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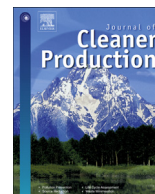
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The diffusion of climate-smart agricultural innovations: Systems level factors that inhibit sustainable entrepreneurial action

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ABSTRACT

Sustainable entrepreneurs are key actors in sustainability transitions; they develop needed innovations, create markets, and pressure incumbents. While socio-technical transitions literature is well developed, questions remain in terms of (1) the different roles that sustainable entrepreneurs can play in sustainable transitions, and (2) how best to empower these roles. To explore these challenges, we review literature and construct a framework combining the multilevel perspective and entrepreneurial ecosystem perspective. We apply this framework to the context of climate-smart agriculture in (Western and Central) Europe. By analysing semi-structured interview data ($n = 27$) we find that sustainable entrepreneurs are constrained by ineffective policy, resistant users, as well as novel alignment issues within the supply chain. We focus on the role of sustainable entrepreneurs as coordinators of action rather than developers of technological innovation within transition contexts characterised by low landscape pressures, large unmotivated incumbent firms, low consumer awareness and demand, and unincited users (farmers).

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1. Introduction

Recent analysis shows that Earth-system biophysical thresholds have been exceeded in terms of biodiversity loss, CO₂ emissions and interference with the nitrogen cycle (Steffen et al., 2015). This creates urgent need for a transition towards sustainability. This transition is reliant on new technological, social and organisational sustainable innovations. However, unless these innovations are adopted, their impact on sustainability transitions is only potential. Many innovations are developed, but few make it to the market. This is potentially the case for the transition to a climate-smart agricultural (CSA) system within Europe. Many technologies and practices exist to facilitate the creation of a more sustainable system, yet action is potentially inhibited.

Many different actors develop sustainable innovations. We focus on sustainable entrepreneurs, as, while many actors can develop

innovations, entrepreneurs are often responsible for changing the systems around them, and so can act as levers for the large-scale socio-economic restructurings required for sustainability transitions (Hekkert et al., 2007; Schaltegger and Wagner, 2011; EIT, 2014). Sustainable entrepreneurship is the process of 'discovery, creation and exploitation of opportunities to create future goods and services that sustain the natural and/or communal environment and provide development gains for others' (Shepherd and Patzelt, 2011, pg. 632). Sustainable entrepreneurs possess capabilities such as ingenuity and flexibility, and drive innovation and adoption processes (Schaltegger and Wagner, 2011).

Many barriers inhibit the successful development and diffusion of sustainable innovations. These can include economic, institutional, behavioural, or organisational factors (Hoffman and Henn, 2008; Long et al., 2015). While these barriers can be quite simple, others can be more complex, due to systemic dynamics. For instance, the transition towards a climate-smart agri-food sector requires investments and adaptations upstream (on farm), while many of the economic benefits (in terms of CSR or reduced supply risk) are found downstream. Other difficulties can include poor legislative support or unsupportive incumbent firms who see new

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entrants and their innovations as threats (Hockerts and Wüstenhagen, 2010).

These barriers are difficult to deal with from an individual entrepreneur's point of view. The system level processes, such as inter-firm and firm-to-government relations within sustainability transitions are likely to play a critical role in the formation and solving of barriers (Markard and Truffer, 2008). How these processes interact with entrepreneurship is less clear (Hörisch, 2015; Thompson et al., 2015). For example, entrepreneur to government relations have been found to be important (Gasbarro et al., 2015), but questions remain over how best to support and enhance entrepreneurial efforts and what system level and eco-system factors moderate their role in transitions.

As such, the aim of this paper is to understand (1) the different roles that sustainable entrepreneurs can play in sustainable transitions, and (2) how best to empower these roles.

Innovation diffusion is explored through a variety of different literature (see Rogers, 2003; Hekkert, 2007); however, we focus on literature dealing with the multi-level perspective (MLP), as this approach links the different levels, introduces a temporal dimension, as well as connects the concepts of sustainable entrepreneurship and the entrepreneurial ecosystem. We synthesise these concepts to develop a framework, which we apply to the case of CSA in Europe. We collect and analyse data from a range of expert respondents (via interview) and through secondary sources such as national and European policy documents. The data collected highlights the state of the transition to CSA and the barriers that sustainable entrepreneurship faces within the socio-technical transition. The theoretical framework is then adjusted to better account for the empirical results.

In doing so, this paper contributes by providing an empirically informed framework that highlights the system dynamics moderating the role of sustainable entrepreneurs and their ability to develop and diffuse sustainable innovations. This responds directly to calls to provide further detail on the role of agency and actors in sustainability transitions and the impact of wider contextual factors in terms of entrepreneurial success (Smith et al., 2005; Genus and Coles, 2008; Ács et al., 2014; Hörisch, 2015). The paper expands on previous research that explored the perspective of entrepreneurs in systems transitions. While previous research has used a technological innovation systems approach (Planko et al., 2016; Planko et al., 2016), we explore the issue of entrepreneurial influence and the factors that impact it through the MLP. We also seek to contribute by integrating the increasingly recognised importance of the eco-systems around innovative actors and entrepreneurs (Etzkowitz and Klofsten, 2005; Isenberg, 2010). We find novel barriers within the transition to CSA, namely, misalignment issues in terms of costs and benefits and investment potential across agri-food chains. Following this, we propose and explore how sustainable entrepreneurs may be more effective as coordinators of action rather than developers of technological innovation.

The research is set within the context of the transition to CSA in Europe. CSA is a transition to sustainability taking place in the agri-food system. Agriculture is responsible for around 10% of greenhouse gas (GHG) emissions within the European Union (European Commission, 2015), and as such, is expected to reduce GHG emissions to achieve climate goals (UNFCCC, 2016). Furthermore, due to increased weather variability, farmers are exploring new production approaches to secure business continuity (Nelson et al., 2009; Bogdanski, 2012).

CSA is the response to these challenges, involving: 1) the sustainable increase of agricultural productivity, 2) adaptation and resilience to climate impacts, and/or 3) reductions in GHG emissions (FAO, 2010). CSA fits within the concept of a sustainability transition because (1) it will provide collective goods, such as

climate change mitigation and other environmental outcomes, and (2) behaviour changes are likely to be important (Praetorius, 2009; Geels, 2011).

We define CSA innovations as new products, services or techniques, or improvements to existing products, services, or techniques, which help achieve CSA objectives. Sustainable entrepreneurs are the entrepreneurs that develop CSA innovations and aim to bring them to the market. Key users are farmers, agri-food companies, and other agri-food chain members.

