Resilience and why it matters for farm management[1]

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Abstract. *Resilience is being widely taken up by both researchers and policy makers, leading to lively scientific debates. This paper examines the concept of resilience and its increasing use in the face of both economic uncertainty and climate change, and applies it to farm management. In this context, resilience is understood as encompassing three capabilities: buffer capability, adaptive capability and transformative capability. I argue that resilience thinking opens up new perspectives and provides the potential to better understand the choices made by farmers in the real world. It offers alternative insights into farm management and how farmers balance short-term efficiency and long-term transformability, balance the exploitation of current strengths with exploration of new options, balance path dependencies with path creation. However, while farm resilience emphasizes how farms can weather shocks and adapt, it should not be understood as promoting the individuation of responsibility. Indeed, farm resilience can be strengthened or eroded by policy measures and family dynamics, i.e. processes at both a higher and a lower level. Overall resilience proposes an alternative conceptual lens to one building on equilibrium, thus highlighting and complex dynamics and the role of farmer agency in navigating change.*

1. Introduction

Resilience is a term that is increasingly ubiquitous in scientific, policy and popular debates. The rise of the popularity of the concept comes at a time when the impacts of two broad societal trends – climate change and globalization – are increasingly acknowledged. As a result of these trends, biophysical, social and economic conditions are seen as increasingly volatile, unpredictable and uncontrollable, rather than following a development along a predictable, fairly stable trajectory.

The unpredictability is partly linked to the impacts of climate change (IPCC, 2013). While there is an increasing acceptance that these can no longer be avoided, the impacts are diverse and the increase in various extreme weather events limits the possibility to identify and implement an 'optimal' set of technical measures. The unpredictability is also partly linked to globalization, broadly understood as the diverse forms of connectivity and flows linking the local to the global, as well as the West to the East and the North to the South (Urry, 2005; Steger, 2013). This increased connectivity has not only intensified and accelerated social exchanges; it has also enabled local disturbances to propagate faster,

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turning local problems into global crises. Indeed, connectivity means that there is a higher risk of management responses in one system inadvertently precipitating undesirable change in far removed systems (Biggs et al., 2011). For example, the global financial crisis of 2008 propagated from the failures of the US housing market to the banking sector in Europe, leading to a liquidity and credit crunch (Brunnermeier, 2009). The financial crisis also affected farmers in Europe, not least because it induced demand drops (e.g. the collapsing milk prices in 2009) and coincided with increasing volatility in many commodity markets (Petrick and Kloss, 2013). Similarly, various food scares, such as the EHEC crisis in 2011 that severely affected cucumber farmers, or the horse meat scandal in 2013, are also linked to globalised food chains. The growing global connectivity highlights the need to increase our understanding of feedbacks and interdependencies, but at the same time indicates the limits to predict or control such crises.

The various 'crises' highlight that while some developments are predictable, many are not. The resulting insecurity does not affect only broader economies or sectors, but also farms. Yet, farmers have always had to find solutions to face unexpected events, not least to cope with drought, hail and frost as well as with market uncertainties. However, increasingly farms have to cope with the impacts of multiple simultaneous shocks and changes, whose effects may be more or less transient, while at the same time facing an increasingly uncertain future, marked by increased price volatility and market de-regulation, an increasing complexity in agricultural policy and environmental regulations and limited public funds due to the sovereign debt crisis in the eurozone.

Resilience is a concept that addresses this new understanding of the world as being fundamentally unpredictable, and as such is a radical departure from equilibrium-based approaches. Rather, than seeking optimal solutions, it emphasises the need to enable the adaptability and transformability of systems. The attractiveness of resilience may thus be due to the fact that in addition to informing policy realities based on narratives of uncertainty, vulnerability and anxiety, it includes a focus on hope, adaptation and transformation (Shaw and Maythorne, 2013).

In this paper I provide a brief overview of the fields in which resilience has been used to show the breadth of applications. With this breadth comes a diversity of conceptualisations of resilience which I discuss to highlight the difference between those that retain a conservative notion of return to equilibrium and those that offer a radical departure by emphasizing transformability. As a first step to operationalize resilience in the context of farm management, I then specify the three aspects of covered by resilience, i.e. buffer capability, adaptive capability and transformative capability. And while resilience does highlight the ability of farms to face changes, it is important to note that it does not justify an individuation of the responsibility to adapt, as this resilience can be strengthened and eroded by regional dynamics and policy measures. I conclude by pointing out how a resilience framework puts efficiency and optimisation in a broader context and thereby strengthens the integration of qualitative and quantitative approaches to farm management.

