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Niche knowledge systems-challenging or invigorating the AKS? An analysis of the Permaculture community in England

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Abstract

This paper examines how knowledge systems within alternative innovative agricultural groups (niches) develop and interact with the mainstream AKS using the notion of boundaries. It draws on empirical data from a study of the Permaculture community in England, a sub-niche entity. Members of this community question the operations of the mainstream agricultural regime and advocate a radical shift in patterns of thinking and action towards new agri-food systems. Analysis shows that a distinctive knowledge system has emerged to support learning in the community independently of the AKS. This is strongly associated with, and coheres around, the community's social system. The boundary between this KS and the mainstream AKS can be characterised in terms of differing sets of beliefs and values, epistemologies, ways of facilitating and supporting learning, approaches to research and modes of development. However, despite these epistemic divides, there is evidence of some interaction across the boundary. The paper explores the potential for the Permaculture's KS to potentially invigorate and transform the AKS.

Keywords: Permaculture; AKS; AKIS; niche; regime; boundaries; innovation; agro-ecology

1   Introduction

The complex problems facing agriculture require approaches that go beyond "traditional" sectorial agricultural boundaries. Innovative forms of agriculture are emerging, often associated with groups and networks where the actors advocate sustainable alternatives to mainstream agro-food systems and challenge the existing socio-technical regime built around industrialised agriculture (Goodman, 2014; Marsden, 2004; Seyfang and Smith, 2007; Whatmore and Thorne, 1997). Such innovative groups, which operate outside or on the fringes of conventional agricultural contexts and outside public funding and established institutional and policy frameworks, can be thought of as synonymous with socio-technical niche[3] (or sub-niche) entities. These groups are typically self-organising; they share common goals and interests; and they learn together to create new ideas and innovative practices (Knickel et al., 2009). Moreover, they follow distinctive modes of development, frequently emerging out of bottom-up processes or socio-technical processes of social innovation rather than the outcomes of the implementation of top-down technological projects.

Knowledge is one of the most relevant resources circulating in such groups or niches. This has been notably revealed, for example, in analysis of transition towns (Seyfang and Haxeltine, 2012), organic farming (Morgan, 2011), agri-environmental action (Lockie, 2006), and Permaculture (Ingram et al., 2014a).

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[3] Originally used to describe technological innovations, the niche concept has also been used to capture socially-oriented innovations based upon different values from the mainstream (Geels, 2004; Kemp et al., 1998 Seyfang and Smith, 2007).

They develop their own distinctive knowledge systems (KS) and collaborative modes of learning in the absence of support from the formal Agricultural Knowledge System[1] (AKS) (Brunori et al., 2013). These KS confront the AKS, which is charged with fostering innovation but is locked into old approaches or trajectories of the incumbent regime. Equally, however, learning and experimentation in niche may enhance the regime's AKS, contributing to its diversity and adaptation, and creating opportunities for innovation and learning.

Understanding potential interaction across the boundaries between the KS of these groups and the established mainstream AKS is important to identify opportunities for mutual learning and for boundary work (Cash et al., 2002; Tisenkopfs et al., 2015). Support of alternative agricultural innovations by the AKS, and provision of an enabling environment to accommodate them, is an emerging theme in European policy. This emphasises the reform of the AKS in the context of the demands of sustainable agriculture and the evolution of a more responsive Agricultural Knowledge and Innovation System (AKIS) (EU SCAR, 2012, 2014).

Despite the centrality of knowledge to innovation, there is little understanding of how KS in emerging innovative niches interact with the AKS of the incumbent regime. This paper addresses this using the notion of boundaries. It frames the analysis around transition, knowledge systems and boundaries literatures and draws on empirical data from a study of the Permaculture community in England, a sub-niche entity studied within the SOLINSA[2] project. The paper explores the potential for this Permaculture community's KS to potentially challenge or invigorate the AKS of the mainstream regime.

2 Niche knowledge systems - challenging or invigorating the AKS?

The exchange and combination of knowledge has always been an important element of alternative agricultures, which develop largely through bottom-up processes or socio-technical processes of social innovation (Barbier and Elzen, 2012; Geels, 2004; Roling and Wagemakers, 2000). This distinguishes them from top down solutions typical of mainstream agricultural development and supported by AKS where a technology-oriented definition rather than social innovation predominates (Boch, 2012).

