Resilience and Sustainable Development beyond farm level: A qualitative assessment for European farming systems

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Abbreviations

Abbreviation	Meaning
AES	Agroecological Systems
EU	European Union
EESi	Economic Environmental Social and Institutional
FAO	Food and Agriculture Organization
NGO	Non-governmental organization
SAFA	Sustainability Assessment of Food and Agriculture systems
SURE-Farm	Towards SUstainable and REsilient farming systems
UN	United Nations

Abstract

European farming systems face a range of economic, environmental and social challenges. These challenges affect the systems' ability to maintain their core functions; which might include food production, maintenance of rural land scape among others. According to EU Farm accountancy data network, the past decade registered about 20% of farm exits across Europe. A trend which raises concerns among researchers and policy makers regarding the long term continuity of farms; an important aspect in maintaining food security. The resilience concept has been introduced into the farming context for over a decade, in order to explore and address ways through which farming systems may be able to persist, adapt and transform when necessary, to keep up with the changes. However, most studies on resilience and sustainability of farming systems have focused on the farm level as the unit of analysis, leaving out all others actors in a farming system. Hence creating a gap on how to determine to what extent a given set of challenges could be a threat to the resilience of a system at large. Given the interdependency of actors and processes in a farming system, this study aimed at identifying to what extent resilience and sustainability issues have been studied beyond the farm level. A systematic review of peer-reviewed articles constituted the literature review. This aimed to establish to what extent resilience and sustainability issues have been studied. Furthermore, resilience and sustainability issues were assessed 11 case studies of farming systems across Europe to link these issues with farming systems' actors. Additionally, key actors in farming systems were evaluated to find out which actors are key in farming systems. Economics and social factors were found to be more than environmental and institutional issues. Although the extent to which issues affect resilience and sustainability of farming systems, some of the outstanding issues included increasing price volatility, decreasing water quality and increasing water scarcity, increasing need for collaborative capabilities amongst actors along the system and changing policies on land tenure and quality standards.

Keywords : Resilience, Sustainability, Farming system, Robustness, Adaptability, Transformability

Preface

I dedicate this work to Prof.dr.ir. Anne Willem van den Ban (late) and the Anne van den Ban Fund (ABF) for providing me with a scholarship to pursue a Master's degree at Wageningen University & Research (WUR). Writing this thesis with the Business Economics group was a great journey. I was able to learn what resilience means not only in farming systems but also in a daily life of a young scientist. The learning experience was rich and diverse in a way that beyond improving scientific writing and research skills, I learned a lot about myself, my abilities and areas of improvement. My gratitude goes to Prof.dr.ir. MPM (Miranda) Meuwissen for not only giving me an opportunity to write my thesis under her supervision and have access to data of the case studies from SURE-Farm project but also for being flexible to adjust to the needs of my schedule and personal circumstances, as a result of my choices and aspirations during my student life at WUR. Dear Miranda, thank you for being a teacher, a coach, a supervisor, a mentor and an accomplished scientist whose commitment to excellence is a trait to emulate for the journey ahead. You believed in me and held me by hand to see me reach my potential. I am grateful for the discussions and helpful comments throughout the thesis period. Even in your silence I drew lines of inspiration. To my dear family, colleagues and friends, thank you for your endless support. To God almighty, thank you for giving me life, wisdom, peace and joy in Christ Jesus.

''Resilience is very different than being numb. Resilience means you experience, you feel, you fail, you hurt. You fall. But, you keep going, because you know you can''

Drs. Annemieke Griffin RT SV

Chapter One: Introduction

1.1 Background

Farming systems across Europe are experiencing rapid and notable changes and must deal with the challenges which come along. These challenges result from economic, ecological, socio-cultural, and institutional changes (Darnhofer 2010; Cabell & Oelofse 2012; Darnhofer 2014). Some of these challenges are gradual, over a relatively long period of time. For example, changes in soil organic matter (van Apeldoorn et al. 2011). Others are rapid, in a short time. For example, floods or fire outbreaks, and other catastrophic climate events. All these Challenges interrupt the delivery of the system's core function, which is the provision of vital goods and services (production of food, feed and fibre, landscape for leisure and tourism, etc.) (Darnhofer 2010; van Apeldoorn et al. 2011).

Some examples of challenges that farming systems in Europe face include more volatile input and producer prices, growing dependence on financial institutions and land owners, great possibility of extreme weather events, changing societal concerns and consumer preferences, competing policy objectives, and changing administrative demands (Rosin et al. 2013; Maggio et al. 2014; van Vliet 2015; Gertel & Sippel 2016). Over time, standard business practices that procure a viable income for farmers have been often based on increasing farm size and agricultural techniques on one hand, yet on the other hand, these techniques have raised some societal concerns and environmental risks related to soil and water contamination, and loss of biodiversity. Furthermore, there has been an increasing reservation by consumers and retailers towards such business practices (Hazell and Wood 2008; Spiller & Nitzko 2015).

Policy makers and academics have shown increasing interest in understanding the dynamics of farming systems such as labour productivity, land use, population growth, financial losses (Folke 2006; Darnhofer 2014; Lamine 2015), as well as understanding how these systems respond and cope with challenges, and the underlying uncertainties. Resilience theory has been used immensely to explore changes in complex socio-ecological systems (Ericksen 2008; Cabell & Oelofse 2012; Lamine 2015). This theory investigates the ability of complex social-ecological systems to deal with uncertainties, and cope with challenges in volatile environments (Meybeck et al. 2012; Darnhofer et al. 2016). Folke et al. (2010) define resilience as the capacity of a system to absorb disturbance and reorganize while undergoing change and still retain essentially

the same function, structure, and feedbacks. This simply means the capacity of a system to change and maintain the same identity.

This means that a farming system that is not able to transform itself when necessary and to adapt to fundamental shifts in its social, economic, ecological and institutional environments (e.g. demographic changes or the globalisation of markets), will not in the long run be able to dependably provide public and private goods. Studies on resilience have classified it into three types (Walker et al. 2004; Lamine 2015; Tendall et al. 2015; Meuwissen 2018). The three resilience types include on include robustness, adaptability, and transformability. They represent different approaches to respond to changes and disturbances in various dimensions of a farming system (Folke et al. 2010). These dimensions are economic, environmental, social, and institutional (EESi). Just like other components within food systems, farming systems are by nature ecological, economic, and social, with mutual interactions across scales and time (Füssel & Klein 2006; Ericksen 2008).

In the EU context, farming systems are mostly regional and specialised, within sectors and subsectors. Thus, the risks and uncertainties vary widely across regions, subsectors, farm types and farming systems. Giller (2013) defines a farming system as a system hierarchy level above the farm at which properties emerge as a result of the formal and informal interactions and interrelations among farms, stakeholders in the value chains, actors in rural and urban areas, consumers, policy makers, and the environment.

1.2 Problem statement

Nearly half of Europe's surface is used for agriculture and farming activities, giving farming a vital role in shaping Europe's ecosystem, habitats and landscapes (Halada et al. 2011). At the same time, many farms are increasingly vulnerable to a wide range of shocks and disturbances, resulting from socio-cultural changes like urbanization and young generations' loss of interest in farming, and dynamic consumer preferences. These preferences have led to an emergency of various certifications and standard requirements. Additionally, decline of biodiversity due to intensive farming methods, strict policy and regulations on farming practices and animal welfare and price volatility, just to mention a few . All these challenges leave farms with high levels of uncertainty about market developments and policy changes (Joosse & Grubbström 2017).

Intensive studies have been done regarding the sustainability and resilience of agroecosystems and food systems. Some of them are empirical (Carpenter et al. 2001; Brand & Jax 2007; Cabell & Oelofse 2012, Brown & Williams 2015; O'Connell et al. 2015; Tendall et al. 2015), and others are normative (Carpenter et al. 2001; Milestad & Darnhofer 2003; Bergamini et al. 2013). Despite the insightful outcome from these studies, existing resilience frameworks do not adequately capture the relationship between actors and processes beyond the farm, and the delivery of system's core function on one hand. And on the other hand, how relationship of actors and the processes beyond farm contribute to the system's resilience, despite their direct or indirect influence on the system's delivery of public and private goods.

For instance, Tendall et al. (2015) focus on the role of value chain actors in regional and global food systems, whereas Darnhofer (2010) discusses sustainability and resilience enhancing strategies at farm level, and Walker et al. (2004) and Folke et al. (2010) conceptualise resilience in broadly defined socio-ecological systems. The same applies for metrics to assess resilience. Although indicators have been defined, a review by Quinlan et al. (2016) shows that indicators mostly focus on a specific dimension, such as biophysical measures (Carpenter et al. 2001), and/or behavioural issues (Cabell & Oelofse 2012), or a different scale, e.g. watersheds or communities. It is only in very few studies that the multi-dimensional nature of interactions in farming systems are highlighted or briefly addressed (Ge et al. 2016).

An assessment of farming systems that does not consider the interdependency between actors, processes and value chains may be misleading because of it might undermine the impacts of direct and indirect effects of interactions that actors, processes or value chains have to ensure the system's ability to deliver its core function of the system (Lamine 2015).

This might be insightful for policy interventions and assessments that aim at enhancing resilience and sustainability of a system beyond the farm (Tendall et al. 2015). Thus, assessing resilience and SD beyond farm level opens up a possibility to find out other key factors or issues that might influence the system's resilience and sustainability beyond farm related issues. Therefore, insights from this thesis might be useful tools for both policy makers and other parties (researchers, NGOS) interested and/or actively involved in agrifood systems at a higher level, beyond the farm household.

1.3 Research objectives

The aim of this thesis was to assess resilience and sustainability issues in farming systems by reviewing economic, environmental, social and institutional issues beyond the farm, and establish who are key actors in a farming system. This objective was achieved by:

a. Reviewing the degree to which studies consider resilience and sustainable development issues beyond farm level.

b. Assessing resilience and sustainable development issues in eleven (11) case studies of farming systems across the EU.

c. Evaluating key actors in farming systems based on the 11 case studies from SURE-Farm project.

The eleven farming systems studied in this thesis are case studies under investigation in the ongoing EU research project, ‘’Towards SUstainable and REsilient EU FARMing systems’’ (SURE-Farm)[1].

1.4 Thesis outline

This thesis report is comprised of five chapters, and each chapter is subdivided into sections. The first chapter includes the background information, the research problem and the research objectives. The second chapter defines resilience and SD concepts; discusses their principles and how they have been used at system level. The conceptual framework is also included in this chapter. The third chapter explains the materials and methods used to realise the research objectives. This includes the choice of boundaries of a farming system, the literature search strategy, an overview of the case studies assessed and the criteria for case studies assessment and the evaluation of farming systems’ actors.

The fourth chapter presents the results. The results include resilience and SD issues beyond farm level, from 18 peer reviewed articles between 2000 and 2017, resilience and SD issues in the case studies from SURE–farm project, and an evaluation of key actors in farming systems. The fifth chapter discusses the results, methods and research approach. Then follows the references of all citations throughout the report, and the appendices.

[1] http://www.surefarmproject.eu/

Chapter Two: Definition and conceptualisation of sustainable development and resilience

2.1 Sustainable development

The goal of sustainable development (SD) is to create and maintain prosperous social, economic and ecological systems (Folke et al. 2002). This is directly connected to the core function of resilient farming systems, which is the provision of private and public goods. In this thesis, SD is interchangeably used with sustainability. Darnhofer et al. (2010) argue that as farming systems undergo rapid changes, with frequently little warnings, they should focus on trade-offs between efficiency and adaptability to ensure the sustainability of the system. As mentioned earlier, EU farming systems are specialised within regions, subsectors and farm types, which makes even the goal of sustainable development not only region or subsector specific but also system specific. This implies that SD goals are likely to differ from one region to another and even within one region that has different farming systems (cropping system, livestock or mixed farming).