2. What is resilience? A review of the concept

2.1. Resilience in different bodies of literature

Resilience stems from the Latin *resilire* denoting the idea of 'bouncing back' i.e. rebounding or recoiling, a negative connotation it has retained both in medieval French (*résiler*) and English (*resile*) (Alexander, 2013). In science it was first used in 1858 in mechanics to denote the ability of a material to resist the application of a force (rigidity) and absorbing it with deformation (ductility); later, in the

1950s, it was used in psychology, and in 1973 C.S. Holling used it in his seminal paper on systems ecology (Alexander, 2013). Being a word in common language use, as well as being used in diverse disciplines is still a hallmark of resilience, and gives rise to the diverse meanings and connotations. Yet, they all have in common a focus on the ability to respond effectively to change, especially unpredictable, sudden change.

The following overview of the literature is meant to be a broad outline of the approaches and issues raised in various disciplines, rather than a comprehensive review of a burgeoning and very broad body of literature (for a review, see e.g. Martin Breen and Anderies, 2011). I group the literature in three strands, which seem relevant to farms as being at the intersection of these three topics. The first strand covers the work on resilience of ecosystems, the second focuses on the individual's and communities' ability to cope with traumatic events, in which I include work rooted in psychology, as well as work in disaster management and regional planning. And finally, as a third, emerging strand, the resilience of SMEs and of farms.

The literature on resilience in ecology starts with the seminal paper by C.S. Holling (1973). This work has highlighted the fact that ecosystems usually have several stable regimes, e.g. a lake may be clear or algae dominated, i.e. turbid (Scheffer and Carpenter, 2003). In this context, resilience is the ability of that ecosystem to remain within the critical thresholds if a given regime (Gunderson and Holling, 2002). The aim is thus to avoid a 'flip' into an alternate regime, which is characterised by a different function, structure, identity and feedbacks (Walker et al., 2006). Importantly, such a 'regime' should not be understood as an equilibrium state, but as dynamic and ever changing, not least in response to disturbances.

As Zebrowski (2013) points out, Holling's (1973) seminal paper led to a 'complexity turn' in ecology, i.e. a radical departure from the equilibrium-based models which presumed that ecosystem tend towards a 'climax' state and will attempt to return to this state if perturbed. Instead there are several possible regimes, and these change over time. Furthermore, since an ecosystem is not organised around a unique 'natural' equilibrium, the aim of ecosystem protection should not be to stabilise it, to protect it from perturbations and ensure it remains at or close to equilibrium by a variety of 'command and control' approaches (Holling and Meffe, 1996). Rather, a management approach based on resilience "would emphasize the need to keep options open, (…) to devise systems that can absorb and accommodate future events in whatever unexpected form they may take" (Holling 1973: 21). As it became evident that the dynamics of many ecosystems are strongly influenced by human activity, from about 2000 onwards, the literature focused on social-ecological resilience, to highlight that the social systems and ecosystems are coupled, interdependent and coevolving (Berkes and Folke, 1998; Berkes et al., 2003; Liu et al., 2007). It thus fuelled research on adaptive co-management and social learning (Plummer, 2013).

The concepts linked to social-ecological resilience have also been applied to agro-ecosystems, e.g. the trade-offs involved in managing the soil organic matter content in grasslands in the Netherlands (van Appeldoorn et al., 2011); an indicator framework for assessing agroecosystem resilience using 13 indicators (Cabell and Oelofse, 2012); the extent to which livelihood strategies they exhibit non-linearity, irreversibility and hysteresis (Tittonell, 2014); or the exploration of alternative regimes and tipping points in agriculture, building on the example of coffee production (Vandermeer and Perfecto, 2012).

The second strand of literature on resilience focuses either on the individual or the community level. Substantial body of work is rooted in psychology, esp. developmental psychology and mental health. At the individual level the process of developing resilience in understood as dynamic interactions

between a person and his or her social and physical context, as well as being influenced by a range of cognitive and emotional factors (Brown and Westaway, 2011; Windle, 2011; Fletcher and Sarkar, 2013). The research on community resilience focuses on the collective capacity of citizens to respond to change. One part of this work focuses on adapting to slow changes (e.g. withdrawal of government services, demographic changes, see McManus et al. 2012; Berkes and Ross, 2013; Skerratt, 2013). The other part focuses on communities facing shocks, especially linked to natural hazards such as hurricanes or floods, and the focus is on how the impact of a disaster can be limited, and on 'bouncing back' to the pre-disaster state and functions (Rose, 2009; Reghezza-Zitt et al., 2012). Related to the work on community resilience, is the work that addresses spatial and territorial aspects of resilience (Simmie and Martin, 2010; Pike et al., 2010; Davoudi et al., 2013; Scott, 2013). This work emphasizes that resilience is understood as a continual development process in facing adversity, rather than an outcome that is maintained once reached.

Finally, there is an emerging literature that addresses the resilience of SMEs, esp. their ability to face shocks. For example there have been studies of SME survival after earthquakes in Christchurch, New Zealand (Radford et al., 2013), or SMEs in the face of austerity measures (Williams et al., 2013). The focus of the studies is usually on reducing vulnerability to shocks and the ability to return to a stable state after a shock (Bhamra et al., 2011; Burnard and Bhamra, 2011). This work is related to another body of literature which analyses the ability of firms to maintain their competitive advantage over the long term, but it usually focuses on large companies and does not refer to resilience, rather using different frameworks such as 'dynamic capabilities' (Teece, 2007; Barreto, 2010).