In the remainder of the paper, section 2 provides an overview and characterisation of research on socio-technical transitions, sustainable entrepreneurship, and the entrepreneurial eco-system perspective, and presents a theoretical framework. Section 3 describes the methods used for data collection and analysis, and the empirical context of CSA. Section 4 presents the results. Section 5 discusses the implications of the findings for both practice and theory. Finally, section 6 closes the paper with some final thoughts, limitations, and potential next steps.

2. Literature review

In this section, we review literature on the management of transitions, the role of sustainable entrepreneurship as well as the systems within which the actors operate. Following this review, we explore the concepts and theories in greater depth to develop a theoretical framework through which we explore the empirical context of CSA in Europe.

2.1. The multi-level perspective and socio-ethical transitions

In this section we focus on the MLP, which is a much-used framework for exploring and explaining socio-technical transitions to sustainability. The MLP helps structure a complex reality. The MLP organises the analysis of the system and its transition into a nested hierarchy of processes – namely, the micro (niches), meso (regimes) and macro (landscapes) levels (Geels and Schot, 2007; Genus and Coles, 2008; Markard and Truffer, 2008).

The MLP explores processes at different levels, as well as how they interact. The meso level (socio-technical regime) represents the rules and routines, artefacts and groups that characterise the status quo of production and innovation (Geels, 2005a,b, 2011). Technologies, practices, regulations, and norms within the socio-technical regime are characterised by stability. It is a highly institutionalised environment, where change is both incremental and path dependent (Geels, 2011). Below the regime are niches, which are conceived of as protected spaces where radical innovations can emerge. Radical innovations have the potential to be regime changing. Whilst many niches may exist, only a minority will produce regime changing technologies and innovations, with most niches likely to die away. Niches and regimes interact, resulting in some innovations from niches becoming established within the regime (Smith, 2010). This interaction can take the form of regime actors entering niches, being involved in joint learning, or in terms of the creation of shared visions of the future (Ingram et al., 2015; Bui et al., 2016). Both the regime and niches are located within the landscape. This is a wider macro structure, which provides social and physical limits. The landscape constitutes economic and consumption trends, politics, society, and the natural environment. The landscape can both enhance the current path or status of the regime as well as be a source of pressures that lead to transition.

A transition occurs when 1) the existing regime starts to become problematic, 2) when key innovations occur that represent potential solutions, and when 3) initial adoption of these innovations starts to take place (Elzen et al., 2004; Geels, 2005a,b). Barbier and Elzen (2012) distinguish between system innovation, with external

actors responding to pressures and creating radical solutions, versus system optimisation, where the response to landscape pressures is more nuanced, building on the existing system, leading to incremental change.

The MLP builds on previous theoretical develops, most notably strategic niche management and transitions management. Strategic niche management seeks to prescribe policies and actions that enable the formation of niches, within which innovations can be developed. A central tenet of the concept is that users needs and wants are not fixed meaning innovation development is open ended and ongoing. Links between the concepts include the MLPs inclusion of the niche level, and the importance it ascribes processes (such as protected innovation development), as well as the MLPs inclusion of shifting preferences at the landscape level. Transition management is a governance and analytical approach that sees society as a series of complex adaptive systems. It is multi-domain, multi-temporal, multi-actor, and multi-level, highlighting a multiplicity of similarities with the MLP. However, transitions management is more forward looking, more action focused, and developed as a method for encouraging transitions, rather than the MLPs greater focus on historical analysis. That said, the MLP is still influential in policy debate, due to its ability to include a wide range of factors and processes, such as outsider and user influences on transitions and corresponding changes to social practice (Van De Poel, 2000). This has meant that it has influenced policymaking (Lawhon and Murphy, 2011).

The approach is also criticised. It is argued that there is an over-emphasis placed upon technological artefacts at the expense of social and political contextual factors (Lawhon and Murphy, 2011). It is potentially biased towards the role of elite actors – such as governments and large businesses – as well as inadequately addressing power relations (Smith et al., 2005; Genus and Coles, 2008). Geels (2011) highlights, in response, that the MLP draws on evolutionary economics, meaning it can accommodate agency; however, Geels (2011) does concede that certain types of agency may be underrepresented, such as rationale choice and power dynamics. Conversely, there is criticism that too much emphasis is placed on niche agency (Smith, 2005). For example, too little emphasis is placed on the role of consumers and a lack of demand acting as a systemic barrier to the success of emerging innovations. There is also a lack of focus on what happens as technologies leave the ‘protected’ spaces of niches, and the role that entrepreneurs play in pushing technologies into regimes (Mignon and Bergek, 2016).

The MLP is also subject to analytical challenges, leading to calls for the integration of additional disciplines and perspectives (Smith et al., 2010), such as political science, geography or management studies. Sustainable entrepreneurship has been examined specifically through this perspective via the context of the green building sector (Gibbs, 2006) and in terms of social entrepreneurship (Witkamp et al., 2011). Questions remain as to the key factors that unlock of regimes and the roles of different actors in this process – for instance, the role that entrepreneur's play and the specific systemic barriers they face. Early examinations of socio-technical transitions took a historical perspective (Elzen et al., 2004; Geels, 2005a,b), but research increasingly considers the current and future prospects of innovations and the changes needed to reach sustainable futures (Lawhon and Murphy, 2011).

2.2. Sustainable entrepreneurs and ecosystems perspective

There is a growing view that entrepreneurs are key levers in the transition to sustainability, due to their role in developing and diffusing needed sustainable innovations (Witkamp et al., 2011; Gibbs and O'Neill, 2014; Hörisch, 2015). Entrepreneurship brings

the necessary people, resources, knowledge and networks together to generate business opportunities, which are often a key force in an innovation being used and practices being changed (Hekkert et al., 2007). However, within the MLP, entrepreneurs have different roles depending upon the transition pathway (Geels and Schot, 2007). Entrepreneurs (or indeed activists) can develop alternative methods and technologies, which in turn can influence regime practice. The broader transitions literature, such as strategic niche management, discusses similar roles, but in little detail (Thompson et al., 2015; Planko et al., 2016a,b).

The specific role of the entrepreneur and the key factors that facilitate or inhibit their role (and success), is underdeveloped (Stam, 2015). This raises the question of how to conceptualise entrepreneurship within sustainability transitions, and more specifically, which factors and actors influence the entrepreneurial processes that are important to innovation diffusion. Broader innovation diffusion literature highlights a range of influential factors (Mignon and Bergek, 2016; Long et al., 2016), split according to their operation on the actor or system level. For instance, the knowledge and experience, financial resources, social capital, motives, values/norms can all be critical factors, operating on both the demand and supply side (Mignon and Bergek, 2016).