There are general principles on the process that a system goes through to achieve the delivery of its core functions. They are usually referred to as SD general principles (Segger & Khalfan 2004). Table 1 gives an overview of SD principles, adopted from the SAFA guidelines of the Food and Agriculture Organization of the United Nations.

Table 1. Sustainable development (SD) principles

Private goods
- Delivery of healthy and affordable food products
- Delivery other bio-based resources for the processing sector
- Ensuring economic viability (viable farms help to strengthen the economy and contribute to a stable regional development).
Public goods
- Maintenance of natural resources in good condition (water, soil, air)
- Protection of biodiversity of habitats, genes, and species
- Ensuring that rural areas are attractive places for residence and tourism (countryside, social structures)
- Improvement of quality of life in farming areas by providing employment and offering decent working conditions.
- Ensuring animal welfare

Table format Adopted from SAFA guidelines, FAO 2013

The SD principles in table 1 are grouped into two; private goods and public goods. These goods represent specific objectives or core functions that a farming system should achieve or fulfil to be considered sustainably sound. Robèrt (2000) argues that most concepts and tools for sustainable development function as metrics. For example, life cycle assessment (LCA), ecological foot printing (EF) and factor X. These metrics are associated with the indicators of the system's core functions (Delivery of private and public goods), and they help to answer questions regarding the system's constituents, such as, what it takes for the system to achieve favourable outcomes and how this is achieved are all explored.

2.2 Resilience

There are many definitions of resilience (Table 2), this is due to the breadth of application of the resilience concept; across disciplines and contexts. The meaningfulness of resilience is context dependent and some authors argue that the importance of the definition of resilience depends on whether the application of the concept is for resilience measurement or resilience assessment (Quinlan et al. 2015; Hosseini et al. 2016). The mostly used definitions of resilience are discipline dependent and the major ones include, engineering resilience discussed by Pimm (1988), ecological resilience discussed by Holling (1996) and social-ecological resilience, discussed by Carpenter et al. (2001). However, in thesis, a few definitions relating resilience to farming systems are briefly discussed, showing the domain or context in which, the definition is used, and the emphasis that these definitions focus on.

Table 2. Definitions of Resilience across domains

Domain	Definition	Emphasis	References
Ecological resilience	Ability of a system to withstand shock and maintain critical relationships and functions	Buffer capacity persistence, robustness	Holling (1996)
Social-ecological resilience	(i) Amount of disturbance a system can absorb and remain within a domain of attraction; (ii) capacity for learning and adaptation, (iii) degree to which the system is capable of self-organization	Adaptive capacity, learning, innovation	Carpenter et al. (2001)
Social-ecological systems	Capacity of a system to absorb disturbance and reorganize while undergoing change and still retain essentially the same function, structure and feedbacks	Resilience, adaptability and transformability	Folke et al. (2010)

Resilience of farming systems	Maintaining the essential functions of farming systems in the face of increasingly complex and volatile economic, social, environmental, and institutional challenges.	Robustness, adaptability and transformability	Meuwissen (2018)

Ecological resilience builds on the assumption of non-linear dynamics observed in ecosystems. Here the view of dominant equilibrium is challenged, given continuous changes in the ecosystem. The focus in this domain is more on how far a system could be disturbed without shifting into a new regime (Walker et al. 2006). However, emphasising on robustness may be a limited view, in case of unbearable disturbances that require a system to transform into a relatively new one or adapt its functions into new reality brought by change. Whereas, Social ecological resilience and the resilience of social-ecological systems domains, go beyond the ability to withstand shocks and talk about the capacity of systems to adapt themselves and the delivery of their essential functions to frequent changes.

The views in these two domains relate the concepts of persistence or robustness with adaptability or the capacity to adapt the system's core functions to changes. Even though they recognise the possibility that systems might transform themselves into new systems with new functions, they do not elaborate on how the two-previous concept interrelate with the transformability (Carpenter et al. 2001; Folke et al. 2010). Unlike social ecological resilience and resilience of social ecological systems' domains which emphasise more on the links between robustness and adaptive capacity of systems, the resilience of farming systems' domain brings together robustness, adaptability and the ability to transform. This is when a system needs to transition into a completely new system, with new functions; a situation whereby existing capacities of a system cannot recover from disruptions. In this thesis, resilience is defined as the capacity of a farming system to maintain its essential functions in the face of increasingly complex and volatile economic, social, environmental and institutional challenges.

A definition associated with the resilience of farming systems' domain. The adoption of a definition from this domain is motivated by the fact that this domain specialises its study of resilience in the context of farming systems rather than a general context of socio-ecological systems. Moreover, in this domain, an interrelation of three types of resilience (robustness, adaptability and transformability) is discussed, explaining how farming systems undergo change over time. Looking back at all the resilience definitions in table 2, it is evident that there is no unique way of defining resilience. Furthermore, despite the difference in focus or emphasis and domain, similarities can be observed across the resilience definitions.

2.2.1 Conceptual development of resilience

Most studies on resilience of agroecosystems have been building on the adaptive cycles concept (Holling et al. 2002; Walker et al. 2004; Cabell & Oelofse 2012). According to this concept, there are four stages through which socioecological systems and their processes go through over time. These stages include; growth, equilibrium, collapse and reorientation. There is however no fixed sequence of stages, and a system might stay in one stage for a relatively long period of time. It is also possible that the shift from one stage to another might occur within a short period of time.

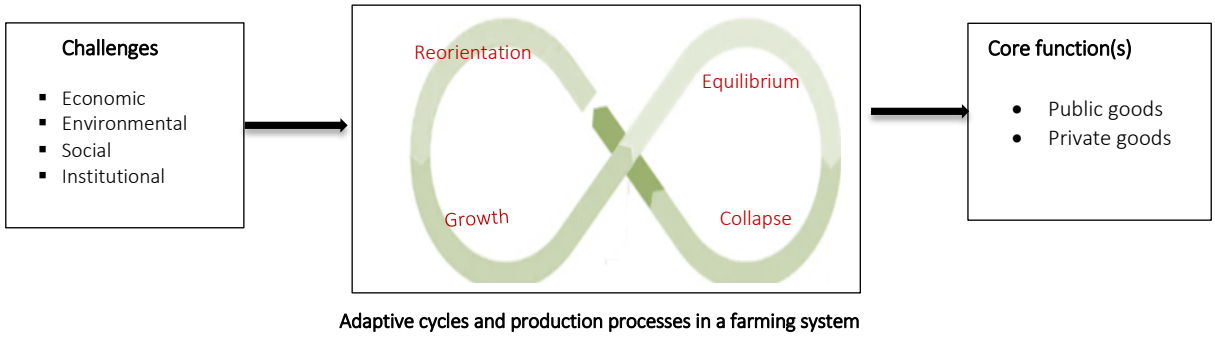


Figure 1. *The resilience concept in farming systems (Source)*

The figure above illustrates how disruptions from the EESi dimensions affect the delivery of private and public goods. The influences of the EESi challenges can influence the delivery of system's core function at one or more stages of the adaptive cycle over time (Walker et al. 2004; Gunes & Movassaghi 2017). The production processes in farming system involve mainly the provision of food and fibre and bio-fuels (Gunes & Movassaghi 2017). Carpenter et al. (2001) argue that understanding the adaptive cycles' concept enhances the understanding of resilience. Moreover, resilience theory emphasizes as well that systems are able to move between phases of relatively stable and slowly increasing accumulation and connectedness, to chaotic and rapid phases of breakdown and reorganization (Holling & Gunderson 2002).

2.2.2 Resilience types

The resilience definition adopted in this thesis presents resilience as simply the system's capacity to maintain its essential functions in the face of increasingly complex and volatile economic, social, environmental, and institutional challenges (Meuwissen 2018). The three resilience characteristics or attributes that this explores further include; robustness, adaptability and transformability (Tendall et al. 2015). These characteristics are also referred to as resilience types (Walker et al. 2004; Tendall et al. 2015; Meuwissen 2018).

a. Robustness

Robustness is a type of resilience which entails the system's ability to continue achieving its core function despite the occurrence of perturbations (Tendall et al. 2015). This type of resilience is mainly emphasised in engineering resilience concept. Robustness is a useful approach in situations where the threats to the system and the system's response to the threats are presumably predicted (Lengnick et al. 2015). Robustness is also referred to as recovery resilience, and as it aims to maintain the same functions and desired levels of output during disturbances (Ashkenazy et al. 2017).

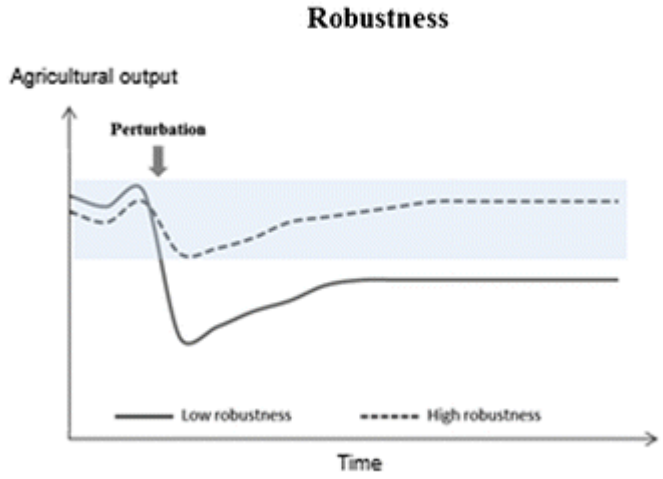


Figure 2. *Illustration of robustness of agricultural output over time adapted from Urruty et al. 2016*

Figure 2 shows how agricultural output of a farming system fluctuates over time through the pressure from perturbations that could be from any of the EESi dimensions. The recovery process to the optimum output level might be low or high based on systems dynamics. However, Urruty et al. (2016) argue also that some of the limitations associated with robustness are due to its tendency to perfectly integrate the biotechnological aspects of farming systems, while paying very little to no attention to the social aspect of farming despite the vital role they play. Therefore, assessing resilience of a system on only robustness attribute might be misleading if the social aspect is not considered.

b. Adaptability

Adaptability is the capacity to adjust responses to changing external drivers and internal processes, and thereby allow for development along the current trajectory (stability domain) (Folke et al. 2010). The need for agricultural systems to adapt themselves to changes in order to stay relevant to their stakeholders is very vital in the sense that if a system can endure disturbance

but not being able to adjust itself to change; after resisting enough, the system will collapse. Koohafkan et al. (2012) argue that maintaining a rich biodiversity strengthens the adaptive capacity of the system and makes it flexible enough to adjust in times of change without losing the essence of its core functions. Lengnick et al. (2015) argue that systems with high adaptive capacity are resilient. They also argue that systems with high adaptive capacity are flexible, they have the capacity to organize, the capacity to learn with an enabling level of capital assets (Natural, human, financial, physical and social).