2.1 The Agricultural Knowledge System

The incumbent socio-technical food regime built around industrialised agriculture has developed a dedicated knowledge base and institutional arrangements to promote and sustain it. In agriculture the notion of Agricultural Knowledge Systems (AKS) emerged to describe the formal set of institutes and actors charged with fostering innovation, and to capture the stable actor networks, which support agricultural innovation and learning (Roling and Engel, 1991). Today it encompasses powerful actor networks (comprising agricultural scientists, extension officials, and agro-chemical suppliers and technologically innovative farmers), and can be thought of a key apparatus of the incumbent mainstream agricultural regime. The AKS is an institution that has co-evolved as part of the regime, conferring legitimacy and scientific authority, reinforcing existing trajectories (the 'agricultural treadmill') and contributing to its path dependency (Leeuwis, 2004). As a core element of the knowledge dimension, it is central to the conventions, rules, and norms that guide the uses of particular technologies and the everyday practices of regime actors (Geels, 2004; Smith, 2007).

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[1] Agricultural Knowledge System is understood here to mean the formal set of institutes and actors: researchers, advisory services, supply industries and progressive farmers.
[2] SOLINSA - Support of Learning and Innovation in Sustainable Agriculture.

Alternative food producer groups can be thought of as socio-technical niches or sub-niche entities where innovation occurs and where social networks are built by those who desire to advance more sustainable alternatives to those present in the existing socio-technical regime. Knowledge is one of the key resources devoted to alternative socio-technical practices, and learning processes are central to niche development and management (Geels and Schot, 2007; Hoogma et al., 2002; Kemp et al., 1998; Smith, 2007). Niches tend to develop their own distinctive KS (e.g. Morgan, 2011; Seyfang and Haxeltine, 2012). The social nature of knowledge in these systems is a central theme particularly in social or grassroots innovations, which are applied to a wider goal of sustainability (Seyfang and Smith, 2007). In these innovations KS cohere around social systems, they are ".a network of actors connected by social relationships, formal or informal, that dynamically combine knowing, doing, and learning to bring about specific actions for sustainable development" (van Kerkhoff and Szleza, 2010, p1). This has been described for the Organic, Transition and Permaculture social movements (Seyfang and Haxeltine, 2012; Smith, 2007; Veteto and Lockyer, 2008).

2.2   Challenging or invigorating the AKS?

Emerging groups with new co-learning approaches and advocating more sustainable activities are said to challenge the assumptions and rules of the AKS (Brunori et al., 2013). Through the development of raised levels of awareness, empowerment and capacity building they follow a 'second order' innovation and learning. This questions and confronts the fixed rule set (or paradigm) of first order innovation of the mainstream AKS which is dependent on technical efficiency and innovations from science and technology (Brunori et al., 2007; Kemp et al., 1998; Seyfang and Smith, 2007). The KS of alternative groups or niches therefore potentially challenge the dominance of the AKS actors and structures and seek to change it through diffusion of more radical ideas and practices. Learning, and in particular social learning, nurtured through the process of experimentation, is considered to be at the core of niche development and very important in overcoming stable and difficult-to-change socio-technical systems. The process is, however, contested, as like the overall niche-regime relationship, niche KSs struggle to find and maintain a viable space within the AKS.

However, it is simplistic to describe the AKS as a coherent system. It is increasingly heterogeneous with diverse actors, entities, coalition networks and organizational structures (Aarts et al., 2007). Some argue the AKS has become more a creative and flexible space arguably less bounded and more accessible to outside initiatives (Garforth et al., 2003). Scholars describe an evolving AKS. They envisage a role for alternative groups in invigorating and strengthening the AKS and helping its transformation into an AKIS comprising all types of public, private and civil society actors, such as inputs and processing industry actors, agricultural traders, retailers, policymakers, consumers and NGOs (EU SCAR, 2012, 2014; Hermans et al., 2015). This analysis suggests that, from one perspective, the KS of niches and the mainstream are opposed and disconnected, and that the niche KS challenges, confronts or aims to transform the incumbent AKS. However, from another perspective, the niche KS can potentially strengthen and invigorate the AKS by bringing in new perspectives and opportunities for innovation.

2.3   Conceptualising connection and disconnection

The notion of boundaries captures the dialectic interaction or tension between AKS and niche KS suggested above, it provides a frame for conceptualising any disjuncture or potential connection between them. Absence of common knowledge is a defining feature at the boundary between different knowledge domains. In KS boundaries demarcate the socially constructed and negotiated borders between disciplines, sectors and communities (Cash et al., 2002). Boundaries delimit functions such as knowledge generation as well as different types of knowledge (e.g., western scientific, traditional, situated, or local). Structural and cognitive barriers can restrict bridging between different KSs (Berkes, 2009) and where they become impermeable, boundaries at the interface between knowledge domains can prevent any meaningful communication taking place across them (Clark et al., 2011; Robinson and Wallington, 2012).