To provide enhanced depth to the key systems factors that affect entrepreneurial success, we draw on a literature that places entrepreneurs at the centre of the system (Stam, 2015), and sees the system as one that can be influenced by the same entrepreneurs. Such a system, or ‘eco-system’, describes the stakeholders who have an interest and effect on entrepreneurial success and can include a wide range of organisations and actors from government or universities through to investors and other businesses (Cohen, 2006; Adner and Kapoor, 2010; Boutillier et al., 2016). The ecosystem perspective introduces the role that (social) context plays in facilitating or restricting entrepreneurship, building on cluster theory (for instance, highlighting the savings available when firms co-locate) (Malmberg and Maskell, 2002). This links to systems of entrepreneurship approaches (Ács et al., 2014), which have previously aimed to bridge innovation systems and entrepreneurship concepts. By placing entrepreneurs near the centre of the system, it becomes easier to identify key facilitators or ‘feeders’ (Feld, 2012).

The creation of successful entrepreneurial ecosystems is dependent on several factors that often come together simultaneously (Boutillier et al., 2016); for example, new ventures, as well as larger established companies, are often important when establishing successful ecosystems (Zahra and Nambisan, 2012). This means policy for developing ecosystem is often challenging, but is thought to include taking local conditions and context into account, engaging the private sector from the outset, reforming legal and bureaucratic frameworks, and focusing scarce resources on ‘high potential’ examples (Isenberg, 2010). For instance, feeders may include government where they provide a supportive regulatory environment, or other professional services firms, such as lawyers or banks. A World Economic Forum (2013) report highlighted that many successful entrepreneurial ecosystems had key attributes such as accessible markets, human capital, funding and finance, support systems, government and regulatory frameworks, education and training, major universities, cultural support (WEF, 2013).

The entrepreneurial ecosystem approach has been primarily a practitioner-focused concept. This means that it – in contrast to the MLP – is subject to criticism that it lacks conceptual and theoretical depth (Stam, 2015). For instance, while access to markets and finances are highlighted as key success factors, there is little explanation as to why or how this is the case. The existence of markets and accessible finance is in turn likely to depend upon underlying factors such as institutions and norms. Further, there has to date

been little appreciation of the interdependencies between these key factors (Spigel, 2016).

2.3. Integrating entrepreneurial ecosystem with socio-technical transitions

To identify the factors and dynamics that inhibit the role of sustainable entrepreneurship in transitions and to identify key levers, we use the MLP as a theoretical backdrop, as it conceptualises the dynamics of change and transition (Genus and Coles, 2008). Barriers that impact sustainable entrepreneurship and the adoption of sustainable innovations have been highlighted at the actor level (Dean and McMullen, 2007; Long et al., 2015) and in terms of organisations and markets (Pinkse and Groot, 2015; Long et al., 2017). The MLP highlights key dynamics and actors, and the levels at which these aspects operate, providing greater clarity as to those factors inhibiting the transition to sustainability. We integrate the concept of the entrepreneurial ecosystem to focus in detail on the different factors around the entrepreneurs that affect their success, and by extension, that of an innovation.

Within the MLP, sustainable entrepreneurship contributes to transitions either by introducing innovations, which have a direct impact, or by influencing and pressuring other actors, such as incumbent firms or governments. Sustainable entrepreneurs can also help create the supportive structures needed for new innovations to compete against incumbent technologies (Geels et al., 2008), such as changing social norms or institutions (Pacheco et al., 2010). What key barriers are and what key processes operate are key questions, that can help to explore the different roles that sustainable entrepreneurship plays in sustainability transitions. Often smaller start-up firms provide innovations. However, larger incumbents often carry these innovations to the market and full diffusion (Schaltegger and Wagner, 2011; Bohnsack et al., 2014). Incumbent firms can block the process of sustainable entrepreneurship, and represent a common barrier and reason for failure (Klein Woolthuis, 2010; Pinkse and Groot, 2015).

While some scholars highlight entrepreneurs as 'lone heroes', broader perspectives are available, such as the entrepreneurial ecosystem perspective that sees many actors involved in supporting entrepreneurship and enabling innovation (Suresh and Ramraj, 2012; Autio et al., 2014; Boutillier et al., 2016). To explore the role of specific entrepreneurial barriers and support structures, we introduce the entrepreneurial ecosystems perspective. This highlights the role of factors such as 1) moral support, for example from society, 2) financial support, from banks, angel investors, or government bodies, and 3) network support, such as from industry or trade bodies, or networks of suppliers or customers. 4) Government support, which can come from publicly funded incubators, or public grants and awards, 5) technology support, often developed in Universities or from imported technology expertise, 6) market support from opportunities in the market, through loyal customers, suppliers or via exhibitions or trade shows. Finally, 7) social support, which can include help in the form of media exposure or the 'moral support' in case of venture failure, and 8) environmental support, such as the availability of natural resources, or environmental pressures which enhance the need for the innovations associated with the entrepreneur (Adner and Kapoor, 2010; Suresh and Ramraj, 2012). Sustainable entrepreneurs utilise this support to carry out coordination activities, technology development and optimisation and market creation (Planko et al., 2016; Planko et al., 2016).

3. Research approach, materials, and methods

This paper seeks to identify and explore the factors and dynamics that inhibit sustainable entrepreneurs' role in sustainability

transitions and identify key levers to enhance sustainable entrepreneurs' role.

3.1. Data collection

Suitable methodological approaches for investigating ongoing transitions from an empirical point of view are open to debate (Genus and Coles, 2008). Socio-technical transitions can only be fully assessed in hindsight (Darnhofer 2015), creating problems when considering 'transitions in the making', as is the case with CSA in Europe. However, research is emerging that analyses current transitions (c.f. Darnhofer 2015), and factors and dynamics impacting entrepreneurs should be identifiable *in vivo*. In line with these examples, we use a combination of expert knowledge and opinion, collected through interviews as well as secondary data in the form of documents (Elzen et al., 2011; Karanikolas et al., 2015; Sutherland et al., 2015). Our research questions were of a 'how' nature (how to understand and improve sustainable entrepreneurs' role in a sustainability transition) and were not trying to establish the size of the CSA transition, nor quantify the relative importance of barriers or challenges. This meant a qualitative design was appropriate, providing rich data on the nature of the problem, from a variety of different viewpoints.

We sought to focus on the key factors and dynamics influencing the role of entrepreneurs and what levers could be used to support entrepreneurs. The interviews followed a semi-structured format, allowing the literature and concepts reviewed to inform the questioning, but also provide scope for additional information and data to be collected. The general themes covered included the key barriers that impacted entrepreneurs developing CSA innovations and how, the role of sustainable entrepreneurship, the wider transition to CSA in Europe, as well as what would have to change to enhance the transition to CSA.