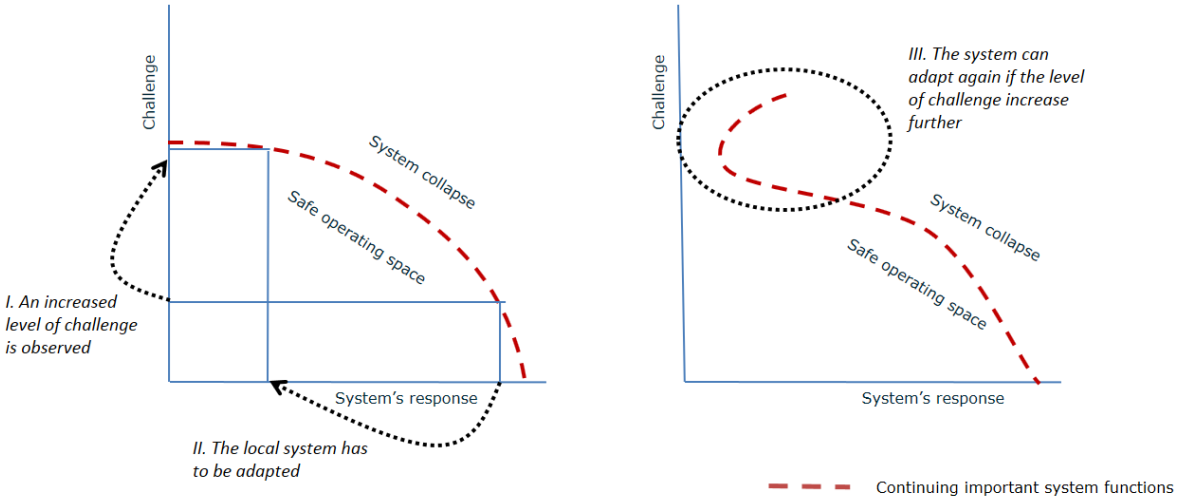


Figure 3. *illustrating the adaptability of farming systems, adopted from SURE-Farm working paper (Meuwissen 2018)*

Due to the complex interdependencies among actors in a FS, enhancing the system's adaptive capacity can only be achieved when all the key actors are involved, working together to ensure that adaptability is achieved throughout the system (Lengnick et al. 2015). Otherwise, one or two actors might be highly adaptive, yet the system is vulnerable and less adaptive. With frequent changes, the system might undergo a cycle of crises and uncertainties and lose its capacity to adapt to changes (Anderies et al. 2006). In this situation, the system might move into a new trajectory, with new functions and a new identity (Folke et al. 2010). Thus, assessing resilience of a farming system based on mainly its adaptive capacity, might be misleading in the sense that beyond adapting to change, some disruptions may cause a system to change into a relatively new system with new core functions. Therefore, being able to transform becomes vital aspect along the way (Darnhofer et al. 2010; Quinlan et al. 2016).

c. Transformability

Transformability is the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable (Walker et al. 2004). Transformability is usually used interchangeably with transformation capacity; which is the system's ability to transition to a new identity when the capacity to respond, recover or adapt is exceeded, and transition is desired (Walker & Salt 2012). Here identity refers to characteristic structure, function and purpose of the system (Walker et al. 2010). For instance, regional wholesale markets are different from national and global supply chains. This type of resilience encourages key system's actors to take a step back and see it with a new eye in order to determine if the system is still desirable or not (Lengnick et al. 2015).

2.2.3 Resilience working principles

Sterk et al. (2017) suggest seven resilience working principles. They argue that these principles are crucial for building resilience of social-ecological systems. A step further is taken to explain how these principles affect resilience. The overview of resilience principles is adapted from Sterk et al. (2017) and includes resilience types that each principle emphasizes on.

2.2.4 Resilience and Sustainable development at system level

In recent studies (Tendall et al. 2015; Lengnick et al. 2015; Ruhf 2015), SD or sustainability and resilience concepts have been used complementarily in farming and food system context. When sustainability is considered as a state that a system should maintain on one hand, resilience on the other hand is considered as a process through which the system reaches the state that enables it to deliver its core function on long term basis. Figure 3 illustrates the complementarity of resilience and sustainability.

Figure 4. *The complementarity of resilience and sustainable development*

Both sustainability and resilience are assessed and /or measured, using indicators (Carpenter et al. 2001; Cabell & Oelofse 2012; Whitehead et al. 2016). Ruhf (2015) and Lengnick et al. (2015) argue that, irrespective of scale (local, national, regional, global), system's resilience and sustainability remain inseparable, making them complementary rather than separate and independent. This complementarity of sustainability and resilience raises questions where to place a clear boundary for resilience and sustainability.

Chapter Three: Materials and Methods

3.1 Farming systems as boundary to analyse ''beyond farm level''

Based on Giller (2013), a farming system (FS) is a system hierarchy level above the farm, at which properties emerge as a result of formal and informal interactions, and interrelations among farms, stakeholders in the value chains, actors in rural and urban areas, consumers, policy makers, and the environment. Gitz & Meybeck (2012) argue that to assess a system's resilience, one should understand the vulnerabilities or challenges (risks) that the system is faced with, within a well-defined context, then clearly define the system by including its components or characteristics, boundaries and delineation. These characteristics or components/properties include farm type, the existing institutions and the agro-ecological context (Andersen 2017). All these characteristics of the system must be related to its core functions and its identity as they influence the type of challenges the system is vulnerable to and the anticipated responses (Cumming et al. 2014, Cumming & Peterson, 2017).

In this thesis, the FS scale is regional, and the system's actors' selection is based on constituents of an FS according to Giller (2013). These actors illustrate the reality of interactions and interconnectedness between actors in order to realise the system's core function. Furthermore, FSs are embedded in larger systems such as food, institutional and social systems, and their mutual interactions are subject to influences which can be a source of unpredictable changes at farm level (Urruty et al. 2016). The FS actors in the context of this thesis include; the farm, financial institutions, rural community (farm's neighbourhood), policy makers, cooperatives and farmers organizations, consumers and other supply chain actors. Figure 5 is an illustration of an FS boundaries in the context of this thesis.

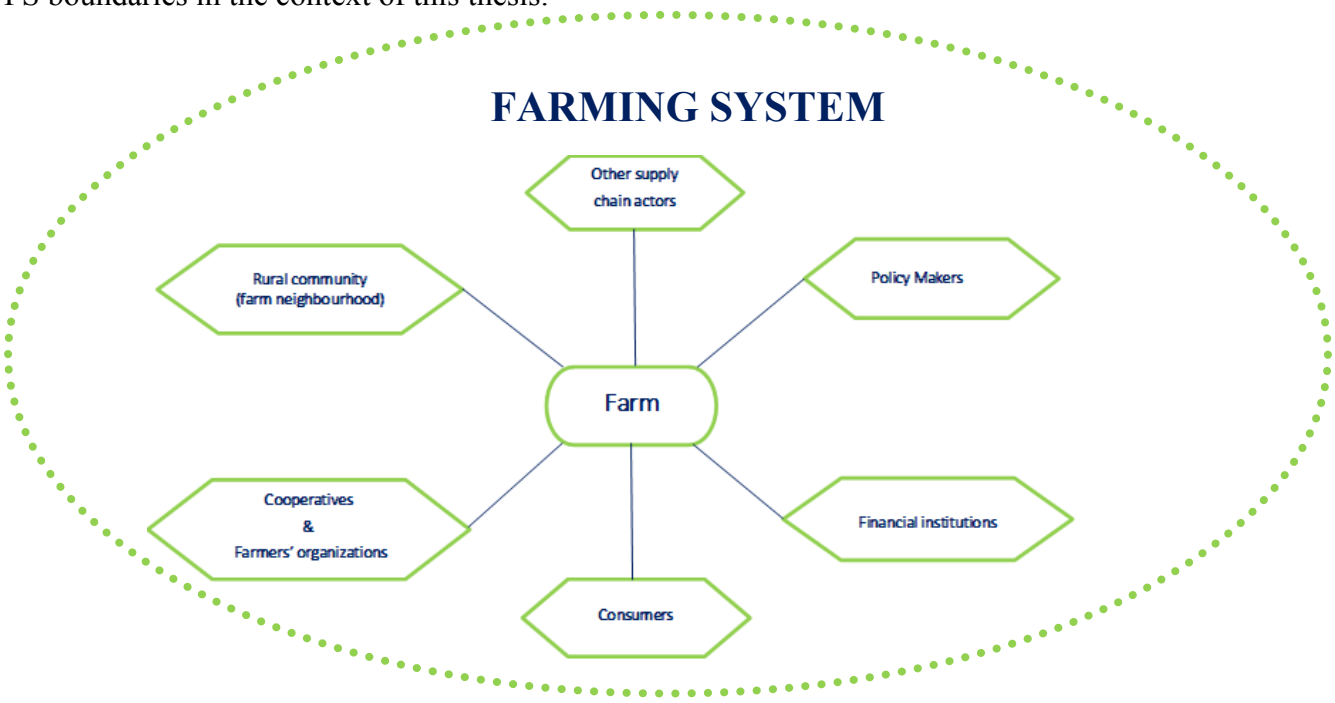


Figure 5. *Illustrative example of some actors within a farming system according Prosperi et al., 2016*

i. The Farm

In thesis, the farm includes the enterprise (crops, livestock or mixed), the farm household and all farm resources (farm equipment and machineries, and other assets). These components of the farm function interdependently to deliver the core function of the farm, and the farming system at large. The selection of farm at the centre of FS is because; the primary activities in a farming system are done at farm level. It is after food has been produced in the farm that processors and other consumers get access and food and farm products. The activities done at farm level set the basis for second other activities such as and from there other activities like processing, transportation, and sales (Darnhofer et al. 2010; Meybeck et al. 2012).

ii. Policy makers

Policy makers play a vital role in addressing trade-offs between food and fibre production, food consumption patterns, population size and the portion of land reserved for nature (Beddington et al. 2011; Bos et al. 2013). These trade-offs have a direct impact on how the FS functions, how it transitions into new functions (Bos et al. 2013). Furthermore, Lengnick et al. (2015) argue that irrespective of scale (either local or global), policies, the CAP for instance, affect the choice of farming practices, land use and innovation, which in turn influence farm processes and the dynamics in an FS in general. For instance, policy measures like the manure policy and milk quotas, led to new dynamics in how Dutch livestock farmers (dairy and pigs) interrelate with other actors active in the disposal and use of manure and other farm by-products (Klootwijk et al. 2016).

iii. Financial institutions

Financial institutions in figure 4 refer to both banks and credit unions or credit cooperatives, through which farmers and other FS actors who have direct influence on the farm processes acquire financing for their operations. Given the capital-intensive nature associated with high transaction cost of EU Farming (Clapp 2014), financial institutions, through Farm Credit System (FCS) play an undeniably important role in assisting farms and their partners in their financial needs and ensuring the growth of the farming sector (Gunes & Movassaghi 2017). It is in the light of this vital role that financial institutions play in agricultural development that they are in included in the framework of the FS boundaries in the context of this thesis.

iv. Consumers

Recently, the role of consumers in food and farming systems has changed rapidly (Verbeke et al. 2010; Renting et al. 2012). Civil societies, NGOs and other activist groups that represent the interests and concerns of consumers have become an important component of food chains (Renting et al. 2012). Renting et al. (2012) argue also that with relatively easy access to information regarding farming practices, standards, consumers focus, perceptions and attitudes have changed significantly, and these changes have got direct influence of how processes at each stage in an FS are performed. This is the reason why consumers are part of the boundary objects of the FS in the context of this thesis.

v. Cooperatives and farmers' organizations

Agricultural cooperatives and farmers' organization are included in the FS framework in figure 4 due to their importance in providing solutions to the need to cope up with high demand of farm products' demand for processing and retail in EU food chains. Furthermore, cooperatives and farmers' organization help farms achieve economies of scale and reduce their transaction costs (Valentinov 2007). Bijman & Hendrikse (2003) argue that the role that agricultural cooperatives play is vital in the way that cooperatives provide services (processing of farm products, sales and marketing, financial services) which altogether help balance market power between producers (farmers) and their trading partners, up and downstream the production chain. The role of cooperatives in an FS might involve marketing, knowledge sharing, whereas farmers' organizations usually serve as knowledge exchange platforms, avenue for advocacy regarding policy or any other functional issue that farmers can address as a group.

vi. Rural community

It has been established from last decade that agglomeration effects from spatial dependence play an important role in farmers' adoption of new farming practices and/or farm technologies (Langyintuo & Mekuria 2005; Schmidtner et al. 2011). While issues such as animal welfare in livestock FS attract the interest of the public (where citizens and farm neighbourhood can be put), the farm neighbourhood, which is part of the rural community, plays an important role in how farming practices are perceived and even push for reforms that might change the dynamics of an entire FS (Schmidtner et al. 2011). It is on this background that rural community (farm neighbourhood) is included in the framework in figure 4.

vii. Other supply chain actors

This category of actors includes retailers, suppliers of farm inputs and technologies and processors of farm products for various consumptions. The inclusion of retailers in this category of FS actors is because of the key role that EU retailers play in bridging the gap between processors, farmers and end consumers (Vorley 2001). Certainly, the list of farming system's actors might not be exhausted, as farming systems are context dependent, some may have short or long value chains as influencing factors. Therefore, this illustration of key actors is not exhaustive.

