platforms and innovation communities are not neutral (i.e. they can be both linked to niches but also can linked to, or even captured by, regime actors that aim to maintain the status quo) (Pel, 2016; Duncan and Pascucci, 2017; Späth et al., 2016). Niches are subject to power struggles between alternative and dominant systems, and also within alternative systems when linked to niches that pursue different interpretations of for example agroecology - Levidow et al., 2014; Migliorini and Wezel, 2017). Thus, these spaces in which the direction and actual unfolding of innovation is negotiated can gradually reconfigure regimes to support broad change (Bui et al., 2016). Attention to aspects of power and negotiation at the level of the innovation platform or community is therefore key to effectively promote sustainability transitions (Avelino and Wittmayer, 2015). For example, farmer-driven experimentation in AIS needs to be monitored as they face the possibility of regime or elite capture (Tittonell et al., 2016), and innovation platforms may become vehicles for execution of government programs (Cullen et al., 2014). While AIS acknowledges power dynamics, it underplays these power struggles in relation to the normative direction of alternative forms of agriculture and their niches, likely due to its original economic-utilitarian view on innovation resulting in less emphasis on political dimensions (Hall et al., 2016; Hall, 2017). The pluralism that is inherent in Innovation Ecosystems requires explicit acknowledgment of deep interdependent multi-dimensional relational linkages (Jackson, 2011; Jucevičius and Grumadaitė, 2014; Oksanen and Hautamäki, 2015), which aligns with recent views of change agency being located both in niches and regimes (de Haan and Rotmans, 2018). Since the success of one actor is considered dependent on the efforts of other actors, Innovation Ecosystems thinking emphasizes the resolution of relational, power and cultural issues within and between the group to ensure that innovation community members operate from a set of common objectives that reflect the groups' shared knowledge and skills (Jackson, 2011; Jucevičius and Grumadaitė, 2014). Innovation Ecosystems thinking also recognizes that multiple and at times contradictory goals may exist within the ecosystem (Nambisan and Baron, 2013), which have an impact on the development and scaling of niches in terms of them gaining critical mass or them diverging and possibly losing momentum (Hermans et al., 2016).

2.2.2. Combined multi-actor and multi-actant networks in niches

While AIS thinking already accounts for a wide range of actors and relationships within agricultural systems, it focuses primarily on socio-technological innovation, rarely emphasizing or acknowledging the roles played by informal actors and natural environments in shaping innovation dynamics (Foran et al., 2014; Vermunt et al., 2017; Wigboldus et al., 2016). Innovation Ecosystems thinking can help to broaden the scope of actors involved by drawing on an ecosystem analogy to highlight the range of specialized organisms (i.e. diverse actors and actants) that cooperate, feed-off, adapt to, support, compete and interact with each other and are inseparable from the environment within which they form the (innovation) ecosystem (Jackson, 2011; Shaw and Allen, 2016).

Innovation Ecosystems thinking can help to expand the types of actors considered to also include actants as contributors to innovation (e.g. technology, software, ICT platforms as well as information content) (Chen and Hung, 2016; Kolloch and Dellermann, 2017). The key role of non-human actants from the biophysical/material world (as opposed to only the social world) have been identified by other approaches such as actor-network theory (Latour, 2005; Chen and Hung, 2016; Watts and Scales, 2015) and have been linked to transition studies (Diaz et al., 2013; Svensson and Nikoleris, 2018). In the context of agricultural systems, interactions between a range of agricultural actors/actants can include: human actors and non-human objects such as other living entities (e.g. trees, plants, crops, micro-organisms, insects, livestock), non-living objects (e.g. tools, mechanized equipment, water, fertilizer), landscape factors like environmental cycles (e.g. seasonal change, degradation and climate change) and linkages that are both material (e.g. run off) and semiotic (e.g. the values guiding farmers) (Diaz et al., 2013; Watts and Scales, 2015; Wigboldus et al., 2016). This inclusive conceptualization of actors/actants in agricultural systems is reinforced and intrinsically embedded in approaches that emphasize human-environment relationships, like agroecological and social-ecological systems thinking (Foran et al., 2014; Pant, 2015; Ollivier et al., 2018; Sinclair et al., 2014). In these approaches the material aspects of the system are seen as drivers of innovation (e.g. by biomimicry- see Blok and Gremmen, 2016; Stojanovic, 2017), but can also be relevant in the context of other approaches such as 'smart' farming, in which cyber-physical systems note a direct connection between ecological production process, information flows, and system optimization (Eastwood et al., 2017; Wolfert et al., 2017), or in circular bioeconomy approaches in which certain material flows act as linking pins that connect different sectors (Borrello et al., 2016). Therefore, for sustainable agricultural innovation the broadest range of actors and actants needs to be considered, since the interactions between multiple actors and actants can shape the ability of other actors to innovate (Touzard et al., 2015; Watts and Scales, 2015).