Similar to resilience of SMEs, there been studies of how farms cope with change, e.g. with the impact of BSE in Canada (Anderson and McLachlan, 2012); of dairy farmers in the UK coping with foot-and-mouth disease (Glover, 2012); the resilience of farms in Australia in the face of protracted drought (Sysak, 2013) and in New Zealand in the face climate change (Kenny, 2011); strategies of Austrian family farmers to build resilience (Darnhofer, 2010); and how French beef farmers maintain their flexibility in the face of market variations and climatic fluctuations (Astigarraga and Ingrand, 2011). Of course, there is a whole body of literature on how farms cope with change over the long term, but while studying the same phenomena, they do not refer to the resilience framework (e.g. Evans, 2009; Rueff et al., 2012). There is thus considerable overlap between the themes addressed within the emerging field of resilience and the more established literature addressing the ability to cope with change.

2.2. Understandings of resilience and their implications

This brief overview shows that there is a wide range of studies of resilience, which differ by disciplinary traditions in which they are rooted, the object of study, the temporal and spatial scales taken into account, and the type of disturbance (sudden shock vs. longer-term trend) they focus on. The different understandings of resilience also differ in the level of formalisation, from using resilience in the common dictionary definition or as a metaphor (Norris et al. 2008), to a formalised framework as e.g. the one of social-ecological resilience (Gunderson and Holling, 2002). All this leads to lively scientific discourses, which are somewhat fragmented (Scott, 2013; Turner, 2014).

Not least as a result of these conceptual discourses and contested interpretations, multiple meanings of resilience have emerged. Some authors have thus pointed out that despite much conceptual debate over 30 years, the concept of resilience seems remains 'fuzzy' (Klein et al. 2003), 'vague and malleable' (Brand and Jax, 2007), and 'polysemic' (Reghezza-Zitt et al., 2012). This fuzziness has led Klein et al. (2003:42) to state that "resilience has become an umbrella concept for a range of system attributes that

are deemed desirable". While the resulting ambiguity allows to draw different interests and actors together – thus contributing to its growing popularity – it may restrict the value of the resilience concept as a practical policy or management tool. Yet, the growing presence of the concept in various discourses can be seen as a testimony to its perceived usefulness. Resilience thinking might thus be worth developing, not least as it might contribute to the further conceptual development through its inclusion of transformability.

Indeed, in the various strands of literature several issues recur, two of which seem particularly relevant to understanding resilience of farms. Firstly, whether resilience is mostly about adaptation or whether it includes transformation, i.e. whether it is about 'bouncing back' or whether it includes a 'bouncing forward'. And secondly, to what extent resilience is a property, an attribute of the system, or displays characteristics of a process, which has both conceptual and methodological implications.

Regarding the aspects that are covered by resilience, two contrasting approaches to understanding resilience can be distinguished: those that focus on the ability to 'bounce back' vs. those that include 'bouncing forward' (Davoudi, 2012; Scott, 2013). Indeed, in the literature that focuses on ecosystem the focus is often on maintaining an ecosystem within thresholds, to avoid a 'flip' into an undesirable state (e.g. avoid that a lake becomes turbid). Thus while the potential for transitions is recognized, they are not necessarily seen as desirable. The focus is thus on buffering impacts and on adaptation to keep the system within one regime. Similarly, the work within disaster relief focuses on the return to the previous ('normal') state (Pike et al., 2010; Reghezza-Zitt et al., 2012)[2]. As a result, some authors (e.g. Pelling and Manuel-Navarrete, 2011; Pearson and Pearson, 2011; Wilson et al., 2013) argue that resilience is a conservative notion used to maintain the status quo, to preserve the existing system, i.e. its identity, feedbacks, structure and functions. In this approach, resilience and transformation are understood as distinct concepts.

The other approach to resilience considers transformability as an core property of a resilient system. It can be argued that this property plays a more important role in social systems than in ecological systems, as social systems need to be transformable, especially when seen over the long term. Indeed, while a return to 'normal' is doubtlessly desirable after a natural hazard such as a hurricane, this view focuses on the short-term restoration of functions and essential infrastructure. This view needs to be distinguished from a medium- to long-term view, where transformation is crucial. Indeed there is ample literature on the need for societal transitions, be it towards a low-carbon economy, lifestyles with reduced environmental footprint, or the reshaping of society to cope with environmental change (Brown et al., 2013). It is because of this transformational component that a range of civil society groups and social movements such as the Transition Towns movement, (Haxeltine and Seyfang, 2009) use resilience concept to design and shape alternative futures, and researchers see resilience as contributing to a move away from conventional sustainable development (e.g. Béné et al., 2012; O'Brien, 2012). Thus, building the ability to transform a social system seems to be essential for its persistence over the long term. If resilience is the ability of a system to persist, it needs to include both the ability to 'bounce back' and the ability to 'bounce forward', i.e. both adaptive and transformative capability.