Through 27 semi-structured interviews during the period 2015–2016, we collected data from CSA innovation providers as well as policymakers and other key actors, such as agricultural support agencies, from the Netherlands, Spain, Denmark, Sweden, Italy, Finland, Ireland, France, Hungary, the United Kingdom, and Switzerland. The research context was somewhat impacted by the realities and constraints of data collection, meaning a diverse geographical sample was collected. That said, these countries face similar political and agricultural contexts, providing sufficient commonality to draw out results, recommendations and conclusions. Participants were selected using a non-probabilistic purposive sampling strategy. Participants were primarily identified through internet searches and then approached for an interview. We continued to collect data until data saturation was reached, as is in line with the qualitative research approach (Strauss and Corbin, 1998); further, as our sample contained a diversity of respondents (a heterogeneous group) a guide of 20–40 interviews are thought to be necessary for data saturation (Morse, 1994). As our number is within this guidance, we are confident that the number of interviews was sufficient to justify the conclusions we reach.

3.2. Data analysis

Data analysis started with the production of the interview transcripts. Audio recordings were taken of most interviews, however, where this was not the case, extensive notes facilitated analysis. We first sought to characterise the transition to CSA in (Western and Central) Europe. Having an understanding of the context within which sustainable entrepreneurs operate within is critical to understanding key factors, dynamics and barriers. To provide this overview, the transcribed data was coded according to the MLP. Key niche level factors and actors were coded to develop

a picture of processes at this level, while the same was done in terms of the regime and landscape. In this sense, the coding was somewhat deductive, using the predefined levels of the MLP. To identify those factors influencing entrepreneurial action, a more inductive approach was taken. With a more open mind, the researchers looked for any mentions of factors relevant to the role and ability of entrepreneurs to diffusion CSA innovations. These in turn were slowly grouped into codes and finally developed in categories. As such, the data analysis used both deductive and inductive coding strategies. The categorisation of data was conducted using NVivo 11, involving numerous iterations to ensure consistency within the developed categories. Triangulation was attempted where possible, using grey literature and internet searches, which were read to gain additional understanding.

4. Empirical findings

4.1. Characterising the transition to CSA

In this section, we characterise and shortly describe key developments in terms of the transition to CSA, according to the MLP framework. We do this to contextually ground the study before considering the factors and dynamics that inhibit sustainable entrepreneurs' role in transitions and to identify key levers for supporting this role.

4.1.1. Niches

Many types of hardware, software, and management approaches are highlighted as available to aid the transition to CSA (CSA Booster, 2014). This highlights that sustainable entrepreneurship is occurring, developing CSA innovations. However, the niche environment is characterised as experiencing a range of 'usual suspect' innovation barriers. For example, there are resources being targeted at the development of CSA technologies and practices; however, entrepreneurs highlight resources access as a barrier. For instance, the European Commission has funding available for niche actors within the H2020 programme. This seeks to foster research-business collaborations on environmental challenges, including CSA (European Commission, 2015; European Investment Bank, 2017). The European Investment Bank assists entrepreneurs and governments in their transitions with budget-friendly loans (European Investment Bank, 2017). In addition, climate change innovation is supported by the European Institute of Innovation & Technology (EIT) – Climate KIC – which funds new business ideas. However, it was reported that much of this funding is targeted at early stage innovation, and that at the diffusion stage there is often a bottleneck, as reported by a sustainable entrepreneur:

Most of the funding available for early technology development is in the academic world, and if you are not part of that it is hard or impossible to access it. (#10)

National level support to connect with European resources is missing. Subsidies are seldom labelled for CSA – a certain degree of creativity and flexibility is needed to get CSA proposals approved within the scope of the subsidies. Funds are eligible for innovative projects; however, the European Commission has not yet clarified how the innovative characters of projects are assessed. Quality proposals are hampered by tight deadlines, while the success rate is low.

A poor connection between the development of CSA innovation and the market was reported. This included R&D failing to consider commercialisation issues, and sustainable entrepreneurs being unable to reach the market and engage with users, as highlighted by an entrepreneur:

The problem is visibility or marketing. No one knows we are here, or that we are doing something innovative. Communication of the innovation is our main barrier. (#6)

Alongside these challenges, respondents emphasised that niches were critical to the development of CSA innovations. The challenge was creating effective links between niches, for example, precision agriculture, and the agri-food regime. Without such links, innovations failed to have an impact.

I think it needs to be done with really innovative smaller companies. On the other hand, to create volume and have an actual impact you will be dependent on the major companies. They have much more power, but they tend to follow. (#27)

The impact of agro-ecological processes was also emphasised, as they limit and slow down innovation processes. Due to the interaction between CSA innovations and agro-ecological systems, testing CSA solutions often involves several growing seasons, equating to the addition of years to development timescales.

Because its agriculture, it's not immediate. You have to wait. You have to conduct numerous tests, for many years, and this is the main challenge. (#11)

Overall, the findings highlight that early stage innovation for CSA is effective, producing a range of relevant practices and technologies. However, these results are rendered ineffective due to bottlenecks impacting their diffusion into the hands of users.

4.1.2. Regime

Key regime actors included farmers and growers, large incumbent agri-food businesses, consumers, knowledge institutions, governments, and financial institutions. Inertia at the regime level was a reoccurring theme in the data, especially in relation to farmers and consumers.

Inertia within farming is related to general conservatism, cynicism, and a lack of an entrepreneurial approach and culture. This included a lack of awareness or ignorance of potential climate change problems. For instance, an agri-policy expert highlighted the farming community could lack the right mentality:

Cultural attitude – not having an innovative mindset – due to the European subsidy system – not a mindset to look forward in the longer term – expecting the government to solve these problems. Farmers are in some parts of Europe a bit conservative. (#26)

While some high-level signalling is evident (see next section), farmers are not pushed to take steps in the transition towards CSA. The tightness of agri-food markets means that there is little scope for experimentation or innovation in terms of environmental or long-term (climate) aims. This results in low driving forces and barriers. For instance, a sustainable entrepreneur highlights that even where farmers were motivated to act, that the overall economic conditions in many agricultural sectors made investment challenging:

You've talked about the tech challenging being solved, and that is how I see it. We just can't get people to buy in right now. A lot of farmers are really struggling – pig guys aren't making any money; the hill farmers aren't either. (#9)

One noted characteristic of where CSA was being pursued by

regime actors was that this often-involved high levels of collaboration. This in turn was facilitated by clusters of relevant organisations, such as universities located close to key partners. This draws clear parallels to the ‘ecosystem’ approach highlighted (Cohen, 2006), being effective in locations such as Silicon Valley in the US. For instance, in relation to CSA, an agriculturally focused bank noted:

So, the critical success factor in the Netherlands is the existence of Universities specialising in agriculture, research institutes for agriculture as well as other important areas, including Philips etc. (#15)