Certain sorts of knowledge, learning and practice are associated with specific groups or communities where social bonds are strengthened by sharing the same knowledge, language, practice, values and repertoires (Wenger, 2000). As Castree (2005, p12) notes "typically, knowledge exists as more or less established bodies of knowledge that distinct groups of people share in common." Boundaries are maintained by such groups to steward and protect critical competence. In the science community boundaries play a role, they are maintained against threats to its cognitive authority from, for example, pseudo-science (Cash et al., 2002).

However, communities or groups can be so tightly knit that they become, insular, defensive, closed in, and oriented to their own focus. Boundaries around them can create divisions and be a source of separation, fragmentation, disconnection, and misunderstanding (Wenger, 2000). Where these coincide with different sorts of knowledge and epistemological language they have been described as epistemic divides (O'Kane et al., 2008). Scholars suggest that, where boundaries exist, this can constrain knowledge flows between communities (Tagliaventi and Mattarelli, 2006). This has implications for niche innovations. For niches to emerge and develop they need to communicate effectively with wider audiences. However, internal learning and networking within some niches has become principally an 'insider' activity, supporting the niches' own development but not translating it beyond its boundaries (Seyfang and Haxeltine, 2012).

The literature on knowledge in organisations recognises knowledge boundaries between specialised domains (Carlile, 2004). With respect to emerging innovations this author argues that there is often a lack of common knowledge to adequately share and access domain-specific knowledge at a boundary. He describes the "curse of knowledge" which recognises the difficulty that actors have in abandoning previous knowledge as an important property of knowledge at a boundary when a novelty or sub-niche appears (Carlile, 2004, p557). Where knowledge is invested within a given practice—it should be seen as "at stake," indicating the significant costs associated with giving it up and acquiring different knowledge (Carlile, 2004, p556). Finding common knowledge therefore is key to promoting effective exchange. This is often the basis of boundary processes (Roberts, 2006) and boundary work, which helps to manage all kinds of demarcations between and within different actors (Clark et al., 2011). Tisenkopfs et al. (2015) provide examples of boundary work in a number of sustainable agriculture networks where individual knowledge stocks are translated into collectively shared knowledge and innovations for sustainable agriculture.

As well as boundaries marking spaces of disconnect, commentators have argued that where boundaries interact they become spaces of unusual learning, where fresh perspectives meet and new opportunities arise (Wenger, 2000). Exposure to new information "creates an environment in which 'creative abrasion', the synthesis that is developed from multiple points of view, is more likely to occur" (Powell and Grodal, 2005, p. 59). Thus, according to Carlile (2004) knowledge is seen, both a source of, and a barrier to innovation.

These different perspectives on boundaries can be drawn on to inform and examine the dialectic interactions between KSs of innovative groups and the mainstream AKS and to frame the analysis of whether niche KS challenge or invigorate the AKS.

3   Methodology

3.1   The context - Permaculture in England

The Permaculture community in England is an emerging group or sub-niche[1] that questions the operations of the mainstream agricultural regime. It advocates a radical shift in patterns of thinking and action towards

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[1] The Permaculture community in England cannot be classified as a complete niche. Instead it is a sub-niche entity developing in a value space (agro-ecological niche) distinct from the mainstream agricultural regime.

new agri-food systems framed around agro-ecological principles. It can be described as a diffuse network of diverse individuals or communities sharing a common approach and vision. Sites include home gardens, community gardens/farms, public spaces, allotments and smallholdings. The community coheres around the Permaculture Association (PA) a membership organisation (over 1200 individual, 67 groups, and 18 businesses) (Permaculture Association, 2011a).

Permaculture is an approach to the design of community and agricultural systems according to the principles that mimic ecological systems (Holmgren, 2002; Mollison and Holmgren 1978; Mollison, 1988). A central theme in Permaculture is the design of ecological landscapes that produce food. As the emphasis is on design principles, it does not prescribe a specific practice of food production, although it is often referred to as agro-ecological production. The movement advocates a paradigm shift from 'business as usual' agriculture by putting community at the centre of agriculture, as this statement from the PA website reveals:

> "Many researchers, including myself, believe that permaculture should form the basis of agricultural and social development. The establishment of a large number of small, permaculture type farms serving local communities and adapted to local conditions, would create tremendous cultural as well as biological diversity, because farming would no longer be geared to uniform global production. Permaculture based minifarms could be the key to agricultural and community regeneration." Dr. John Zarb, Newcastle University [PA, 2011b]

Its goals in this sense are transformative, in that it reframes how agri-food systems should be organised. Permaculture can be described as a second order innovation, it represents a sub-niche entity that is radically different from the incumbent agricultural or food regime.