The second issue that pervades the discourse around resilience and is relevant to the resilience of farms, is the question whether resilience can be seen as a system attribute, or whether it needs to be

[2] Especially in the context of disaster relief, resilience is often seen as the opposite of vulnerability. However, the relationship between resilience and vulnerability is the subject of intense debates (see e.g. Adger, 2006; Gallopín, 2006; Cutter et al., 2008; Miller, 2010).

understood as a process. The two positions have different methodological and theoretical implications, but are not conflicting (Reghezza-Zitt et al., 2012:9).

If resilience is a property of a system, it is an inherent quality, a pre-existing potential that is revealed through the impact of a shock. This understanding allows initiating prospective and preventive approaches, establishing criteria to assess the resilience of a system. Indeed, it allows prescriptive approaches that aim to improving the resilience of a system in anticipation of disruptions, strengthening its ability to cope. However, measuring the resilience of a system has proven to be like aiming at a moving target. Indeed, complex systems are characterised by nonlinear feedback mechanism which occur at multiple spatial and temporal scales, leading to unpredictable dynamics and patterns of abrupt changes. Adaptive systems are learning systems, so that the feedback mechanisms change over time. As a result, complex adaptive systems are characterised by involving many components that adapt as they interact, thus posing unique challenges when attempting to model them (Holling, 2001; Holland, 2006; Mitchell, 2009). Understanding social systems as complex adaptive systems highlights that there is rarely a long stable state, there is no 'normality', no stable final equilibrium state that is maintained over long period of time, rather, there is on-going change, especially if a system is considered over the medium and long-term. Flowing from this understanding of complexity, there should not be "the presumption of sufficient knowledge, but the recognition of our ignorance; not the assumption that future events are expected, but that they will be unexpected. The resilience framework can accommodate this shift in perspective, for it does not require a precise capacity to predict the future, but only a qualitative capacity to devise systems that can absorb and accommodate future events in whatever unexpected form they may take." (Holling 1973: 21).

As a result the dynamics engendered by complexity, 'measuring' resilience in social-ecological systems has proven an enduring challenge. It may be more useful to aim for less precise, heuristic rules of thumb, such as the four critical factors identified by Folke et al. (2003), the behaviour-based indicators of resilience in agroecosystems compiled by Cabell and Oelofse (2012) or the seven generic principles for enhancing resilience of ecosystem services in the face of ongoing change proposed by Biggs et al. (2012). These general indicators and principles then need to be specified for each specific system and its current context.

The understanding of the dynamics of complex systems has also highlighted that resilience is "emergent", i.e. not a fixed asset, but a continually changing process, not a 'being' but a 'becoming' (Davoudi, 2012:304). As such resilience is embedded in a time continuum, with its own temporalities and rhythms (Reghezza-Zitt et al., 2012:20). Understanding resilience as a process highlights the need to understand feedbacks, i.e. the cognitive, institutional and material structures that hinder or enable change. It also highlights that resilience is actively and creatively performed when a system is confronted with disturbance and stress, and can thus not be reduced to an 'automatic' response directly deriving from the properties of the system. Rather, resilience depends on continual learning to make better choices and improve the capacity to handle change (Cutter et al., 2008:600; Davoudi et al., 2013). Understanding resilience as a process thus makes it a relational concept, and as such it emphasizes "fluidity, reflexivity, contingency, connectivity, multiplicity and polyvocality", rather than "reified fixities and certainties" (Davoudi and Strange 2009: 37).

Methodologically this understanding implies that resilience cannot be properly captured using a 'snapshot' approach. Indeed, focusing on characterizing a farm, a farming system or the agriculture in a region at a particular point in time gives insufficient attention to change. It underplays the fact that the current condition is a short-term situation in a larger cycle of change, an entanglement of past choices that still linger and new choices that have been made, but are not yet fully expressed. It will not be able to adequately capture periods of turbulence and fluctuation, marked by indecisive remodelling

and lingering situations inherited from the past. Nor will it be able to adequately capture the cognitive and social processes that enable the emergence of resilience.

Thus, rather than being a formal theory, 'resilience thinking' is a conceptual framework that helps us think about processes in new ways, ways that are more dynamic and holistic (Davoudi, 2012). It allows to incorporate the dynamic interplay between persistence and change, adaptability and transformability across multiple temporal and spatial scales (Gunderson and Holling, 2002).

3. Conceptualizing farm resilience

3.1. Distinguishing three capabilities

Building on the work within social-ecological resilience, as well as others (e.g. Béné et al., 2012; Keck and Sakdapolrak, 2013; Davoudi et al., 2013), resilience of farms is understood as covering buffer capability, adaptive capability and transformative capability. The term capability is used to denote that it is not so much an asset, but the ability to identify opportunities, to mobilize resources, to implement options, to develop processes, to learn as part of an iterative, reflexive process. The capability is thus a precondition, a latent characteristic that must be activated to effect change, rather than an automatic response that can be deduced from the characteristics of the farm.