Ecological actants are present across agriculture-related sectors and could also act as a unifying feature to link the various complex systems governing natural resource management sectors and ecosystem services (e.g. bioeconomy and circular economy) (Borrello et al., 2016; Hermans, 2018). Thus, one key implication of the expanded range of actors and actants is that there is a need to better consider the ecological dimension as a steering factor for innovation niche design. Improved consideration of non-human ecological actants (e.g. plants, crops, micro-organisms, soils, insects, weather) may help to design 'innovation niches' that more explicitly include and consider elements of the natural environment, as well as their impacts on existing networks and systems to stimulate transitions in agricultural systems (see, for example, Elzen and Bos, 2016; Meynard et al., 2017). Since ecological dimensions have the ability to co-shape emergent regimes (e.g. energy transitions – see Sutherland et al., 2015), it has the inherent ability to exercise change by acting as an agent that impacts feedback loops in systems in flux. This emphasizes the need for lock-ins to go beyond the socio-technical landscape and to recognize that ecological dimensions may act as an actual agent of change through feedbacks as well as a symbolic proxy for change (Wigboldus et al., 2016; Ollivier et al., 2018; Svensson and Nikoleris, 2018).

While Ritala and Almpanopoulou (2017: pg39) argue that *"the prefix eco in innovation ecosystems implies a specifically ecological aspect"* to Innovation Ecosystem thinking, the relevance of the ecosystem analogy has been debated in the context of business and management innovation and is yet to become a rigorous construct (de Vasconcelos Gomes et al., 2016; Oh et al., 2016; Ritala and Almpanopoulou, 2017). If fully operationalized, the ecosystem analogy has the potential to enrich the identification of different networks and systems, to include both biological (e.g. plants, crops, micro-organisms, insects, humans) and socially constructed (e.g. economic agents, relationships, non-economic elements, technology, institutions, sociological interactions, culture) elements that come together to influence landscape-level innovation dynamics and potential (Jackson, 2011).

2.2.3. Crossing scale, paradigm and sector boundaries in niches

It has been recognized that transition processes imply crossing several boundaries. Such boundaries can be between scales in the agricultural systems in transition, between the technological paradigms or normative orientation of different innovation niches, and between sectors. Innovation Ecosystems thinking conceptualises the need for cross-sector interactions to facilitate transboundary innovation (Walrave et al., 2017) and therefore may make a contribution in expanding the scope of AIS thinking.

With regard to crossing scales, transitions to sustainability will require the ability of innovation niches to move innovation processes ahead by working across scales (Hermans et al., 2016), recognizing that outcomes at one scale are shaped by processes (e.g. feedbacks, flows, interactions) at other scales (Svensson and Nikoleris, 2018; Wigboldus et al., 2016). This is explicitly recognized in several alternative agriculture innovation niches. For example, agroecology has long sought to integrate multiple scales in order to advance innovation and scaling of novel agroecological systems (Dalgaard et al., 2003). Additionally, 'smart' farming (also called digital farming) works on the premise that it enables real time connections between different scales in agricultural production, processing, commercialization, and consumption processes (Eastwood et al., 2017; Wolfert et al., 2017), which may also enable circularity due to the integration of information, energy and material flows. While AIS does consider scale, by considering actors and their relationships at different scales of agricultural systems (e.g. spatial: village, country; and innovations: crop, technology) (Kilelu et al., 2013) and recognizing the role of actors beyond agricultural production chains (e.g. financial sector, civil society) (Klerkx et al., 2010), it seems that Innovation Ecosystems thinking is more explicit on the need to continuously move between and adaptively engage with different scales to consider emergent effects due to feedback loops between scales (see Table 1; also note that AIS has touched on this in studies taking a complex adaptive systems perspective – Hall and Clark, 2010; Klerkx et al., 2010).