3.2 Search strategy for literature review

The search strategy for literature review was guided by the exploration of three keywords that summarized the focus of this thesis. The keywords include ''Beyond the farm'', ''sustainable development'' and ''resilience''. The search engines that were used to retrieve articles included Scopus, Web of science of the WUR library, Google scholar. Because of the scarcity of literature that addresses the keywords directly, a proxy measure was used to enlarge the sample and easy the process of retrieving peer-reviewed articles. From initial hints of the three keywords into the search engines, each of the three keywords was substituted by a few specific search terms in order to maintain the focus and context in which literature should be reviewed.

Thus, on one hand ''beyond the farm'' identified with search terms like; food system, farming system, supply chain and agroecosystem. On the other hand, along ''resilience'' as keyword, robustness, adaptive capacity or adaptability and transformability were also used to explore resilience. For ''sustainable development'' specific terms used together with sustainability included, biodiversity, healthy food and farm continuity. These specific search terms helped to easy the search process and increase the possibility to find useful literature that is in line with the research objectives.

The selection of articles for final review of resilience and SD issues beyond farm level comprised two steps. On the first step, the abstract and conclusion of articles are browsed, key actors and SD and resilience issues in the FS or supply chain from that article are identified as well. If the full document cannot be retrieved for a systematic review, then the article is excluded from the ones needed for final review. The second step is where articles that fulfil the selection criteria, with at least 2 out of 7 actors of an FS, illustrated in figure 4, and their full document can be retrieved are selected for systematic review.

Table 3. Initial hits and selected articles for literature review

Research focus	**SD & Resilience issues beyond farm level**	
Search Engines	**Step 1**	**Step 2**
Google scholar	20	8
Web of Science WUR library	12	7
Scopus	10	3
Total	**42**	**18**

The selection criteria for literature review involved adopting only Peer-reviewed articles, written in English and published between 2000 and 2017. This was in line with the first research objective that sought to find out to what extent FS are reviewed beyond farm level. The time demarcation intended to maintain focus on the recent findings on resilience and SD but also due to the fact that it is in that time frame that resilience and SD have gained momentum in farming contexts. Furthermore, content from books, book sections, proceedings from conferences and dissertations were primarily excluded. Although in some rare cases, findings from the FAO and the deliverables from SURE farm project were adapted to maintain the focus of the research beyond farm level.

There was no strict selection strategy on the geographic boundaries of the studies in reviewed literature. Although, studies performed in EU, the USA, Canada, New Zealand and Australia were highly preferred due to easy access of peer-reviewed literature of FSs. Both article with empirical and normative articles were reviewed. Furthermore, articles that did not focus on either crop or livestock (beef, dairy, sheep, pig) farming systems were excluded from the search. Literature focusing on flowers or non-cash crops were also excluded from literature.

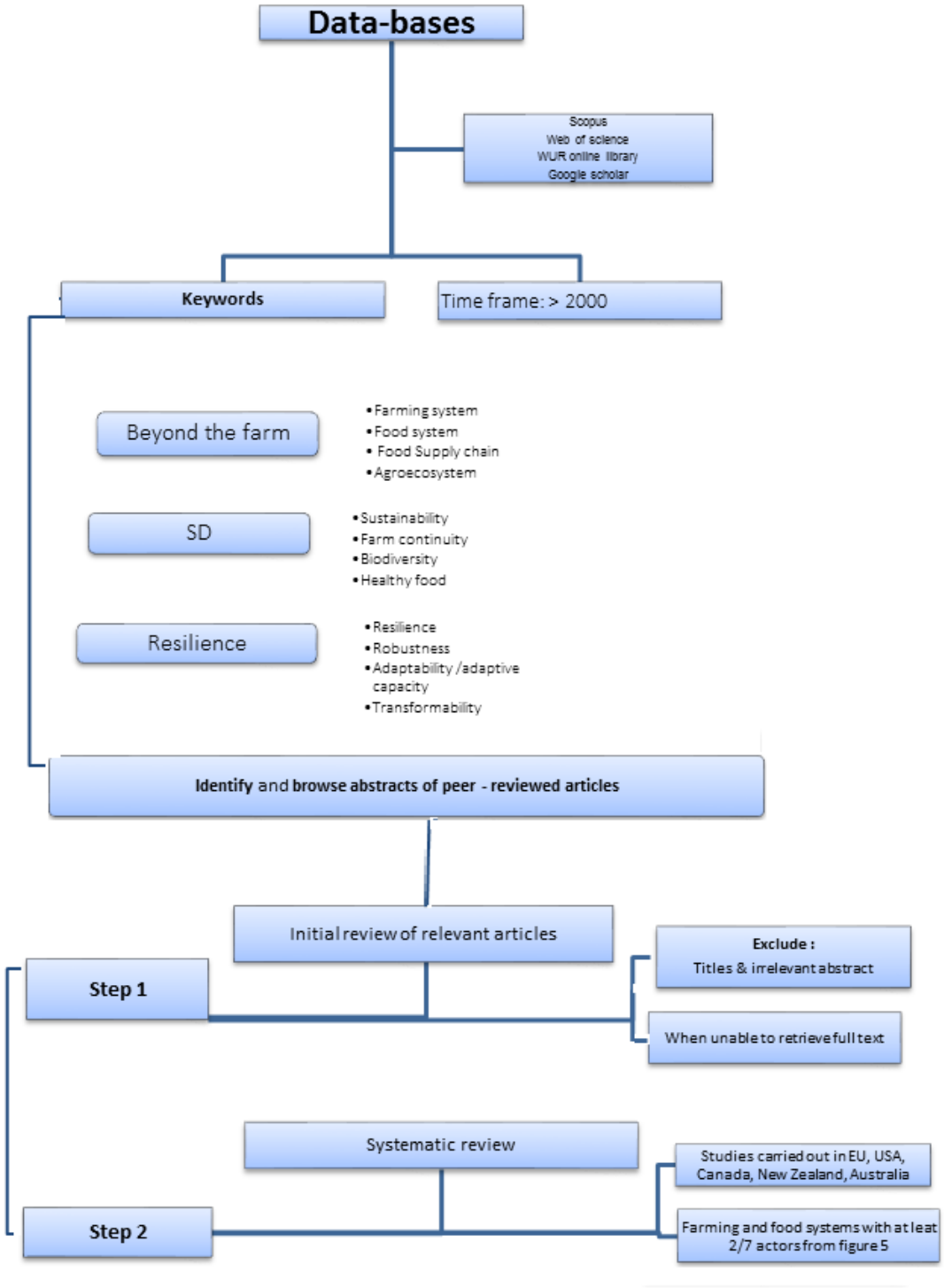


Figure 6. *Overview of search strategy for relevant literature on resilience and SD issues beyond the farm*

2.2.3 Literature assessment

This sub-section explains how choices and assumptions were made during literature review. The choices made included for instance, selection of actors of a farming system from empirical and normative data, the classification of resilience and sustainable development issues under EESi

dimensions in empirical and normative papers. One assumption made during literature review was determining the resilience type of emphasis in every reviewed article.

i. Actors' identification in reviewed literature

In empirical papers, FS actors' identification was simply based on the stakeholders the that were interviewed and referred to during the study. Whereas in normative papers, actors were identified by highlighting all actors mentioned in the abstract and results and make a count of the number of times these actors are mentioned and/or referred to in the paper. The underlying assumption for actors' identification was that all stakeholders involved in processes of delivering the system's core function from farms to final consumers are actors in an FS.

ii. Resilience and SD issues beyond farm level

Lengnick et al (2015) and Ruhf (2015) argue that SD or sustainability is a state where the system continues to deliver its core function, over a long period of time, regardless of changes and challenges that it encounters along the way. Whereas resilience is a process through which the system goes through to attain the SD state. This insight of complementarity of resilience and SD guided the identification of resilience and SD issues at system level. These issues are challenges of negative and/or positive effect on the system's delivery of its core function. classified following the EESi dimensions.

iii. Assumed resilience type of emphasis

Another essential choice made in regard to resilience and SD issues was the determination of the resilience type of emphasis in the reviewed paper. The assumption of the resilience type of emphasis (Robustness, adaptability, transformability) resulted from in-depth review of the article to identify the key characteristics that the authors associate with resilience. Robustness was mentioned as the resilience type of emphasis in the data where characteristics such as maintaining the status quo, buffering capacities/resources, are emphasized as resilience characteristics or attributes. Whereas, adaptability was assumed as type of emphasis when characteristics such as flexibility, customized responses to variations and/or change, and learning are considered as the most essential.

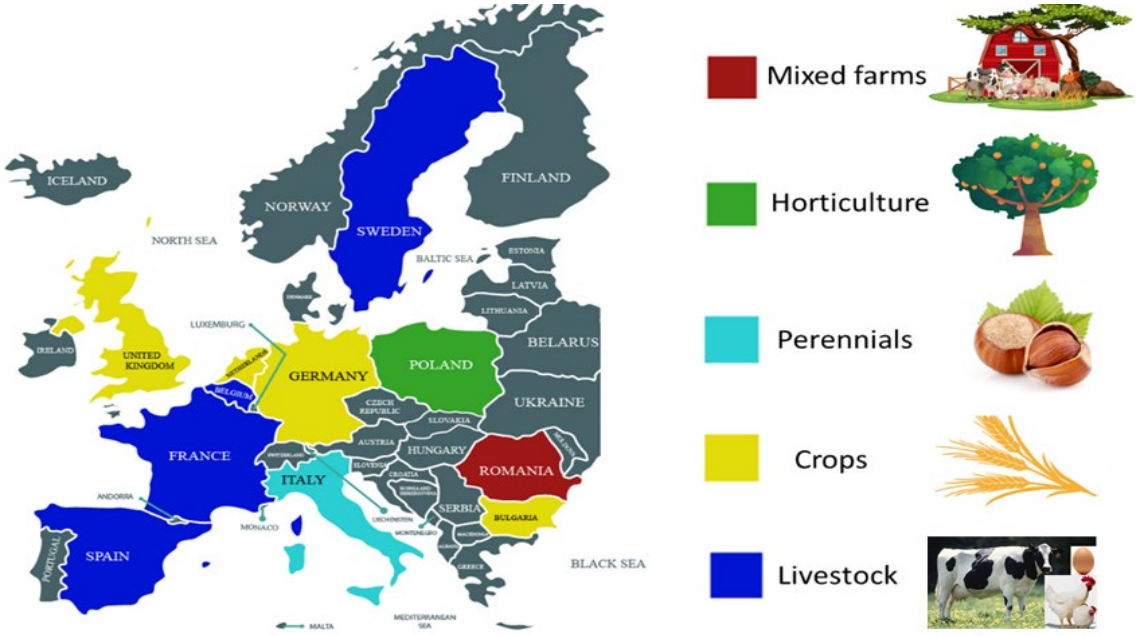
Transformability was assumed as the resilience type of emphasis in a paper when characteristics such as stimulating and/or enhancing innovation, in-depth learning, long term focus, are considered as very crucial to attain resilience. Nonetheless, there are also cases where the

assumed resilience type of emphasis is more than one type. The assumption still relied on characteristics highlighted as very important or crucial for a system to be resilient.