Buffer capability is akin to persistence (Folke et al., 2010). It denotes the ability to assimilate a perturbation without a change in structure or function. A shock such as a sudden price increase, a disruption in feed supply, the breakdown of a piece of machinery or a drought, is weathered without substantial changes on the farm. While there may be an impact, the farm activities bounce back, e.g. through the temporary reallocation of resources. It may result through mobilising financial or labour reserves, using inventory (stockpiles of working supplies), using excess capacity (idle equipment or storage), through the availability of redundant machines or storage facilities, or through the provisory shift between established marketing channels. Further mechanisms include conservation, i.e. maintaining production with fewer inputs; as well as input substitution, i.e. shifting input combinations to achieve the same function or level of productivity (see Rose, 2009: 10-11). The buffer capability is thus not akin to rigidity, but ability of the farm to maintain itself through a disruption. Buffer capability is particularly important to buffer small disturbances (e.g. weather events such as low rainfall at crucial periods of crop development) and in the initial phases of coping with large shocks.

Adaptive capability is the ability of a system to adjust in the face of changing external drivers and internal processes, thereby allowing for development while staying within the current stability domain (Folke et al. 2010:6). It requires resourcefulness, i.e. the ability to identify problems, establish priorities, mobilize resources in face of disruption, to combine experience and knowledge to adjust responses to a changing context or internal preferences, to plan for the future. However, the changes implemented do not bring something that is radically new. It is something that is added, building on established structures and functions, marked by path dependence. The changes are thus incremental, guided by the same goals and values, which are not questioned. There is learning, from both success and failures (Glover, 2012). However, it is 'single loop learning', i.e. incremental improvements of established routines (Pahl-Wostl, 2009).

Changes implemented may cover new technologies, a change in product characteristics, the identification and establishment of new marketing channels, an increase in storage facilities, the new pooling of resources with other farmers, or making production processes more flexible (Rose 2009).

Adaptive capability is linked to on-going experimentation, tinkering and bricolage (Senyard et al., 2014), as well as to flexibility and diversity (Darnhofer et al., 2010b). Farms draw on their adaptive capability both to cope with changes that build up over time, such as drought (Beilin et al., 2012); to face broader trends such as changes induced by policies such as the Water Framework Directive or changes in the Common Agricultural Policy; and to take advantage of new opportunities such as those offered by information technologies. Implemented changes might – inadvertently – open new avenues for later adaptation, i.e. there might be a cumulative effect that might or might not be intended.

Transformative capability relates to the ability to implement radical changes, the ability "to create untried beginnings from which to evolve a new way of living" (Walker et al., 2004:7). A transformation implies a transition to a new system, where a different suite of factors becomes important in the design and implementation of response strategies. It is a qualitative change, in which the farm adopts new basic operating assumptions, new 'rules of the game', i.e. a different logic organising resource flows and linkages of activities on- and off-farm. For example a farming system organised around cattle on rangeland can be transformed into ecotourism (Cumming, 1999). Such a transformation is often linked to shifts in perception and meaning, to new patterns of interaction among actors. It thus implies a commitment to innovation and novelty to imagine alternatives and possible futures (Schoon et al., 2011). It thus relies on human creativity to reconceptualise meanings and relations, to create a fundamentally new farm with clearly different linkages and feedbacks.

A transformation is likely be a process over a certain period of time, where it can be difficult to isolate a clear break between the 'old' and the 'new'. Indeed, during the transition period there will often be a variety of conflicting processes going on, with the old and new logics being intertwined. As such the period will be marked by uncertainties, ambivalences, contradictions, entanglements of processes, and multiple points of view (Reghezza-Zitt et al., 2012:21). During the transition period it might thus be unclear whether the cumulative changes will amount to transformative change or whether it will remain incremental, more akin to adaptation than to transformation. Moreover, a transformation may be gradual, resulting from the deliberate or incidental accumulation of marginal changes, or might be abrupt and surprising.

Transformations may well be triggered by crisis, which makes it more likely that novel, alternative production systems or organisational forms will be considered and changes implemented. In the context of farming, a crisis can be understood as a time when the farm family agrees that some components of their farming system are dysfunctional (e.g. resulting in chronic work overload, in high debt load, in the use of inputs that no longer match the farmer's environmental values, or in degraded agroecosystems). As such crises should not necessarily be understood as 'negative' events: they can open up opportunities for revaluating the current situation, trigger cognitive and social mobilization, and spur learning through reconsidering experiences and knowledge. As such a crisis can be a 'window of opportunity', enabling transformative change. so that the ability to plan for and recognize opportunities associated with crisis contributes to transformability (Berkes et al., 2003). In this, the ability to recognize and seize opportunities is key, as is the ability to reconfigure assets and competencies (Augier and Teece 2009). Importantly, a crisis may stem from a shift in actors' understandings of the system, or from shifting conditions in the systems (Scoones et al., 2007:38).