With regards to paradigmatic and sectoral boundary crossing, multifunctionality and circularity of resources are key considerations in the transition to sustainable agricultural systems. Multifunctionality includes production (e.g. food, feed, fiber, fuel), environmental (clean air, soil and water, attractive landscapes, biodiversity), and human aspects of agricultural production (e.g. education, livelihoods, health and wellbeing, social inclusion) that are key to sustainability concerns (Brooks and Loevinsohn, 2011; FAO, 2016; Rockström et al., 2017). Sectoral divides (e.g. agriculture versus health or energy) or sub-sectoral divides within agriculture due to specialization (e.g. separation of crop and livestock sectors) have long hindered enacting multifunctional approaches to agriculture and functional cross-overs with non-agricultural sectors (Brooks and Loevinsohn, 2011; Hassink et al., 2013, 2018; Sutherland et al., 2015). As indicated in the introduction, AIS thinking has largely been applied in the mainstream industrialized agriculture sector (i.e. the regime), which may be explained by the emergence of AIS thinking from a school of thought aimed at innovation for economic growth (Hall et al., 2016; Hall, 2017), rather than having clear transformative ambitions (i.e. transitions towards novel sustainable systems and new functional combinations) (Schot and Steinmueller, 2016; Schlaile et al., 2017).

Innovation Ecosystems thinking may help to better consider multifunctionality at the 'ecosystem' level (de Vasconcelos Gomes et al., 2016), where different alternative forms of agriculture are considered as niches within a shared habitat, each with their own designated innovation system (which may be more or less developed and resourced). Approaches that emphasize mainstream agriculture without opening to lessons from alternative forms of agriculture may contribute to lock-in and other self-reinforcing processes that exclude the introduction of competing and potentially innovative technologies (Vanloqueren and Baret, 2009). There is a need to foster diversity to counter lock-in and to support transitions to sustainable agriculture (Stirling, 2011). An innovation ecosystem could be conceptualized to simultaneously support niches for mainstream industrial agriculture and alternative forms of agriculture as well as emergent (and different) interactions fitting within broader concepts (e.g. circular and bio based economy, local and place based agroecological food systems) that encompass combinations of different sorts of alternative approaches. This can also support cross-overs between a multitude of innovation systems operating in multiple natural resource management sectors (e.g. agriculture, fisheries, forestry, water and energy). To this end, Innovation Ecosystems thinking may foster transboundary linkages between sectors and promote enabling environments to better address cross-cutting sustainability issues and integrative alternative approaches to agriculture.

3. Conclusion: an *Agricultural Innovation Ecosystems* approach as a way forward

To better address the complex and unbounded sustainability issues facing agriculture today, it is imperative to design an appropriate systems architecture that can stimulate transitions, but this remains a key challenge for policy and practice (Meynard et al., 2012; Meynard et al., 2017; Prost et al., 2017). However, addressing this challenge is increasingly important in view of so-called mission oriented innovation policies emphasizing the need for innovation systems to realize sustainability transition ambitions (Schot and Steinmueller, 2016; Mazzucato, 2016; Schlaile et al., 2017). Innovation Ecosystems thinking may offer a useful umbrella concept that is appropriate for the wider multifunctionality of agricultural systems, with the potential to better support deveopment of transboundary innovation niches designed to realize collective and integrated innovation in support of sustainability. Through our brief comparison it has become clear that Innovation Ecosystems thinking appears to complement and build on the established foundations of AIS thinking to enhance the conceptualization of more sustainable agricultural systems. Although in some ways AIS may already function like an ecosystem, (e.g. feedback loops) it does not in other ways (e.g. blurred sectoral boundaries), and an *Agricultural Innovation Ecosystems* (AIES) approach would expand AIS in three ways: 1) to be more explicit on the power dynamics in innovation platforms or communities, 2) to include both human and non-human change agents (actants) across the innovation ecosystem, and 3) to be more cognizant of boundary crossing.

An *AIES* approach appears to offer new insights for designing cross-sectoral and multi-scalar innovation niches, as this short communication paper has outlined. However, future research is needed to operationalize an *AIES* approach by further integrating concepts from Innovation Ecosystems thinking into AIS in order to examine how we can practically design and use *AIES*. By broadening the change agents considered for agricultural innovation to include actors and actants that are currently operating in different innovation systems, an *AIES approach* raises new questions about the potential need to reconceptualize important relationships and interactions between actors and actants across niches and regimes to better support transitions. Insight could be garnered from a structural-functional assessment of who/what is currently included in the AIES and an assessment of the actors/actants that would constitute an effective *AIES* in favor of niche development and regime transformation. An *AIES* approach also highlights the relationships between multiple co-existing innovation systems linked to niches and regimes, and identifies interactivity with the different systems (and sectors) as a key aspect affecting agricultural outcomes. Future investigations into *AIES* may thus seek an improved understanding about transboundary relationships and the role of power within and between different, yet interdependent, innovation systems.

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