3.2   Methods

The research was carried out as part of the three year EU funded project SOLINSA (Support of Learning and Innovation in Sustainable Agriculture). This project was underpinned by transdisciplinary approaches and five participatory workshops were carried out over the project period. Participants (15-20 in each workshop) were selected to represent the diverse range of actors who engage with Permaculture in England including practitioners and PA representatives. Interviews were also carried out with 14 individuals from the community to supplement the workshop data. The workshops and the interviews focused on understanding the community's learning and innovation networks including the emergence of its KS. One workshop specifically looked at the interaction between KS of mainstream and agro-ecological KSs and included a range of participants from both. Further information is available in Ingram et al. (2013) and Home and Rump (2015).

4   Results - the Permaculture Knowledge System boundary interactions

4.1   The Permaculture Knowledge System (PKS)

In England a distinctive Permaculture Knowledge System (PKS) has emerged around the Permaculture community to support learning. This is characterised by a broad community of individuals and groups, a social learning system, who learn experientially, and share and validate their knowledge through multiple social networks, supported by a formal set of structures and activities run by the PA.

Knowledge and learning are at the centre of the Permaculture movement. Learning is guided by a belief in Permaculture design, self-reliance and a trust in the system of production. The ethos is one of mutual

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support through shared learning, both in terms of helping people change their perspective on life according to the three core ethics, but also with respect to practical knowledge about Permaculture design tools and techniques. Permaculture is underpinned by a certain set of values and understandings of what constitutes valid and relevant knowledge. However, there are multiple personal understandings of what Permaculture means and, as such, approaches to learning vary: for some it is a scientific process, for some practical, for others it is a philosophical or even a spiritual one.

The PA has developed a set of frameworks, ideas, tools and information that the community can share. It aims to promote the understanding of the theory and practice of Permaculture in England by educating the public, providing individuals and groups with access to advice, support, information and training and researching Permaculture. The PA legitimises the design principles, provides accredited training courses, supports a website and newsletters and runs events for members, and coordinates research. It also coordinates the 'Learning And Network Demonstration' (LAND) and FarmLAND initiatives.

4.2   Individual learning and networking

The nature of Permaculture means that practitioners learn experientially on their own sites combining knowing and doing. There is an acceptance that people have different knowledges, that "*It is so site-specific; so people specific*" and that there is "*no right or wrong*". There is a considerable personal investment in experimental learning and a significant level of individual, local, context-specific knowledge is built up. There are codified resources that individuals refer to, most commonly the Designers Manual (Mollison, 1988), However, knowledge also tends to be personified, there is a lot of knowledge embedded in inspirational and charismatic individuals who act as advocates for Permaculture. Practitioners welcome the chance to network and connect to others (virtually or at events) and share and validate their learning. This sharing is enabled by people having the same sort of "*ethical mindset*", or being on "*the same page*", according to some respondents. The significance given to this tacit or 'unspoken' knowledge generated and circulated within the community, and the allegiance to those who share the same identity, beliefs and values, serves to strengthen internal ties and networks but can restrict external linkages.

Many practitioners also seek out information to complement and support their experimental learning, they need to enhance their discovery driven learning by absorbing knowledge from others. They cultivate personal channels and networks and seek information and training from a range of sources outside of the PA. This networking reveals, what some described as the "*magpie*" tendencies of Permaculture actors who seek out and use different aspects of knowledge and practice from a number of sources. The breadth of networking also reflects the wide and multiple interpretations of Permaculture design that the diverse constituency subscribes to, as well as their variable sites and personal motivations. Thus a dynamic exists between the strong internal ties, which reinforce the boundaries of the PKS and the weaker ties some actors make connecting across the boundaries.