More common, and in line with the MLP concept, the regime is characterised by inertia. Supermarkets and agri-food businesses downstream in the supply chain are significant actors. They have the resources and power to influence the whole supply chain – yet, are not focused on CSA – resulting in little action. Two different agricultural consultants highlight the power of supermarkets and the importance of the supply chain:

Very often that is driven by supply chains, so for example, in the UK one of the real successes has been PepsiCo and their supply chain. They set out almost 5 years ago now to reduce the carbon and water footprint of their farming supply chain by 50% in 5 years. (#12)

[In] Western Europe, it is the supermarkets who are key. They decide prices and force them on producers – and these prices are low. And effectively, government can say agriculture is important, but it is a free market in terms of supermarkets – they provide the price. (#18)

This dynamic results in misalignment within agri-food chains which creates a drag on the CSA transition. Specifically, margins are very low upstream (on farms) but higher downstream (for supermarkets and agri-food companies). Yet, investment requirements for CSA are higher upstream (where margins and available capital is limited). For instance, organic agriculture has responded to recent trends towards organic consumption in Europe. However, the value added of this type of agriculture is mainly captured by supermarkets, while farmers are left to content with a less stable and more complex farming system.

At the regime level, policy instruments are in place that could support the CSA transition, including budgets for rural development within the second pillar of the CAP (European Commission, 2015). This European funding is regionally distributed, and the local government approves innovative proposals. Some member states are considering the topic of CSA in national policy, e.g. Ireland (Department of Agriculture s.d.). However, there is no strict regulation yet in place to directly influence agri-food producers, growers, processors etc. (i.e. the socio-technical regime). Firm-level emission targets for the agricultural sector will be developed by the member states to achieve the Paris Agreement objectives. Overall, the policy agenda is highlighting CSA as an issue, but the question is if this will provide sufficient pressures to influence appropriate actions in the short term by actors within the sector (supermarkets, farmers etc.).

In summary, the regime includes some front-runners exploring the topic of CSA. Inertia is present in most of the regime network for a range of reasons. Large incumbent firms hold the resources and power, often via supply chains, but due to the tightness of markets, few landscape pressures (see next section) and low to no consumer demands, little action is apparent.

4.1.3. Landscape

The data that highlighted landscape aspects include higher-level policy, the environmental situation in terms of climate change and agro-ecological processes, and the current logic and mechanisms of financial markets. The transition to CSA is characterised by some drivers, several barriers as well as benign factors at the landscape level.

In terms of policy trends (and their signalling impact), CSA is on the European policy agenda because of climate change mainstreaming activities (European Commission, 2017). CSA is mentioned as an ambition in the European Common Agricultural Policy (CAP). Other European policy areas contribute to CSA, although in a fragmented way, such as water policy, flood policy, innovation policy, energy policy. These policies demonstrate a commitment at the European governmental level that CSA is a legitimate issue – in part due to the Paris Agreement – and is a signal to business and investors. But tangible impacts on regime actors are absent.

The member states had the freedom to tailor European Common Agricultural Policy to the national needs, and the European regions have the responsibility to allocate the European rural development funds according to submitted projects from local stakeholders. In addition, there are currently no politically agreed CSA objectives (Matthews, 2015) resulting in a landscape that can differ in each member states, depending on the national CSA ambitions.

Environmental drivers, including changing weather patterns, are expected to be key CSA drivers. Some recent extreme weather events illustrate expected increases in extreme weather; for instance, the 2013 floods in central Europe, which caused €1 billion worth of damage (Credit-Suisse, 2013), or the downgrading of wheat forecasts in 2015 due to a heat wave (Agrimony, 2014). However, these events are not acting as a European-wide driver for action at farm or supply chain level. The extreme weather events are perceived as conventional business risks (Fleming and Vanclay, 2010). Insurance schemes, run by many national governments through the Rural Development Plans, compensate farmers for weather-related losses without requiring adaptive changes.

The power of consumption trends was highlighted as a required pressure for the transition, including how consumer demand is fed through supply chains to farm production. Vegetarianism and organic agriculture were increasingly popular consumption choices in Europe. Organic agriculture can form part of a CSA approach. However, it was highlighted that these either did not necessarily feed into climate friendly farming practices or were not of sufficient size to have a substantial impact.

The second major driver is consumption and consumer demand. If it wasn't for people buying organic tomato's in the Eko-plaza, then Albert Heijn [Dutch Supermarket] would have never started it. (#27)

Some respondents highlighted that awareness of the links between food and climate change was low among consumers, and that food held an emotive place in people's lives which restricted change.

The whole transition from animal to vegetable proteins is something that is almost a personal insult to some people ... Also, the relationship with climate change and the impact of present food production systems is something that is clear, but we would rather not be reminded of it every day. (#27)

Finally, a key landscape factor was the short-term focus of conventional financial markets and general measures of business

performance. A sustainable approach to agriculture was felt unlikely whilst taking a long-term approach was not rewarded.

What gets measured, gets done. So, if you are measuring short-term profit, yearly revenues, then that will be the emphasis in management. These people are not educated to think into the long term. (#27)

The key characteristics of the transition to CSA in Europe are illustrated in Fig. 2.

In summary, the landscape around the CSA transition is characterised as having few drivers and a range of inhibiting factors. For example, whilst policy is signalling CSA as an area for concern and action, current efforts are mixed. Recognition of environmental drivers attributable to climate change is missing.

4.2. Factors inhibiting the role of entrepreneurs in socio-technical transitions

This section explores the factors that emerged during the analysis which act as barriers and hindering factors to sustainable entrepreneurs.

User resistance emerged as a key barrier. This included cynicism and the lack of an entrepreneurial mind-set among key users of CSA innovations (primarily farmers). This had the effect of restricting demand and effectively increasing diffusion costs for sustainable entrepreneurs. In turn, this meant that sustainable entrepreneurs did not just have to develop diffusion technologies and techniques, but also attempt to install new norms and values. One sustainable entrepreneur highlighted that:

I think its cynicism – I think farmers are incredibly cynical about new things. The way we tend to do it now is that we offer to put the system in for free and show them. Often, after a while, they see the impact and will ask for more. Once you're in the door you can continue. (#13)

Poor links between research and development activities and users mean that CSA innovations do not align with user demands. This, in turn, makes it more difficult for sustainable entrepreneurs to commercialise and diffuse innovations. There is a lack of capabilities in terms of translating scientific and research successes into commercially successful innovations. For instance, one of the entrepreneurs highlights the importance of engaging with user groups, while the agricultural bank highlighted that innovation processes often did not pay enough attention to commercialisation:

The more we talked with the customers, the more we learned what they need and ask for. This is one of the major issues – we weren't sure initially of their specific demand. (#7)

I think often, the problem is that when systems or technologies are developed in the laboratory, they don't think about commercialisation. (#15)

Government and policy were also inhibiting entrepreneurs' ability to develop and launch CSA innovations. Respondents highlighted how the role of the government was to facilitate and regulate, and that without government support sustainable entrepreneurs were struggling to diffuse CSA innovations. Legislation plays an important role in creating markets and demand. Moreover, some policies actually reduce demand for CSA innovations – for example, through the provision of extreme weather insurance within the EU which may reduce the need to adopt resilience-enhancing CSA innovations.