3.4 Case studies

The purpose of the case studies is to make sure the findings in this thesis match with the local contexts of various EU farming systems. The case studies provided insights on the agricultural sector (crop, livestock, horticulture, mixed farming), the actors who form the system and the challenges their perceived challenges in EESi dimensions. The data obtained from case studies helped to assess resilience and SD issues in the context of the case studies chosen by the SURE-Farm project. Just like sustainability and SD are used interchangeably in this thesis, likewise are issues and challenges as well.

In total, 11 CS covering the various EU agro-ecological zones, farming systems were selected. These FSs included 4 livestock systems, 4 large scale corporate farms, crops systems, 1 small scale hazelnut FS, 1 private family FS (fruits and vegetables) and 1 system of small scale farms. Figure 6 and table 5 give an overview of the case studies and where they are located, their sector and also the key actors for the specific case study.



France	Spain	Sweden	Belgium	Germany	Bulgaria	Netherlands	England	Italy	Poland	Romania
Extensive beef cattle systems	Extensive bovine and ovine farms	High-value egg and broiler farms	Intensifying dairy farming	Large-scale corporate farms	Large-scale corporate farms	Arable farming	Large-scale corporate farms	Small scale Hazelnut production	Private family fruit and vegetable farms	Small scale farms

Figure 7. *Overview of the 11 case studies, Adapted from SURE-Farm project, working paper*

The selection of these 11 cases studies is to help draw a representative and meaningful conclusion of resilience and SD issues in EU farming systems. On one hand, the 11 cases are

comprised of different farming sectors, which include; cropping sector, livestock, horticulture and mixed farms. This is one aspect of representativeness. Additionally, among these cases, there are some managed as family farms, others are large corporate farms. This includes both large and small scales. On the other hand, the 11 cases were selected in different agro-ecological zones, in different European regions.

3.5 Assessment of SD and resilience issues in 11 CS

The assessment of resilience and SD issues in the context of the case studies from SURE-Farm project was to ensure that findings in this thesis might be representative of the reality in various local contexts of European farming systems. Data was obtained from the 11 cases studies of SURE-Farm project, through surveys, interviews and SWOT analysis made by partners of the SURE – Farm project. The case studies were derived from five different farming systems. The five farming systems included livestock, crop, mixed farms, horticulture and perennials farming systems.

In the assessment, perceived challenges within the EESi dimensions were used interchangeably with resilience and SD issues. This was because ‘’perceived challenges’’ mentioned in the case studies were related to challenges that might have an effect on the delivery of core functions of the farming systems. The assessment of resilience and SD issues in the case studies involved reviewing the 11 case studies derived from 5 farming systems. The perceived resilience and SD challenges were systematically listed based on the EESi dimensions. Thereafter, the frequency of each issue in the farming systems is obtained by counting the number of times the issue is mentioned in the farming systems. A final score was given to each issue as a total count of the times the issue is mentioned in the farming systems.

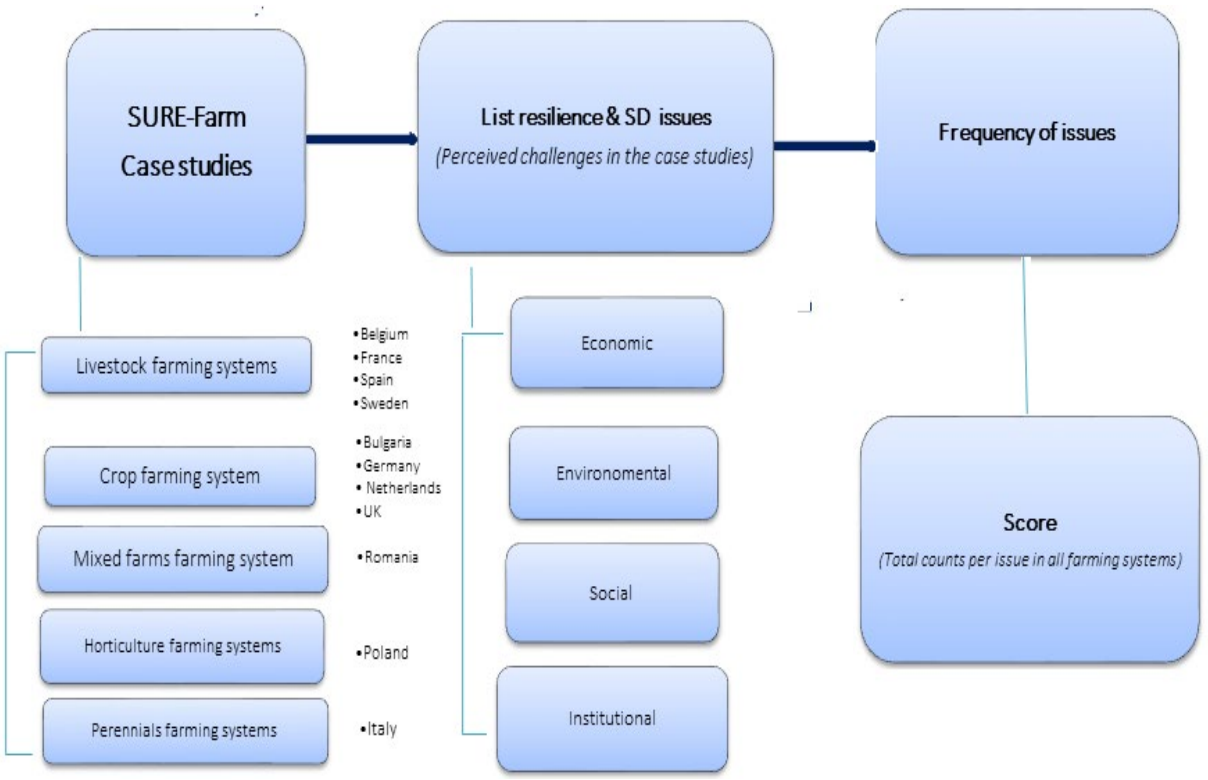


Figure 8. *Overview of the assessment framework for resilience and SD issues in the 11 case studies of the SURE-Farm project. An issue was considered to be 'beyond the farm level' when it is mentioned or reported by the farm/ farrm household and other actors of the farming system.*

3.6 Key actors in farming systems

The review of literature on SD and resileince issues beyond farm level had an assumption whereby all stakeholders active in the process of food production from farm to final consumer are key actors in an FS. Whereas in the 11 CS, FS actors were specific to the CS and the sector. Thus, the evaluation of who are FS key actors will be done by counting how many times a particular actor is repeated as an FS actor in both the reviewed literature and the 11 CS.

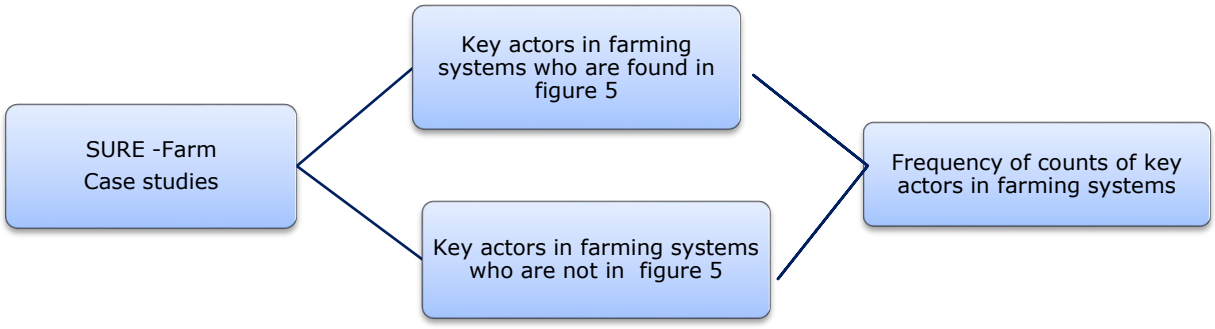


Figure 9. *Illustration of the evaluation framework for key actors of farming systems*

Chapter Four: Results

4.1 Resilience and SD issues beyond farm level in reviewed literature from 2000 - 2017

Table 6 presents a comprehensive summary of resilience and SD issues beyond farm level. This data helped to understand to what extent resilience and SD issues have been studied empirically beyond the farm. This comprehensive table summarises resilience and SD issues in the EESi dimensions, from peer-reviewed articles between 2000 and 2017.

Outcome of Empirical and normative studies on resilience and SD issues beyond farm level between 2000 and 2017

A high proportion of empirical data over normative data on resilience and SD issues beyond farm level is shown in figure 9. The respective proportions are 11 over 18 and 7 over 18.

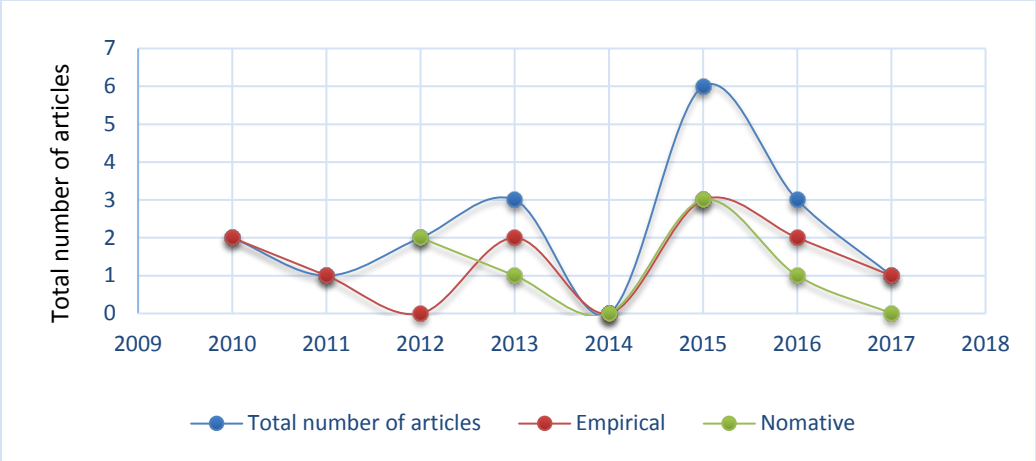


Figure 9. *Overview of the distribution of empirical and normative data on SD and resilience issues mentioned or reported by the farm and other actors within the farming system as important issues in terms of impact on the system's core function.*

Furthermore, in terms of availability of a single data type (Empirical or normative data alone), ¾ of cases with only one type of data in a particular year are of empirical data. Whereas, cases with normative data represented only ¼ in that category. Additionally, apart from the year 2014 that had no data, the trend of cases with available empirical and normative data in the same year shows high frequency of empirical data over normative data (2013 and 2016).

The year 2015 makes a difference in that trend. Despite having the highest count of available data, the empirical and normative data had the same count, 3 studies each. Besides the difference in availability of data type per year, this data was obtained from studies conducted

in different regions, an important aspect in evaluating how close to the EU context would the data. Figure 9 shows that there was no study on resilience and SD issues beyond farm level conducted before 2010.

The regional distribution of studies on resilience and SD issues beyond farm level showed a high frequency in the EU region. Interestingly, the amounts of empirical and normative studies are equal in the EU region. The USA, Canada, Australia, and New Zealand were also important regions where studies on SD and resilience issues beyond farm level have been conducted. The multi-case represented findings from a study with findings from EU, USA, and New Zealand at the same time.