Although personal links are made with individual AKS actors, for some in Permaculture, their enthusiasm for unorthodox approaches means that they participate in, and draw inspiration and information from, a number of communities in the 'alternative' social learning system operating on the fringes of the AKS (e.g. local Community Supported Agriculture and Transition groups). In this sense there is a tendency to operate outside of the usual farm AKS information and advisory sources. Often this is linked to their belief and conviction in Permaculture as a system of production and their principles of self-sufficiency. They distinguish themselves from farmers who they perceive as reliant on subsidies and needing formal certification for their food products. Although some respondents said they had good social networks with local farmers, these were not used to share knowledge about food production. A lack of understanding seems to be the main barrier to communication, one problem being that Permaculture is a hard concept to describe, as this farmer applying Permaculture principles explained. Such comments reveal a critical lack of common knowledge.

"Even to the closest farmers that we work with, if you said do you know what Permaculture means, if they do, it will be nothing to do with us. They know that we're organic, and they know that we're grass fed". Organic farmer

4.3   Permaculture Association actor networking

The PA staff have a strong allegiance to the Permaculture community and to the PA's vision (PA, 2011a); they reinforce the community's boundaries through a number of internal activities. However, PA staff members are also active in building partnerships with external organisations. These tend to be like-minded organisations such as Campaign for Real Farming and the Organic Growers Alliance suggesting that, as with individuals, interaction is mainly with those in the same 'alternative' social learning system. Whilst some connections are made with mainstream AKS organisations, PA actors tend to view these as dissemination, rather than learning, opportunities. They also identify mainstream concepts, which resonate with Permaculture principles (e.g. sustainable intensification, catchment based approaches), as a means of accessing AKS knowledge and funds. These concepts, however are often re-interpreted through a Permaculture lens; such re-framing of knowledge is characteristic of boundary processes. These boundary interactions are essentially informal connections, with most boundary work done at the individual level rather than by any recognised boundary organisations. Indeed respondents pointed to a lack of structures and funding for boundary work, which restrict opportunities for sharing knowledge between KSs.

4.4   Permaculture Association training and supporting learning

Running alongside and supporting individual experiential learning is a well-developed training programme coordinated by the PA delivering the Permaculture Design Course (PDC) (with more than 3500 graduates), viewed by many as an essential route into Permaculture, and the higher level Diploma in Applied Permaculture Design. The training style emphasises co-learning, reflecting the Permaculture ethos and culture of sharing. One participant reflected on the training: "*The [tutor] was there as a facilitator to draw out of you and out of the group what the ideas they had and so on…*". Another commented: "*it is quite inspiring and transformative to be working with a group of like-minded people and to be learning about something*". This mutual learning does create some problems in reconciling it with mainstream learning systems – it is difficult to standardise curricula, and to monitor, evaluate and certificate the courses. This limits the transferability of courses to outside the PKS. As with the individual experiential learning, the training element of the PKS appears to strengthen internal ties. Attaining the course qualifications confers some level of cognitive authority on the participants and builds a critical competence, which reinforces boundaries. It also represents a level of investment in knowledge both by trainer and trainee, since the courses can be demanding on time and money.

However, the recent accreditation of some PDC courses and modules (e.g. level one mulching module) by the Open College Network (a credit awarding organisation), marks the first stage in making the courses accessible to a wider audience and provides common fora for knowledge sharing. Thus although training reinforces a closed knowledge system, there is an element of boundary crossing, with educational structures.

4.5   Permaculture Association outreach and dissemination

One of the aims in the PA strategy is to reach out to new groups and sectors (PA, 2011a). The LAND and FarmLAND initiatives in particular are opportunities for diffusion of Permaculture ideas into the AKS. LAND is a network of some 80 demonstration sites for Permaculture practitioners and the general public. Some managers of Permaculture LAND sites interact with their local community, as one participant remarked "*We have contacts on many fronts, farmers, local government, architects, urban food growers, we're reaching out to a lot of people*". However, respondents remarked on the difficulties in explaining Permaculture to

these people. There is also resistance from conventional farming bodies, one LAND practitioner described attempts to communicate with local farming union representatives: "*We have been trying to knock on door of the NFU [National Farmers Union] for ages without success…NFU is a hard nut to crack*".

FarmLAND aims to promote Permaculture design at the farm scale by working with farmers and AKS partner/training organisations. This initiative is ambitious and largely aspirational, it reflects the PA vision to transform the food production system. So far it has attracted interest mainly from smallholders already interested in Permaculture. A few larger scale mainstream farms have engaged, either attracted by the Permaculture approach or by training events on certain selected practices, such as mob grazing, which can be implemented on conventional farms. Attempts to take some of these events out to a wider farming community have met some resistance. One large scale dairy farmer, who is using Permaculture design, described an organised farm walk led by a well-known expert in mob grazing:

> "*The meeting attracted some local farmers. All the people for Permaculture design course also came. Some of the farmers thought they were a bit weird and one described them as 'fanatical'. I thought I can see what you're saying. But you're looking at it purely from a farming point of view and not listening to what they are saying. Sometimes we can come over as quite fanatical*". Dairy farmer

4.6   Permaculture Association Research

The PA regards research as important, both in providing feedback to the community about best practice, but also as providing evidence to outsiders. There is a wider interest in the Permaculture community to prove that Permaculture works (Perkins, 2012) and to gain some credibility. As Holgrem (2011, p 23) noted, there is a "*perception of lack of intellectual rigour, which has continued to inhibit the concept being taken seriously in academia*".