It must be the government. Regardless of how good it is, or whether people want it, if the government is not putting their stamp on it, or supporting it, then it's difficult. (#3)

The regulatory framework for food and agricultural innovations inhibits entrepreneurs' ability to develop CSA innovations. Licensing regulations were felt to be vague and restricted development speeds.

It is a legislation driven industry – so more help in terms of understanding legislation but also changes to make it simpler and more supportive. (#11)

And, one that would take a lot of legislation change, which would have taken a real fight with the European food standards agency. (#10)

The respondents also highlighted *economic and financing barriers*. These included difficulties in obtaining financial backing by investors, through to the current economic systems focus on short-term profit.

well, there has to be money ... the societal thing is a benefit as well, and some people, altruistic people might do it just for the societal aspects. But there are a lot of investment people who are only interested in making money – that's why they invest – to make money (#10)

One of the underlying mechanisms of the financial system is not working – as the head of a large corporation, you are facing challenges in the way that the financial world works and treats you (#27)

Included in this category was the phenomenon of incumbent regime businesses being unlikely to benefit from CSA innovations. As such, they could be seen to be failing to provide needed links between niche innovations and actors, or actively inhibiting niche actors.

I think here there are other interesting aspects – looking at CSA doesn't necessarily play in the whole big boys like Monsanto. So, there is an important need to review the innovation structure in the different areas that are currently affected by climate change. (#18)

Table 2 provides an overview of the key dynamics and factors restricting the role of sustainable entrepreneurs in the transition to CSA in Europe.

5. Discussion - implications for theory and the theoretical framework

By exploring the transition to CSA through the MLP we can see that a range of actors and processes are critical to sustainability transitions. The case of CSA illustrated a transition in its infancy, with low landscape pressures, large incumbent agribusiness firms, low consumer demand and users (farmers) who are unincentivized and culturally non-entrepreneurial. This means that sustainable entrepreneurs, while producing innovative technologies and practices, are constrained in their role. This provides an interesting context in which to consider the dynamics inhibiting entrepreneurial action in this transition, what actions are available to enhance sustainable entrepreneurship and by extension a transition to sustainability. This research is able to contribute to transitions and sustainable entrepreneurship theory specifically in

relation to contexts characterised by low landscape pressures, large unmotivated incumbent firms, low consumer awareness and demand, and unincentivized users (farmers).

We find that sustainable entrepreneurs within the CSA transition face novel barriers. Much as with wider sustainable innovations attempting to compete in broader neo-liberal style markets (Pacheco et al., 2010), the CSA innovations being developed by sustainable entrepreneurs are likely to face a competitive disadvantage. However, the transition context of CSA provides additional problems that sustainable entrepreneurs must overcome, including broadly: poor links between sustainable entrepreneurs (niches) and users (regime), and a misalignment within agri-food chains. We consider the nature of the problems and consider factors and actions that could enhance the potential of entrepreneurial action to overcome these barriers.

Although sustainable entrepreneurs are noted as key actors in bridging the divide between niches and the regime (see Fig. 1), the results indicate that they may not be singularly able to achieve this end. Indeed, the forces that link niches with the regime and users may be more precarious than often indicated or assumed (Schot and Geels, 2008), especially where users are unmotivated. This could be attributed to cynical and conservative users (farmers), but also highlight problems with the conception of niches in terms of their ability to produce innovations able to impact the regime (Elzen et al., 2004; Geels et al., 2008; Smith et al., 2010). Further, the results highlight that incumbent firms (such as supermarkets and larger agribusinesses) are at best ineffective in supporting the transition to CSA, and at worst, obstructive (Klein Woolthuis, 2010; Pinkse and Groot, 2015). It is these actors who are likely to be able to benefit in the short term from CSA, due to their proximity to consumers, and take advantage of green marketing potentials. Part of this barrier links to a misalignment within supply chains.

There is a misalignment within agri-food chains which is likely to require external coordination to rectify. Most CSA technologies

and innovations require action upstream on farms; as such, it is in these locations that investment is required. Yet, adaptive changes as well as efforts to reduce GHG emissions are often costly and can have long ROI periods, while farmers often have very thin profit margins and limited capital for such investment (especially where ROI are extended). By contrast, downstream actors (large agri-food businesses) often have healthier profit margins and better access to capital. So, where action and investment are needed, there is limited ability to act, while where there is the power to act, there is limited motivation. Sustainable entrepreneurs within this context can develop technological innovations, yet these innovations will not be successful due to more structural barriers within the transition.

While these barriers are inhibiting sustainable entrepreneurial action, we propose that sustainable entrepreneurship is also likely to have a key role in overcoming them, if suitably supported and facilitated. Previous transitions research has highlighted roles for intermediaries (Smith et al., 2005). Indeed, it is well known that for sustainable advances to be made, current structures and institutions often need changing, and that collective action and co-ordination is needed (Pacheco et al., 2010; Woolthuis et al., 2013). As such, sustainable entrepreneurs' key role in a CSA transition may need to be more focused on coordination and institution building, rather than technology development and deployment. For instance, sustainable entrepreneurship is likely to be most beneficial where it is able to establish mechanisms that can overcome the interest misalignment, for instance through developing new collaborative relationship in agri-food chains so that more short-term benefits can be gained by farmers. One option for instance, could be the funding of CSA initiatives by downstream supply chain actors. This finding agrees with literature that criticises broader transitions literature for its focus on technological artefacts, often as the expense of management and coordination issues, and the wider roles that sustainable entrepreneurs (or other actors) may need to take (Lawhon and Murphy, 2011).