3.2. Tensions and complementarities between the capabilities

Farm resilience is thus related to the ability to integrate the three capabilities, thereby enabling the farm to address sudden shocks, unpredictable 'surprises' as well as slow-onset changes (Darnhofer et al., 2010a). It builds on a dynamic, process-orientation and thus focuses not so much on what a farm

'is' but what it makes of its assets, i.e. how it purposely creates, extends and modifies these assets to address both internal changes (e.g. linked to the farm family life cycle) and external changes (e.g. linked to new customer demands or CAP reform).

The three capabilities allow to address change processes of different duration, from short-term resource shifts to long-term transformations. They also cover the full range of change a farm might undergo: from no changes to the system (buffering a shock), to incremental change (adaptation), to radical change (transformation). Indeed, the processes involved in these changes are not necessarily distinct, but tend to partially overlap. For example, buffering a shock may be the short-term response while adaptive measures are implemented but take effect only over the medium-term.

However, while marginal change may cumulate synergistically and lead to a transformation, this is not necessarily the case, as a farm may fall into the 'incremental adaptation trap' which hinders transformability. This may happen because slow variables with long time-lags between causes and effects – as characteristic for many ecological processes – tend to be underestimated (Anderies et al., 2006; van Apeldoorn et al., 2011). Farmers thus have to navigate change carefully to avoid lock-in. Such lock-ins can be of various kinds: functional or cognitive, financial or due to the entrenched vested interests (Allison and Hobbs, 2004; Scheffer and Westley, 2007; Schoon et al., 2011). However, if economic, social and institutional outlooks, relationships and configurations ossify over time, if previous growth paths are relied upon, it will limit adaptation (Pike et al., 2010) and is likely to inhibit transformation.

This indicates a trade-off between the capabilities. Indeed, a management approach based on resilience emphasizes the need to keep options open, to ensure an opportunity to change, to develop, to evolve. The aim is thus to devise conditions for self-organisation and adaptability, enabling a co-evolution with the ecological, social, economic, and political context. However, at the same time as exploring emerging possibilities, a farm also needs to ensure that the farm exploits current strengths which require that sufficient resources are invested in those activities that are currently economically profitable. Those resources will not be available for exploration.

Similarly, diversified farms are frequently seen as more adaptable, as the diversity act as it dissipates the negative effects across an array of activities, rather than reinforcing and concentrating them. Furthermore, diversity and redundancy enable future recombinant strategies. However, while adaptive and transformative capabilities are strengthened by diversity of on- and off-farm activities, this diversity will need to be tampered by the need to maintain the coherence of the farm and ensure that sufficient resources are available for key processes. There is thus a trade-off between diversifying and specialising. Thus, diversity may be better achieved at the regional level, i.e. within a network of farms rather than considering each farm individually. Such cooperation creates reserves, i.e. potentials for future developments (Darnhofer, 2010).

The trade-offs between the capabilities are also linked to the fact that they address different needs, depending on whether the system (i.e. the farm and/or its context) is undergoing a period of slow and continual change, or whether it is in a period of abrupt and radical change. Indeed, 'quasi equilibria' are frequently punctuated by dramatic changes, ruptures in practices and discourses (Vandermeer and Perfecto, 2012). In social-ecological resilience these distinct phases are conceptualised within an 'adaptive cycle' (Holling, 2001; Burkhard et al., 2011). Thus, during a fairly stable period, the emphasis will be on ensuring adequate buffer and adaptive capability, while during periods of rapid change, more resources will be invested to strengthen transformative capability.

This discussion shows that the distinction between the three capabilities is analytically useful to highlight that there are qualitatively different responses, which might be more or less appropriate

depending on the system and the change it faces (Darnhofer et al., 2010a; Pike et al., 2010). Distinguishing between the three capabilities also highlights that buffering shocks is not sufficient to achieve resilience, nor is adaptability given the risk of 'lock-in'. To achieve resilience requires a creative tension between maintaining the system despite a shock and changing the system, as well as dynamic interplay between incremental and transformational changes.

3.4. The role of farmer agency

To understand farm management choices, at least three sets of factors need to be taken into account: the farmer, the physical farm and the context (Darnhofer et al., 2012). The term 'farmer' is used as shorthand for the farm family and should not be understood as implying an individualistic decision-maker. Indeed the various members of the farm household will have different histories, projects, perceptions, preferences and priorities, thus resulting in tensions and in on-going negotiations about what to do, how to do it and why. The physical farm comprises the various resources and assets, such as building, machinery, land, animals and financial capital. And finally the context comprises the social networks, economic opportunities, political incentives, agro-ecological and climatic production conditions. How the farmers makes sense of the resources at their disposal and of the opportunities and constraints in the context will greatly influence how the farms are managed (van der Ploeg, 2003). Thus farming results from the ongoing combination, interaction and mutual transformation of social and material resources; through farm management new constellations emerge, building on a novel combination of resources (van der Ploeg et al., 2006).