The PA supported by a Research Advisory Board (RAB) (which includes a number of interested academics) is in the early stages of developing and implementing a research strategy for the PA (PA, 2011c). The Permaculture principles underpin the PA's approach to research with co-production of knowledge, a systems approach and participatory methodologies at the core. The PA views its network of practitioners as a ready-made research resource, they are referred to as the Practitioner Research Network (PRN) and are seen to have the potential to carry out small scale, technologically simple research into a wide range of topics, as one of the RAB explained:

> "*One characteristic of Permaculture is a large number of amateur practitioners in the field, in terms of practice the knowledge lives with the practitioners, so the structures we've created around research are intended to gather momentum, not reinvent the wheel, just do a few case studies… we have started some participatory trials, so people can try things at home and report in a format that we can aggregate*". RAB member

Advocates also argue that Permaculture's systems approach is better equipped to tackle complex issues compared to single issue research communities. Permaculture is also seen to provide a novel approach and to offer freedom for researchers. The PA's ambition is to bring together the data available from a number of plots and to produce a published research evidence base.

> "*So a few years down the line we will put out paper to prove that Permaculture works and draw on evidence of applying principles to a plot from all continents, we will have 10-20 examples from the main ecosystems on the planet, we will go granular. We can offer evidence that Permaculture design works, the approach is working.*" RAB member

In this sense the PA are seeking credibility with AKS actors and looking for validation by using a common knowledge and language (peer reviewed publication). However, they are doing this on their own terms, using methodologies (small scale participatory trials of wheat and poly vegetable production) which some

consider will not be acceptable because they will not be written up "scientifically". Furthermore the PRN lacks research skills and equipment and there are inadequate systems for measuring and recording, since the PA has not historically carried out research in the traditional sense. They anticipate problems in communicating their findings to the AKS due to their non-conventional approach and different views about what constitutes valid knowledge. One RAB member described the "*difficulty of sticking your head above the parapet when you don't fit with the norm*".

There are, however, areas of common understanding and knowledge between PKS and AKS research. Some respondents pointed to fundamental knowledge and principles shared between the mainstream and Permaculture KS (for example, an understanding of the carbon and nitrogen cycles). This is regarded as value-neutral knowledge that all systems could draw on as a baseline. Furthermore agro-ecology and systems thinking, central tenets of Permaculture, are recognised approaches in the AKS, and underpin many practices in mainstream farming. PKS and AKS actors are exploiting this potential commonality and the emerging interest in mainstreaming agro-ecological farming, by collaborating in partnerships to explore and access associated new streams of research and project funding.