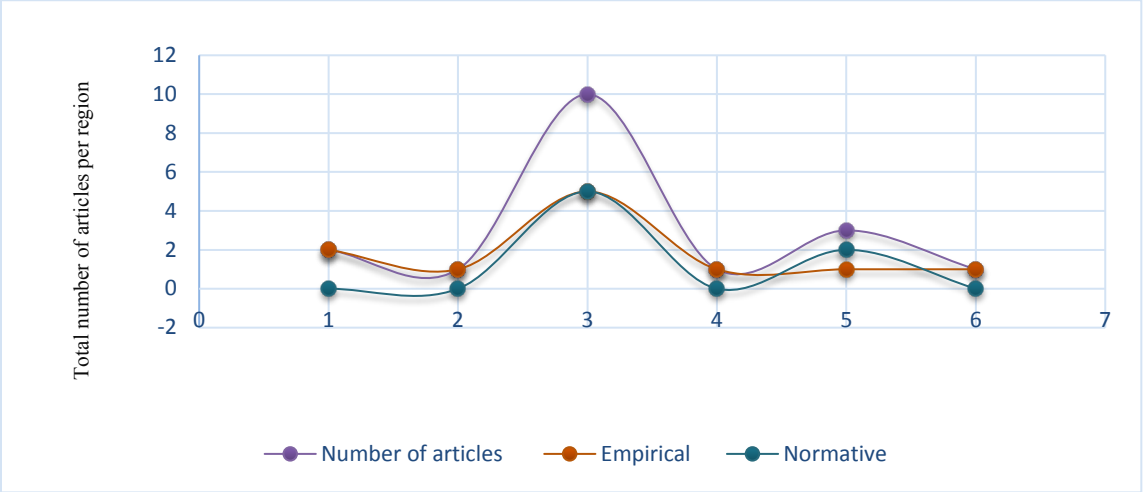


Figure 10. *Overview of the regional distribution of empirical and normative data on SD and resilience issues mentioned or reported as important issues in terms of impact on the system's core function in Australia, Canada, EU, New Zealand and USA .*

Table 6. Resilience and SD issues beyond farm level in reviewed literature from 2000 -2017

References	Country	Sector	Normative (N) or Empirical (E)	Actors	Resilience type emphasized	SD & resilience issues beyond the farm			
						Economic	Environmental	Social	Institutional
Darnhofer et al. (2010)	Austria	Crop & livestock	E	Farm (1) , Consumers (2), Rural community (3)	Robustness & Adaptability	commodity price volatility (1)	x	Changing social norms (1,3)	Environmental regulations (1) Quality requirements (1,2) Revision for CAP? (1)
Milestad et al. (2010)	Sweden	Unspecified	E	Farm (1), Consumers (2), Rural community (3)	Adaptability	Short food chains (1,2)	Climate change (1,3)	social connection (1,2,3) high level of collective learning (1,2)	x
Van Apeldoorn et al. (2011)	Netherlands	Livestock	E	Farm (1), Cooperatives (2), Policy makers (3)	Robustness	Declining enterprise viability (1,2)	Declining Soil organic matter (1,2) Pressure on landscape conservation (2,3)	X	Quality standards (1,2,3)
Marsden (2012)	UK	Unspecified	N	Farm (1), Consumers (2), Policy maker (3), Rural community (4)	Adaptability	Financial crisis (1,2,4,3) Decreasing Profitability of farms (1,4)	x	Increasing pressure to Connect with consumers (1,2,4) Changing consumer interests (1,3)	Flexible policies (1,4)
Sayre et al. (2012)	USA	Livestock	N	Farm (1), Cooperatives (2), Rural community (3), Policy makers (4)	Adaptability	Income variability (1)	Declining biodiversity (1,2,3)	Land ownership pressure (1,2,3) Enhancing Collaboration among ranchers (1,2) Education of ranchers (1,2)	Need for creative land tenure policies (1,2,4)
Blay-Plamer et al. 2013	Canada	Unspecified	E	Farm (1), Processor (2), Distributor (3), NGOs (4), Policy makers (5)	Transformability	Economic viability of farms (1,4)	X	Increasing Connection with consumers (1,2,4) Building collaborative capacity (1,2,3 4,5)	X
Bowman & Zilberman (2013)	USA	Crop	N	Farm (1), Consumers (2), Policy maker (3), Knowledge provider (4)	Adaptability	Fluctuating food prices (1,2)	Declining biodiversity (1,3,4)	changing social expectations (1,2,4) Adaption of farming practices (1) Lack of market coordination (1,3)	Elimination of subsidies (1,3) Crop insurance programs (1,3)
Leat & Revoredo-Giha (2013)	UK	Livestock	E	Farm (1), Cooperatives (2) Processors (3), Retailer (4) Consumers (5)	Adaptability	Market and price security (1,2)	Low animal performance (4,5)	More vertical collaboration (3,4) More attention on animal provenance (4,5) Increasing animal welfare (1,2)	Meat quality (3,4)

Duru & Therond (2015)	France	Livestock	N	Farm (1) Input suppliers (2) Local government (3)	Robustness Transformability	Input price variability (1)	Animal health problems (1,3)	changing social expectations towards farming (1,2,3) local governance (1,3)	Changing regulations (1,2,3)
Lamine (2015)	France	Crop	N	Farm (1), Cooperatives (2) Processors (3) CSOs (4), Policy Makers (5) Consumers (6)	Robustness Transformability	x	High Diversity of food products (1,2,4,6)	Weak Farm vs Consumer relationships (1,4,6)	Strict Seed regulations (1,2) CAP regulations (1,2)
Lengnick et al. (2015)	USA	Crop and livestock	E	Farm (1), Processors (2), Distributors (3)	Adaptability Transformability	Balanced accumulation of capital assets (1,2,3) More specialized production (1,3)	Need for increased diversity (1) Increased Modularity (1) Constant weather variability (1)	high urban density (1,3) regional specialization (1,2,3)	x
Macfadyen et al. (2015)	13 Case studies EU, NZ, Australia, USA	Crop and livestock	E	Farm (1), Retailer (2), Processors (3), Distributors (4) Consumers (5)	Robustness Adaptability	Variability in supply (2,3,4) Yield maximization (1,2)	water and soil protection (1)	Population ageing (1)	x
O'connell et al. (2015)	Australia	Livestock	E	Farm (1), Policy makers (2) Cooperatives (3)	Transformability	Less capital reserves (1,2) Less access to shared resources (1,3)	Weak ecosystem diversity (1,3)	Farmer-led institution (1)	x
Tendall et al. (2015)	Switzerland	Unspecified	N	Farm (1), Policy makers (2) Retail and industries (3) Consumers (4)	Adaptability	Financial crises (1,3)	X	Rapid urbanization (1,2) Population ageing (1)	X
Prosperi et al. (2016)	France	All (crop, livestock and mixed farming)	N	Farm (1), Processors (2), Distributors (3), Retail (4), Consumer (5), Policy makers (6)	Robustness Adaptability	Increasing food price volatility (1,4,5,6)	Climate change (1,5,6) Water depletion (1,6) Biodiversity loss (1,5)	Changes in consumption patterns (1,2,3,4) Nutritional quality of foods (1,4,5)	Political instability (1,2,3,4,5,6)
Smith et al. (2016)	Australia	All (crop, livestock and mixed farming)	E	Farm (1), Cooperatives (2) Processors (3), Distributor (4), Supermarket (5), Consumers (6)	Robustness Adaptability	Collapse of infrastructure (1,3) Financial loss (1,2)	Limited product diversity (1,6)	Low level of cohesion (1,3,4,6) Loss of trust and cohesion (1,2,3,4)	x
Whitehead et al. (2016)	New Zealand	Livestock	E	Farm (1), Processors (2), Distributors (3), Consumers (4)	Robustness	x	x	Collaboration amongst producers (1) Vertical collaboration across the system (1,2)	x
Ashkenazy et al. (2017)	14 EU countries (Case studies)	All (crop, livestock and mixed farming)	E	Farm (1), Cooperatives (2) Rural community (3), Rural institutions (4)	Robustness Adaptability Transformability	Market forces (1,2,3) Promoting diversification (1,2) Changing technological innovation & cost efficiency (1,2,3,4), Entrepreneurship (1,4)	Resource constraints (1,2)	Societal demands (1,2,3,4), Valuing traditions and local capacities (1,2,3,4) Increasing cohesion between social groups (1,2,3,4)	Place based actions (1,2,3,4) optimizing the use of public support (1,2)

4.1.1 Economic issues beyond the farm based on findings from literature review

Resilience and SD issues associated with the economic dimension were clustered into three categories, namely; price volatility, declining profits and market dynamics. Each category had a number of specific issues associated with it. For example, the following issues were in the price volatility category; commodity price volatility, fluctuating food prices, input price variability, food price volatility, unstable market and price security. Whereas, declining profits category included; decreasing profits, declining economic viability of farms and financial loss. And in the market dynamics category, financial crisis, variability in supply, growing short food chains, changing technological innovations, were the associated issues.

Most issues were specific to the farming sector (crop, livestock, mixed farming, all sectors, unspecified). For example; fluctuating food prices was strictly specific for the crop sector. Whereas, income variability, input price volatility, unstable market and price security, less capital reserves and less access to shared resources were specific to the livestock sector. Issues such as, commodity price volatility, more specialised production, variability in supply, yield maximization and lack of balanced accumulation of capital assets were particularly identified in mixed farming sector. The capital assets referred to in this context include natural assets, human, financial and technological assets.

Lengnick et al. (2015) showed that when the accumulation of capital assets deviates from the core function of the system, the imbalance is created, and it affects the resilience and sustainability of the system. The economic issues affecting resilience and SD were clustered into 3 main Figure 11 shows an overview of the count of economic issues over time. (2010 - 2017).

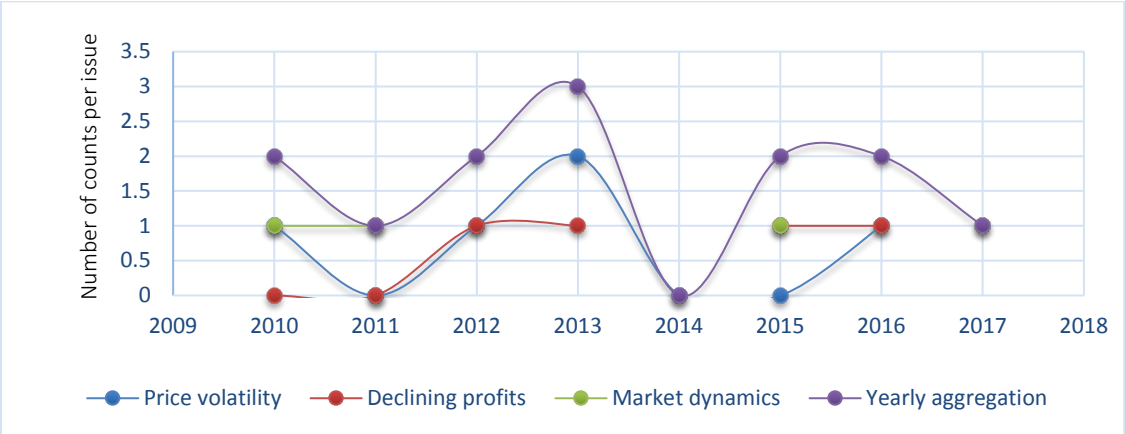


Figure 11. *Overview of economic issues and the number of counts per issue between 2010 and 2017.*

The observed absence of economic issues in figure 11 is due to the unavailability of data on resilience and SD issues beyond the farm in 2014.

a. Price volatility

Issues clustered under price volatility category included; commodity price volatility, fluctuating food prices, input price variability, food price volatility, unstable market and price security. The results shown in figure 12 are an extract of the extensive summary of results in Annex 1. In figure 12, the number of times each of issues related to price volatility is appeared in different farming sectors (Crop, livestock, mixed farming, all sectors and unspecified).