The three capabilities clearly build on this actor-oriented, constructivist approach, thus putting farmer agency at the forefront (see Bandura, 2006). It is not so much what the farm 'is' or what resources it 'has', but how they are perceived and deliberately put in relation. Resilience is clearly dependent on the farmers' perception of change and her creativity in the combination of resources. Indeed, resilience builds on the ability of actors to interpret and make sense of disruptive challenges, rather than just reacting or limiting themselves to 'off-the-shelf' responses (Pike et al., 2010:68). Despite confusing circumstances, farmers need to be able to face cognitive uncertainties, to make sense, frame and articulate the nature of a change, to construct a discursive narrative of adaptation, to discern emerging opportunities, to recognise a 'window of opportunity' and envision transformation.

Adaptation and transformation thus result from intentional efforts (Davidson, 2013:22), and may be linked with tensions and conflicts. Indeed, it is not self-evident what needs to be resilient to what, nor what would be a desirable future to strive towards, nor what strategy should be pursued or which scarce resources devoted to achieving this future. Differences of opinions within farm family members (e.g. between generations or within the farming couple) are bound to occur and need to be resolved.

This contrasts with approaches build to the notion of economic rationality, where the 'optimal' solution is unequivocal and the way forward usually seen as is clear and unambiguous (Kaplan, 2008). Similarly, it contrasts with the notion in biology, where ecosystem dynamics result from mechanisms such as time delay, hysteresis, evolutionary selection. While the comprehensive work in ecology has been valuable in highlighting the limitations of direct cause-effect relations and the complexity of the dynamics in ecosystems (Gunderson and Holling, 2002; Chapin et al., 2009), critical social scientists point out that the dynamics of social systems cannot be reduced to those identified in ecological systems. In social systems additional dynamics need to be taken into account, possibly overriding some of the mechanisms in ecosystems. As a result, in social systems, many mechanisms should be understood as tendencies rather than inevitabilities (Davoudi, 2012:305). Indeed, the feedback processes in social systems are not primarily defined by structural variables, but by agency, and agency

is a conceptual layer not present in ecological systems (Davidson, 2010:1142). While people can act consciously, both individually and collectively, components of ecosystems cannot, so that many causal mechanisms describing ecological processes can be treated as reasonably deterministic (even if thoroughly complex).

Thus, while resilience as emerged in ecology, it is important not to transfer ideas about ecological systems uncritically to the social realm, as this would implies that the dynamics of ecological and social systems are essentially similar (Adger, 2000; Davidson, 2010; Brown and Westaway, 2011; Davoudi, 2012; Cote and Nightingale, 2012; Hyatt, 2013; MacKinnon and Derickson, 2013; Brown, 2014). Resilience should thus not be understood as promoting a scientific and technical rationality, which builds on assuming consensus about what needs to be changed, how and for whom. This assumption underplays social tensions, conflicts over resources, and power asymmetries. However, large number of studies have highlighted the complex web of interest, power, multiplicity of interests, gender dimension and generational conflict, thus highlighting the struggle, pain and insecurities of individual farmers or individual members of farm families. Thus, when assessing capabilities, in addition to objective measures, it is necessary to consider both subjective and relational factors and view them as reflexive and dynamic, as well as differentiated socially and temporally (Brown and Westaway, 2011:321).

3.5. A cautionary note regarding policy implications

Resilience thinking clearly highlights the ability of farms to adapt in the face of change. However, a farm is linked to its context and thus to the broader processes, which will necessarily influence – but not determine – farm dynamics. Thus, a radical reorganisation of political, economic and social institutions – as was the case in post-socialist countries – is bound to affect farms, closing some options while opening up new opportunities. Indeed, as Brown (2014) points out, adjustments occur at all (and interlinked) scales – individuals, society, institutions, technology, economy and ecology – and may involve changes to practices, lifestyles, power relations, norms and values. Farm resilience will thus be both enabled and constrained by dynamics at a lower scale (e.g. the farm family) and those at a higher scale (e.g. regional dynamics and agricultural policies) (see Walker et al., 2006). This highlights the role of adequate governance regimes in strengthening farm resilience, and indicates that governance failures might well erode farm resilience (see Pahl-Wostl, 2009).

For example, Sysak (2013) has shown that the resilience of farmers in Australia has been eroded through various shifts in policies in the face of a 10-year drought (e.g. regarding provision of social support and rights to access to water for irrigation). The shift in policies were enabled by reframing responsibilities. As a result, farmers, who were initially seen as a victim of circumstances beyond their control (i.e. a prolonged drought), were progressively framed as being responsible for their predicament as they have failed to be prepared and take appropriate action. This shift in narrative enabled the withdrawal – rather than the redesign – of government support, which eroded the resilience of farms.