5   Discussion

It is apparent that in each of main elements of the PKS there is a tension between internal facing activities which create and reinforce PKS boundaries, and external facing activities that cross these boundaries (Figure 1). Challenges to the AKS, that is activities that aim to persuade AKS actors that Permaculture is a suitable alternative to conventional agricultural, are often limited by boundaries around the PKS and AKS. However, tensions at the PKS-AKS interface arguably also lead to new opportunities and perspectives. Thus, the distinction drawn between challenging and invigorating is more subtle that previously hypothesised.
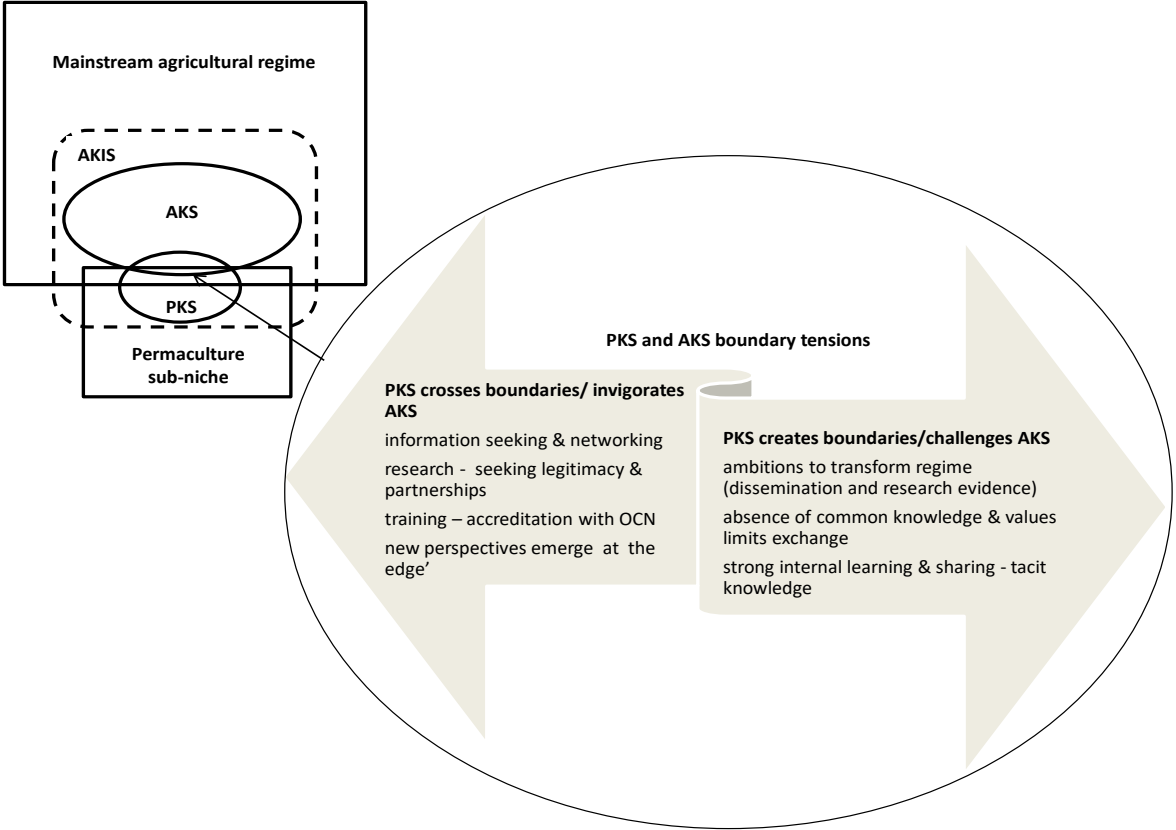
Figure 1: PKS and AKS boundary tensions in the context of the mainstream agricultural regime and Permaculture sub-niche

In many ways Permaculture and mainstream agriculture actors inhabit different worlds. Consequently, there are different views of what constitutes reliable or useful knowledge. Fundamentally, absence of common knowledge is a defining feature at the boundary between the respective knowledge systems. Every component of the PKS (individual learning, training, networking, dissemination and research) is centred around values, beliefs and co-produced through experience and mutual support. Such tacit knowledge is hard to standardise and codify and lacks a means of validating it according to the rules and assumptions of the AKS. This is further hampered by the perception from the outside that its knowledge base, and associated claims, lack rigour or evidence. Conversely, the universal knowledge of the AKS is not seen as relevant to the local context in which Permaculture actors operate, nor does it address the more complex problems they face at the systems level. Furthermore the commodified knowledge of the AKS is not always accessible to them.

In the PKS knowledge has a tendency to circulate internally and boundaries are maintained by shared internal understandings, invested knowledge, and the cognitive authority attached to personified knowledge and to Permaculture qualifications. Learning within the sub-niche is primarily an internal activity. However to counter this tendency Permaculture actors, both as individuals and as representatives of the PA, are starting to make connections and communicate with wider audiences 'outside' of the PKS boundaries. This inside/outside dynamic is being played out at all levels of the PKS as actors endeavour to, both maintain a cohesive PKS true to Permaculture values and ethos, and cross boundaries to challenge the regime, and seek information and legitimacy from the AKS. This interaction across the boundary, although still in the early stages, arguably provides opportunities for generative tension (Wenger, 2000) or creative abrasion (Powell and Grodal, 2005).