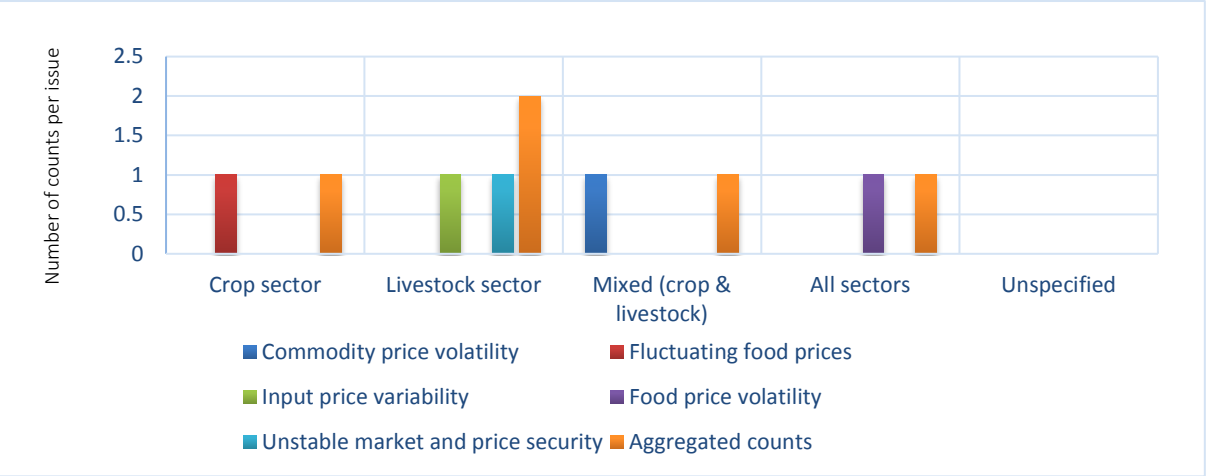


Figure 12. *Overview number of counts of the economic issues pertaining to price volatility in various farming sectors as components of farming systems.*

Figure 12 shows that the issues related to price volatility vary in almost each farming sector. For example; food price volatility was an economic issue in all farming sectors. Whereas, input price volatility was reported specifically in the livestock sector. On hand, fluctuating food prices were an economic issue in the crop sector. On the other hand, commodity price volatility was an economic issue in the mixed sector (crop and livestock). A step further was taken to identify which farming system's actors are affected with these issues related to price volatility.

Some issues related to price volatility affected actors in both upstream and downstream levels of the farming system. For example, fluctuating food prices was a cross-cutting issue among all the actors. Whereas, some other issues related to price volatility showed effect, on the upstream level only. For example; commodity price volatility and input price variability were counted as economic issues affecting the farm only. Food price volatility showed effects on the farm and consumers. Whereas, unstable market and price security counted for the farm and cooperatives.

The farm, which included the farm household, and all the farm resources (buildings, machineries, and the entire enterprise), was shown to be affected by all the aspects of price volatility (5 counts). Cooperatives and consumers had also two counts each on issues related to price volatility as well.

b. Declining profits

The economic issues or aspects related to decreasing profits included; decreasing profits, declining economic viability of farms, and financial loss. Financial loss was a cross-cutting issue in all farming sectors. Whereas, decreasing profits was only reported in the livestock sector. Furthermore, declining economic viability of farms, was identified in a study with unspecified farming sector. The livestock sector showed the highest count (2 counts) of issues related to declining economic viability of farms.

Farms and cooperatives had each a single count on decreasing profits, and on financial loss as well. The total counts showed the highest count at the farm (3), and the lowest count with NGOs (1). From these results, declining profits may probably affect mostly actors in the upstream of a farming system (farm, cooperatives).

c. Market dynamics

The economic issues or aspects related to market dynamics included; financial crisis, variability in supply, growing short food chains and changing technological innovations. Variability in supply and changing technological innovations were identified in both crop and livestock sectors, with the same counts each, per sector. The only market dynamic related issue in the mixed farming sector was the changing technological innovations. Other two important issues related to market dynamics, were identified in farming systems with unspecified actors. Figure 13 shows another important aspect of the identification of these issues, which is showing which actors are affected by the market dynamics related issues.

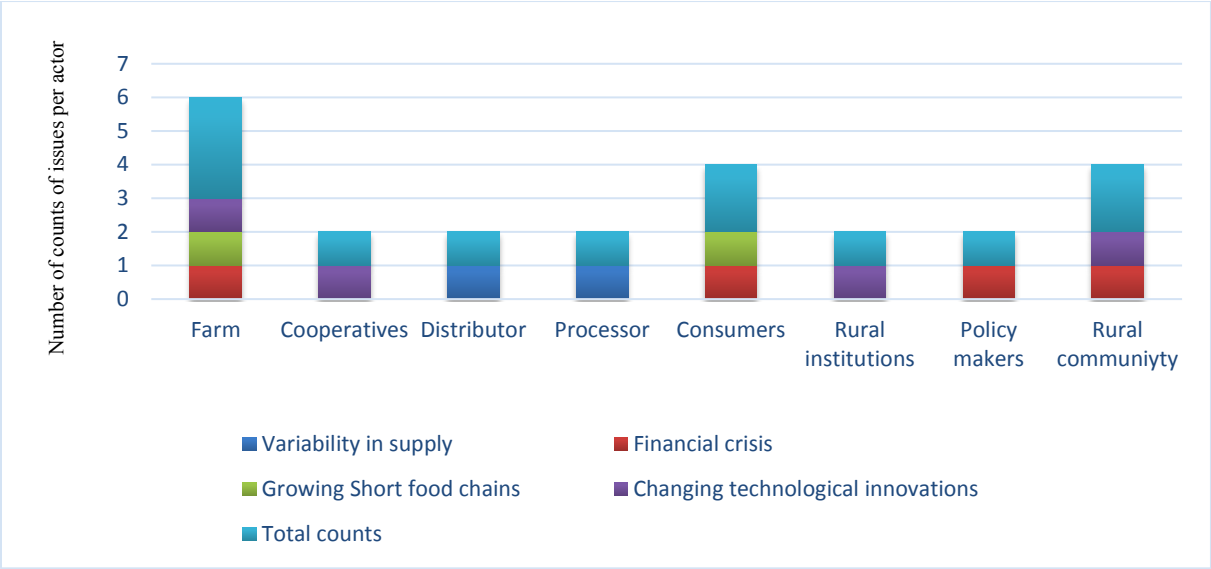


Figure 13. *Overview number of counts of the economic issues related market dynamics among various actors of farming systems.*

Figure 13 shows the highest count of issues related to market dynamics at the farm. The farm included, the farm household and all the enterprise's resources. In terms of total counts, consumers and the rural community come after the farm with 2 counts each. In regard to the issues related to market dynamics, financial crisis and changing technological innovations were to a great extent, cross-cutting issues among actors in farming systems.

4.1.2 Environmental issues beyond farm level based on findings from Table 6

Resilience and SD issues associated with the environmental dimensions of farming systems included; declining biodiversity, declining soil organic matter, soil quality and water depletion, and climate change.

i. Declining biodiversity

As a concept, biodiversity has been argued that it should be treated with lots of care because conceptually, biodiversity is bi-dimensional. These dimensions present diversity either as an aim for ecosystem conservation or as a mechanism for ecosystem conservation. When biodiversity is viewed as the aim for ecosystem conservation its reasoning aligns with ways through which In most resilience studies, biodiversity has been viewed as a mechanism for the conservation of the ecosystem's conservation.

This issue was identified in 4 studies, conducted in the USA, France and Australia. In the USA case, this issue arose in crops, livestock and mixed farming (crop and livestock) sectors. In France it was in a mixture of all sectors, and in Australia in livestock sector. The actors who

were affected with this issue included the farm, cooperatives, rural community, consumers, knowledge providers and retailers.

ii. Declining soil organic matter, soil quality and water depletion

This issue arose in a case study conducted in 13 countries, covering Europe, the USA, Australia and New Zealand, in both crop and livestock sectors. From actors' perspective, the results shown that this issue affect the farm primarily.

iii. Climate change

This issue arose in France, Sweden and the USA. One of the specific aspects on this issue was constant weather change. All sectors (crop, livestock and mixed farms) recognised this issue as important for sustainable and resilient FS. The actors who related with the effects of this issue included, the farm, rural community, consumers and policy makers.

4.1.3 Social issues beyond farm level based on findings from Table 6

Resilience and SD issues associated with the social dimension of farming systems included; Changing consumer preferences and consumption patterns, changing social expectations towards farming and increasing cohesion between social groups.

a) Changing consumer preferences and consumption patterns

Marsden (2012) and Prosperi et al. (2016) showed that the farm, processors, distributors, retail and policy makers are all affected with Change in consumer preferences and consumption patterns. For example, when consumers start for products with less miles from producer to consumer or retail, then low cost products that are imported from areas with heavy subsidies have to be replaced with what can be found closer to the consumer. This in most cases will lead to creations of new partnership with local producers, leading to new challenges in terms of organizing the supply chain, policy and best practices but also a fair price that consumers are still willing to pay. Furthermore, these issues cut across all agricultural sectors (crop, livestock and mixed farms).

b) Changing social expectations towards farming

These expectations are connected with socio-cultural traditions, norms and values such as solidarity, mutual respect and preserving farms from one generation to another. Studies conducted in the USA, France, and other EU countries, showed that this issue is pertinent to all sectors (crop, livestock, mixed farms). Actors who were reportedly affected with this issue

included; the farm, cooperatives, rural community, rural institutions, retail, consumers and knowledge providers.

c) Increasing cohesion between social groups

Under social cohesion, aspects like collective learning, collaboration between actors, building collaborative capacities, fit in all. Studies conducted in the USA, New Zealand and many over 15 EU countries found this issue pertinent to the resilience and sustainability of FS in all farming sectors (crop, livestock, mixed farming). Actors who related with the effects of this issue included; the farm, cooperatives, rural community, rural institutions, processors, NGOs, consumers, distributors.

d) Aging population

Aging population has been identified as an issue whose effects might influence both the processes and the state that a system should undertake to continuously deliver its core function. With this issue the various actors have to collaborate and find solutions that help farming to continue. To solutions on how to address the aging issue, there comes another aspect of finding ways to attract young people into farming. Succeeding on that will not only help to make sure food production is guaranteed but also the preservation of rural landscape will be addressed. This brings in policy makers and the list of actors to work together keeps growing at every solution point.

4.1.4 Institutional issues beyond farm level based on findings from Table 6

Institutional issues affecting the SD and resilience of farming systems were identified in 18 studies performed between 2010 and 2017. A step further was taken to identify which actors in the FS are affected by these issues, under which Farming sector. The recurrent issues included; Changing and less flexible policies and CAP regulations.

i. Changing and less flexible policies

These policies are related to the environment protection, quality standards, health and welfare of livestock and land tenure. Studies conducted in Austria, USA, UK, France showed that this issue is pertinent to all farming sectors (crop, livestock, mixed farming). The farm, consumers, processors, retail and rural community, related with the effects of this issue.

ii. CAP regulations

These regulations were found to be an issue in studies conducted in Austria and France, in both crop and livestock sectors. The effects of the issue brought by CAP regulations were pertinent to the farm and cooperatives.