This example shows that it is not constructive to abuse references to resilience to support political constructions of adaptability that display a one-sided emphasis on the farmers' ability to face crises, thereby putting the focus on individual responsibility (Reghezza-Zitt et al. 2012:49-51; Davoudi 2012:305). Such narratives need to be understood as resulting from political processes and power relations, where interested parties exercise their influences to achieve their own interests, rather than as grounded in resilience thinking. Rather, resilience thinking would promote research in governance regimes characterised by flexible regulations that leave room for context specific implementation and

local-scale dynamics, that enable polycentric structures, social learning and informal networks (see Pahl-Wostl, 2009). Such an approach would strengthen farmer-led initiatives such as civic food networks or care farming, support farmer-led innovations in production methods (e.g. organic farming, which was also initiated and developed by farmers), as well as enable a broad range of social innovations (see Bock, 2012).

Indeed, while farmers may be resilient, their ability to adapt and transform their farms will be strengthened or eroded by government policies and the economic structures they promote. As Beilin et al. (2012) point out: "current policy directions entrench the values of the global market and its elite, leaving farmers locked-in to historical structural responses that will not be successful in the long-term and will diminish their ability to imagine radical and diverse ways of avoiding the maladaptive structures currently surrounding their production systems". A reference to resilience thus does not absolve the government from its responsibilities, is no substitute for responsive and accountable governance (Beilin et al., 2012; Sysak, 2013).

Furthermore, resilience thinking will only realize its potential if the transformative component is taken seriously. Yet, many policy documents (e.g. EC, 2012) have a one-sided focus on the conservative component of resilience, i.e. withstanding and quickly recovering from stresses or shocks. As such they focus on the persistence of the current system, on securing the status quo. Indeed, despite a rhetoric stressing adaptation and change, there are powerful interests to protect against a dynamic or radical change. As a result there is much attention to adapting to changes that are under way or expected, rather than on deliberately transforming systems and society to avoid the long-term negative consequences of global changes (O'Brien, 2012; Davoudi et al., 2013; Brown, 2014).

4. Conclusions

Resilience builds on the 'complexity turn', which entails a paradigmatic shift in how we think about the world. Rather than seeing it as orderly, mechanical and reasonably predictable, it acknowledges it as chaotic, complex, uncertain and unpredictable (Davoudi, 2012). One of the key contributions of resilience thinking is highlighting the complex interdependencies within social-ecological systems, and the recognition that they are constantly changing in ways that cannot be fully predicted or controlled (Chapin et al., 2009:25). Indeed, we are regularly confronted with events even experts and dedicated institutions failed to anticipate, highlighting the difficulties of prediction and the limits of focusing on known risks.

Managing a farm for resilience thus entails overcoming positivist approaches and equilibrium-based models. These are rooted in a Newtonian worldview, which considers the world as an orderly mechanical device whose behaviour can adequately be explained and predicted by mathematical rules and monitored by command and control systems. This worldview allows for quantitative predictions of likely future developments as well as for economic optimisation under the 'ceteris paribus' assumption. These led to management approaches which seek to reduce variability and change to facilitate efficient commodity production (Holling and Meffe, 1996; Darnhofer et al., 2010b; Schiere et al., 2012).

Through the rejection of equilibrium and the emphasis on inherent uncertainties and discontinuities, resilience thinking enables insights into the dynamic interplay of persistence, adaptability and transformability. It promotes qualitative approaches striving to understand the dynamics of farms so as to enable self-organisation, adaptability and transformability. Indeed given a context marked by

uncertainty, management decisions must not only ensure efficient allocation of scarce resources under the current circumstances, but must at the same time enable a flexible response to unanticipated changes.

Understanding the ubiquity of change and accepting that many perturbances are unpredictable, implies that farmers spend fewer resources on identifying potential weaknesses or quantifying the impact of expected developments. Rather, resources are allocated to strategies that allow to reduce the impact of a wide variety of potential events and on identifying emergent opportunities. While this may imply that the allocation of resources is not 'optimal' at any point it time, it is a trade-off that is necessary to enable adaptability and transformability. Indeed, resilience emphasizes the need to give more attention to processes, to the 'becoming' of a farm, to enabling multiple potential futures.

While resilience thinking offers a way to conceptualise uncertainty and dynamics, it raises a methodological challenges. It requires us to develop approaches that do not solely focus on analysing what 'is' but on understanding processes, esp. the conditions that enable such processes. This will allow us to understand the interventions that can diminish, sustain and enhance resilience. Furthermore, resilience thinking requires the integration sociological approaches in farm management, so as to adequately capture agency, intentionality, sense-making and learning. Indeed, these play an important role in understanding how farmers make sense of their current situation, how they balance exploitation with exploration, when they choose to adapt their processes in the face of emerging trends and how they take advantage of emerging opportunities to transform their farm.

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