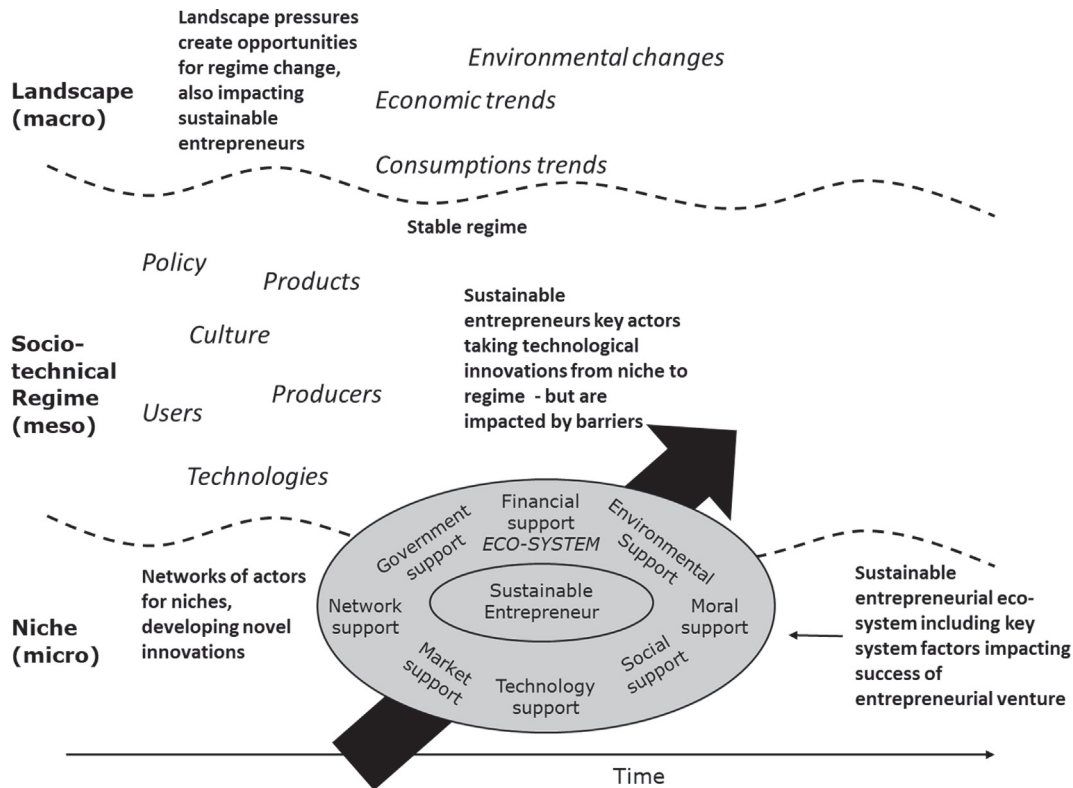
Table 1
List of interview respondents, including respondent type, nature of expertise, and date interviewed.

#	Nationality/ region	Respondent Characteristics/Technology	Date of interview
#1	European level	Agro-chemical corporation	September 2015
#2	Netherlands	Sustainable management practices for agriculture (Sustainable Entrepreneur)	October 2015
#3	Netherlands	Vermiculture (Sustainable Entrepreneur)	January 2016
#4	Hungary	Aquaculture smart farming technology (Sustainable Entrepreneur)	February 2016
#5	Netherlands	Unmanned cleantech tractors (Sustainable Entrepreneur)	February 2016
#6	Spain	Arable smart farming technology (Sustainable Entrepreneur)	February 2016
#7	Italy	Arable smart farming technology (Sustainable Entrepreneur)	February 2016
#8	Netherlands	Development agency	June 2016
#9	UK	Soilless growing system (Sustainable Entrepreneur)	June 2016
#10	UK	Waste to fertiliser technology (Sustainable entrepreneur)	June 2016
#11	UK	Next generation agro-chemicals (Sustainable Entrepreneur)	June 2016
#12	UK	Agritech consultant	June 2016
#13	UK	Soil sensing (Sustainable Entrepreneur)	June 2016
#14	Ireland	Decision support tools for grazing (Sustainable Entrepreneur)	June 2016
#15	Netherlands	Agricultural Bank	July 2016
#16	Netherlands	CSA Financing Consultant	July 2016
#17	UK & Netherlands	CSA Policy Consultation Meeting	July 2016
#18	UK	Innovation consultants	August 2016
#19	Netherlands	CSA Innovation Consultants & Sustainable Entrepreneur	June 2016
#20	Netherlands	Economic board	November 2016
#21	Netherlands	Development foundation	November 2016
#22	Denmark	Central Denmark Regional office	November 2016
#23	Italy	Regional Agricultural Ministry	November 2016
#24	Northern Ireland	NICP for the agri-food sector supporting sustainable food production, looking at food safety and security for the European community	November 2016
#25	Sweden	environmental strategist for Sweden region	November 2016
#26	Finland	Academic Agri-policy expert	November 2016
#27	Netherlands	Sustainable agriculture change management consultant	October 2016

Table 2

Summary of barriers inhibiting sustainable entrepreneurs' role in the transition to CSA.

Key Barriers to Entrepreneurial Action in Transition
User resistance
Poor links between research and development activities and users
Government and policy
Economic and financial barriers

**Fig. 1.** Multi-level perspective (adapted from Geels and Schot, 2007) with integration of entrepreneurial eco-system perspective.

Based on sustainable entrepreneurial ecosystem concepts and the broader sustainable entrepreneurship literature, we consider in more depth the coordination role able to be played by sustainable entrepreneurs and what mechanisms are available to support or enhance this role (Adner and Kapoor, 2010; Suresh and Ramraj, 2012; Boutillier et al., 2016).

Beyond funding innovation and development activities, the government has a critical role in supporting sustainable entrepreneurs. This can be achieved through ensuring that contradictory policy is eliminated and regulations smoothed, for example through policy coherence (OECD, 2017). The government can also play a key role in helping coordination efforts, a key aspect of sustainable socio-technical transition (Planko et al., 2016). Forms of institutional entrepreneurship are likely to be critical when trying to coordinate and develop supply chain wide action. This type of entrepreneurship may well originate from government (Battilana et al., 2009), highlighting that public sector based actors may well be the key entrepreneurs within a CSA transition requiring coordination and collaboration, rather than technology development.

Social and moral drivers may also play a key role, in terms of creating societal demand for a transition and the innovations that it involves. Without the support of society at large, through consumer demand or shifting values, innovations will not be adopted by key actors to the transition. Moral support can create landscape

pressures that impact the regime (Konefal, 2015), impacting consumer preferences and helping to create a market for the products of sustainable innovations. Media is a key tool in the use of this lever (Suresh and Ramraj, 2012). This shows that sustainable entrepreneurs seeking to coordinate action may have to be more media savvy or more sensitive to social and moral drivers. While demand for CSA may be niche, the ability of sustainable entrepreneurs to identify and then leverage landscape drivers could be critical.