At the level of the individual, tacit learning strengthens internal ties. However, this is balanced by the weaker external ties some actors make by networking, disseminating and seeking information outside of the PKS boundary. These informal interactions seed connections across the PKS-AKS boundary. According to the idea of the "strength of weak ties", it is often people loosely linked to several communities who facilitate the flow of knowledge among them (Granovetter, 1973). Furthermore the importance of individual actors in the networking, negotiation, adaptation and translation processes in linking niches and regime has been demonstrated in other studies (Ingram et al., 2014b; Klerkx et al., 2010; Smith, 2007). At the PA level some staff members possess bridge building qualities and competences. They are not intermediaries, 'innovation brokers' or 'boundary spanners' (Swan et al., 2002) in the strictest sense, as their motivations and intentions are not value-free, nevertheless they are starting a dialogue with actors in the AKS. These people are able to operate in a different world and look for opportunities to advance the interests of Permaculture, to appropriate or reframe knowledge, ideas and associated resources from the AKS, and to enter partnerships where knowledge stocks might be translated into collectively shared or new knowledge, as described in other contexts (Tisenkopfs et al., 2015). At the same time they are also prepared to defend Permaculture and the validity of evidence to support it. As argued in this book (Steyaert et al., 2015) such intermediation cannot be described as a strictly functional role, as it involves navigating between different social worlds where values are at stake. In this case those navigating have done so by finding their own meanings to disputed concepts.

Reconciling the PA's internal training processes and legitimisation with its efforts to accredit the courses in the OCN further demonstrates efforts to balance strong internal learning with recognition in the wider community. This connection potentially exposes both the Permaculture and the wider education community to fresh perspectives. Furthermore the boundary interaction at the Permaculture-farming interface is providing new learning experiences (about novel practices: mob grazing, polyculture, agroforestry) for both mainstream and Permaculture producers. It is also providing common fora, such as farm walks and workshop events, where interaction can take place. The PA's efforts to seek legitimacy for Permaculture by publishing research according to the rules and routines of the AKS shows an attempt at bridge building.

Such exchanges may help to create a common platform for knowledge sharing and potentially innovative research methodologies. However, using evidence from participatory research may be resisted by the AKS, as described by the organic movement who faced problems establishing scientific proof due to the ecological philosophy held by activists and the need to understand the full system (Smith, 2007).

Despite a tendency to operate in an alternative social learning system, the many ways in which Permaculture is interpreted, and the overlapping networks practitioners and PA staff engage in, do help to create learning opportunities across boundaries with the AKS. Thus, the communities are following one of their own design principles, the edge effect, an ecological concept that describes how there is a greater diversity of life at the boundary or interface between two biological communities (Holmgren, 2002; Turner et al., 2003). Tensions within the regime open up opportunities for niche boundary crossing as well. Respondents argue that as the different KS deal with common problems and goals, more partnership opportunities and synergies will emerge. The need for integrated approaches to tackle complex problems of the modern food system can also be seen as a window of opportunity for the systems approach of Permaculture research, as one participant remarked Permaculture's "time has come". Thus the PKS can potentially strengthen the AKS by bringing in new perspectives and opportunities for innovation.

6   Conclusion

Sustainable transitions are inevitably disputed and controversial because they lead to confrontations of systems of knowledge, interest and value. This is revealed in this research which describes the boundary between the PKS and the AKS where differing sets of beliefs and values, epistemologies, ways of facilitating and supporting learning, approaches to research and modes of development confront each other. The interaction between the knowledge systems is characterised by the tension between the strong learning processes which reinforce the PKS boundaries and the tentative external links being forged in an attempt to connect across PKS-AKS boundaries. This tension reveals the complex nature of processes involved. Rather than a dichotomy of the PKS challenging or invigorating the AKS, there is a subtle set of overlapping processes that involve some contested diffusion of Permaculture ideas into the AKS, as well as some potential co-learning and emergence of fresh perspectives and opportunities for innovation

Scholars propose the need for boundary work to negotiate interactions between different knowledge systems while maintaining the integrity of each knowledge system. Such work would enable the interactional space between PKS and the AKS to develop further. It is argued that such activities could be fostered in an AKIS, and so offer a more comprehensive concept for accommodating the newly emerging coalitions of actors, which are pursuing different, sometimes competing goals (EU SCAR, 2012).

However, the essence of this boundary work, and who performs it, have not been widely considered in a situation where niche KS are linked to such transformative ambitions for the food system. In such situations intermediaries between KS, rather than a purely functional role of communicating objective knowledge, have to negotiate, interpret and represent different values, epistemologies and visions for the future. In the case of Permaculture these intermediary processes have been ad hoc and opportunistic and shaped by individuals; there have been no formal attempts to align actors' cognitive frames, perceptions and motivations. The relative merits of such emergent and adaptive interactions, compared to formalised approaches, needs further consideration in the context of sustainable transitions.

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