By exploring and detailing the case of CSA, we uncover novel transition characteristics which have implications for the role of sustainable entrepreneurship and how to support sustainable entrepreneurial efforts. Characterising these barriers adds needed detail to this aspect of the MLP and responds directly to calls to explore the changes (or not) that sustainable entrepreneurs can bring to transitions (Loorbach and Wijsman, 2013). The entrepreneurial eco-system perspective we introduced into the theoretical framework can complement the MLP, and vice versa. This perspective can inform the role of sustainable entrepreneurs in the MLP of socio-technical transitions, as it allows us to highlight the entrepreneurs to act as effective levers for sustainability transitions. This is especially pertinent, as in the case of CSA, while economic support structures are made available for entrepreneurs, these appear insufficient. In turn, this emphasises the need for a

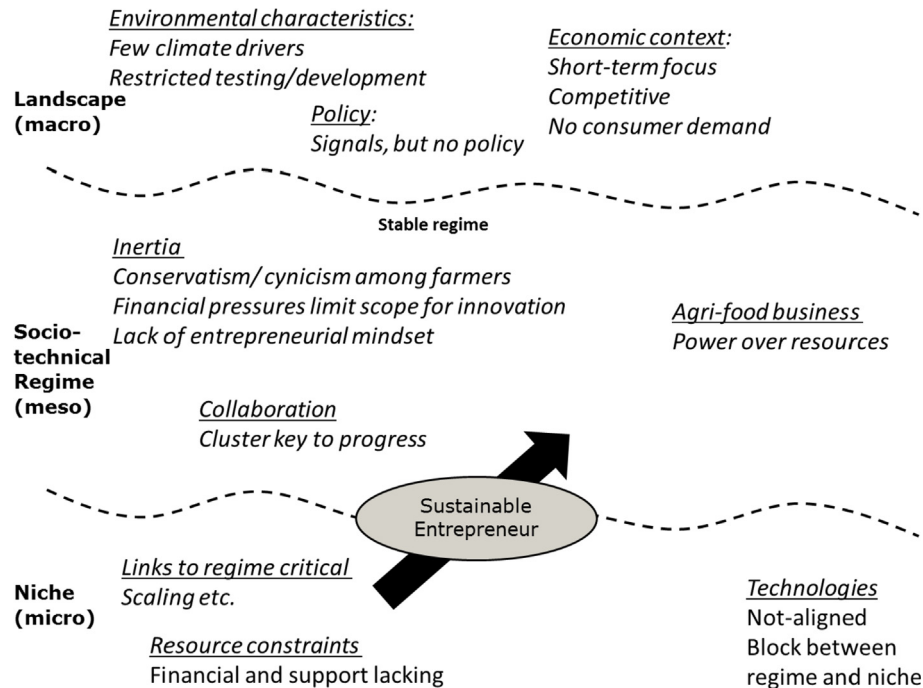


Fig. 2. Assessment of current state of transition to CSA in Europe.

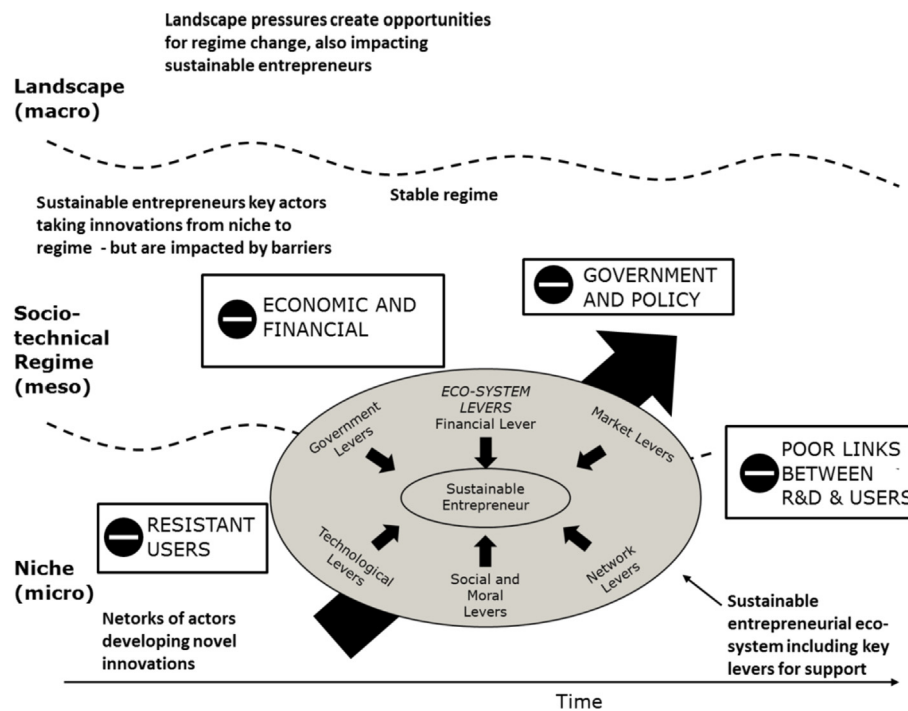


Fig. 3. Multi-level perspective of socio-technical transition including key entrepreneurial ecosystem levers and system factors and dynamics that inhibit sustainable entrepreneurial role.

broader understanding of what support entrepreneurs need. This result was aided by placing the sustainable entrepreneur the centre of the system, a perspective which was facilitated with the entrepreneurial ecosystem perspective. We contribute to the literature on sustainable entrepreneurship and socio-technical transitions by building a more detailed picture of the niche and regime contexts that inhibit and constrain innovation adoption and sustainable

entrepreneurial processes. We also contribute by proposing key levers within the entrepreneurial eco-system that could be utilised by governments or other motivated actors. See Fig. 3.

6. Conclusions

This research sought to explore the factors and dynamics that

inhibit sustainable entrepreneurs' role in socio-technical transitions and to identify key supporting levers, based on the case of the CSA transition in Europe. By doing so we contributed to the literature on sustainable entrepreneurship and socio-technical transitions. Starting from the principle that sustainable entrepreneurship is a key activity and lever for sustainability transitions, we highlighted the barriers in the system that inhibit their ability to develop and deploy innovations. We highlight that sustainable entrepreneurship in the CSA transition (and transitions with the same characteristics) may need to play more coordination type roles. Building upon the entrepreneurial eco-system perspective and wider sustainable entrepreneurship literature, we consider some implications for government and public sector actors and sustainable entrepreneurs themselves.

We provide our contribution within the context of the transition to CSA in Europe. This was a suitable context, as systemic barriers affected sustainable entrepreneurs. The context also allowed us to contribute to research and practice focused on CSA. We found that the current transition is very much in its infancy and constrained. While high-level policy drivers exist, alongside some corporate responsibility drivers and environmental stressors (such as weather variability), these factors are providing insufficient pressure onto the socio-technical regime. It should be recognised that the respondents who contributed data to the study did not represent all European regions, meaning the results may be limited in their generalisability. Further, CSA is likely to have sectoral characteristics not applicable to other sectors.

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