4.2 Assessment of SD and resilience issues beyond farm level in the 11 case studies

The SD and resilience issues assessed in this section derived from perceived challenges by FS actors in the case studies. These perceived challenges are categorised into economic, environmental. social and institutional. Table 7 presents an overview of resilience and SD issues in the case studies. The table includes; The case study with its region and the country where of location, the main actors in the case study and then follows the resilience and SD issues per case study. Resilience and SD issues are classified in the EESi dimensions.

Table 7. SD and resilience issues in the 11 case studies of SURE-Farm

Case study Region, Country	**Main Actors beyond farms**	**Perceived resilience and SD challenges per case study**			
		Economic	**Environmental**	**Socio-cultural**	**Institutional**
Dairy farming in **Flanders, Belgium**	• Processors • Contract workers • Farms of other sectors • Farm household • Neighbors • Consumers	• Liquidity and profitability • Dependence on exports • Competition on the world market	• Weather changes • Animal diseases • Fertile soil	• Age (average is quite old) • Low succession • Education • Societal perception and image of meat and milk products	• Subsidies • Environmental policies and regulations (CAP) • Political limits to the way farmers can use dominant pathways (Permits)
Crop farming **(Cereals and industrial crops) North East, Bulgaria**	• Policy makers • Financial institutions • Local governments • NGOs • Land owners • Knowledge providers • Farm household • Consumers	• lack of insurance services • Low level of investment	• High level of pesticide • Partial problems with soil erosion • Farm management • practices in regard to biodiversity	Deterioration of age structure (farm managers and workers) Lack of succession Lack of farmers' representative structure Participation in social life	Positive change towards formal cooperation Continuous changes into legal framework Lack of stability
Cow calf producer and beef finisher **Bourbonnais - Allier, France**	• Breeding industry • Feed and fertilizer supplier • Producer organization Slaughter houses • Advisory & Veterinary	• Income diversification	Water pollution (Nitrates) Protection of biodiversity Diversity and abundance of key farmland plant and animal species	Labor organization Strong support of farming practices by citizens	Job creation related to beef cattle farming Projects supported by RDP related to landscape preservation
Large scale corporate farms **Altmark, Germany**	Agric. Policy makers Financial institutions	Lack of managerial -level labor force	Water pollution Access to irrigation canals by new farms Sandy soil Clay-rich soil	Generational renewal problems Lack of skilled/educated workers	Protests against intensive pig farms Odor pollution (biogas plants) A week internet connection
Hazelnut farms **Virtebo, Italy**	• Processors • Producers organizations • Farm household	Concentration of industrial processors Low bargaining power of farmers Price volatility	Water quality and scarcity Extreme weather events (droughts, floods, pests)	Generational renewal problems Changing societal concerns regarding farming practices Changing consumer preferences	Change in foo d safety regulations (Increase/decrease regarding some food, feed contents)
Arable crops **(potato, cereals, sugar beet), possibly in combination with livestock farming Old Ambt region, Netherlands**	• Processors • Farms of other sectors • Farm households	x	Heavy clay soil limits crop variety Wind erosion Underdeveloped water holding and water drainage system	Lack of successors Little specialized hired labor	Local innovation, learning and research initiatives Regional projects aiming to integrate arable and livestock farming

Horticulture **(Fruits and vegetables) Mazovian region, Poland**	• Agric. Policy makers • Financial institutions	Poor market organization Improvements of land structure (small farms)	Deficit of organic matter in the soil Water resources instability Soil erosion	Lack of seasonal workers Lack of successors Changing societal concerns (protests again poultry farming)	New EU regulation on biofuels Challenges towards emissions and animal welfare
Mixed cropping and livestock **North -East region, Romania**	• Farm household • Neighbours • Consumers • Land owners • Mechanical service suppliers	• Limited access to markets • Price volatility • Lack of cooperation among farmers	Water scarcity Soil pollution with pesticides Balance of nutrients Extreme weather events	Demographic changes (Aging of farm managers, lack of young replacements) Lack of skilled workers Unavailability of seasonal workers Young people living rural areas Self-consumption	EU regulations regarding use of neonicotinoids Lack of clear land operation code for small farms
Extensive beef farming **Sierra de Guadarrama, Spain**	• Feedlots • Dealers • Slaughters • Suppliers (fodder, animal health services) • Other farms • Land owners • Public administration	• Land ownership; 50% owned and 50% rented • Increasing price volatility	Proximity to the national park endangers livestock by wildlife Quality of pastures affected by droughts	Combination of old and new young farmers Access to all public services Little interaction and association Changes in consumption patterns Urban pressure	National park regulations limit construction and treatment of waste Subsidized premiums in insurance and CAP subsidies Animal welfare
Eggs and Broiler production **Southern Sweden, Sweden**	• Processors	• Low level of value added on farm level	Nutrition balance Soil erosion Climate change	Age and gender structure Lack of skilled/educated workers Social life	Depopulation Different standards for domestic and imported products
Arable crops **(potatoes, cereals, industrial crops, sugar beet) East of England, UK**	• Policy makers • Financial institutions • Neighbours • Agronomists • Social media	• Managerial capacity (social networks, use of information, education)	Water quality and climate General cropping dependent on quality of soil, water and nutrient capacity	Succession problem Access to labor Brexit Customer expectation is important for general cropping	Policy and change in policy

4.2.1 List of Perceived economic issues beyond farm level in the case studies

Table 8 shows an overview of economic issues that were mentioned or reported by the farm and other actors within farming systems of the case studies. These economic issues were perceived to be important for the resilience and SD of the various systems. Price volatility had the highest frequency among all the economic issues. Cases from livestock, perennials and mixed farming systems indicated price volatility as an important issue. Although the count of price volatility is the same in each of these in livestock farming systems, there is a difference in terms of significance of the frequency.

Table 8. Frequency of perceived economic challenges in the 11 case studies of SURE-Farm

Perceived economic challenges	**Frequency**					
	Crop	Livestock	Horticulture	Perennials	Mixed farms	Total
Liquidity and profitability		1				1
Dependence on exports		1				1
Competition on the world market		1				1
lack of insurance services	1					1
Low level of investment	1					1

Income diversification		1				1
Lack of managerial -level labor force	1					1
Concentration of industrial processors	1					1
Low bargaining power of farmers	1					1
Price volatility		1		1	1	3
Poor market organization			1			1
Improvements of land structure (small farms)			1			1
Limited access to markets					1	1
Lack of cooperation among farmers					1	1
Land ownership; 50% owned and 50% rented		1				1
Low level of value added on farm level		1				1
Managerial capacity	1					1
(social networks, use of information, education)						

In terms of significance, price volatility is more significant in the mixed farms farming systems than it is in livestock and crop farming systems. It has a score of 1 in four cases within the livestock and four and a score of 1 in the single case of mixed farms and a single case of perennial farming systems. Although the frequency of an issue in a farming system might give some insights, it might not determine to what extent the same issue is significant in the entire farming system. Furthermore, an issue might be important in one sector of the farming system yet in another sector of the same system, it might be less important if not at all.

Furthermore, looking at the overall count of economic issues in the five farming systems from which the 11 case studies were derived, on one hand the livestock shows the highest count of economic issues (7), followed by the crop farming system (6), then mixed farms (3), horticulture (2) and perennials (1). On the other hand, this might not be a balanced representation of the reality in the farming system as for example, within the livestock farming system there are dairy sector, poultry and beef production, on one hand and on the other there might be differences in focus in terms of markets, some might be global other local. Even these differences might already show some differences in terms of which issues matter and to what extent.

Moreover, lack of insurance services was indicated as an issue in crop farming systems, but it such an issue for only one case out of four cases. Thus, its importance in might vary from one case to another. Thus, to get a more meaningful picture of these issues, the importance of each issue should be first considered in the context of the case study to avoid generalizations that do not portray the reality at system level.

The perceived economic issues that might have an effect on the resilience and SD of farming systems were categorized into three classes; challenges related to price volatility and profitability, challenges related to management and challenges related the market.

i. *Challenges related to the price volatility and profitability*

Price volatility and profitability were perceived as important economic challenges in both livestock and crop farming systems. The perceived challenges in this category included; increasing price volatility, low bargaining power of farmers, liquidity and profitability and low level of value added on farm products

ii. Challenges related to farm management

Challenges related to management included, lack of managerial-level labour force and low managerial capacity on farms. Although the effects of these issues may be profound at farm level, their consequences may spread throughout the FS affecting other actors indirectly and being a problem to the delivery of system's core function.

iii. Challenges related to the market

Challenges related to the market included limited access to markets, land ownership, lack of insurance services and competition on the world market

4.2.2 Perceived environmental challenges in the case studies

Table 9. Frequency of environmental issues in farming systems from the 11 case studies of SURE-Farm

Perceived environmental challenges	**Frequency**					
	Crop	**Livestock**	**Horticulture**	**Perennials**	**Mixed farms**	**Total**
Weather change & Extreme weather events (droughts, floods, pests)		2	1		1	4
Animal diseases		1				1
Soil fertility & quality	2	1	1		1	5
Problems with Soil erosion		1	1			2
High level of pesticide	1					1
Water quality & water scarcity	2	1	1	1	1	6
Protection of biodiversity	1	1				2
Access to irrigation canals & water drainage	2					2
Wind erosion	1					1
Balance of nutrients	1	1				2
Proximity to the national park endangers livestock by wildlife		1				1
Quality of pastures affected by droughts		1				1

The key resilience and sustainability issues related to the environmental dimension of farming systems included; issues related to water quality and scarcity, soil fertility and quality and weather change and extreme weather events. In terms of farming systems, the livestock systems had a higher count issues related to extreme weather events and climate change, whereas, the crop systems had higher counts on issues related to soil fertility and quality on one hand and quarter quality and scarcity on the other hand.

4.2.3 Perceived social issues beyond farm level in the case studies

Although each issue is important as far as a specific case study is concerned, looking at a farming system beyond the boundaries of a single case, key resilience and sustainability issues related to the social dimension included; unbalanced age structure and generational renewal problems, low succession of farm workers and farm managers, lack of skilled workers (seasonal, specialized) and consumer changing expectations. The frequency of age structure and generational renewal problems was the same in both crop and livestock farming systems although its score in perennials and mixed farms was lower than in livestock and crops. There could be however other factors playing a role in the frequency level. For example, the mixed farms farming systems in the case studies are mainly small holder farms in Romania, whereby in case the farm closes, the gap it causes to the supply chain might not be as evident as it would be for the case of a closure of a large-scale farm in Germany. Thus, the frequency may vary due to other specific aspects within the farming system.

Furthermore, although the frequency of issues related to lack of skilled/educated and/or specialized farm workers is perceived across almost all the farming systems, the crop systems showed a higher frequency than the rest. However, in terms of importance, effects deriving from this issue might be much more important in mixed farms and horticulture farming systems which had a single case each in the case studies than maybe it would be in the crop system which had four case studies.

Table 10. Frequency of social issues in farming systems from the 11 case studies of SURE-Farm

Perceived social challenges	Frequency					
	Crop	Livestock	Horticulture	Perennials	Mixed farms	Total
Unbalanced age structure & generational renewal problems	2	2		1	1	6
Low succession of farm workers and farm managers	3	1	1		1	6
Changing societal perceptions on farming and farm products		1		1		2
Changing consumer preferences and expectations		1	1	1		3
Lack of farmers' representative structure	1					1
Labour organization		1				1
Strong support of farming practices by citizens		1				1
Lack of skilled/educated workers & specialized hired labour	2	1	1		1	5
Changing societal concerns		1	1			
Young people living rural areas					1	1
Self-consumption					1	1
Combination of old and new young farmers		1				1
Access to all public services		1				1
Little interaction and association		1				1
Changes in consumption patterns		1				1
Urban pressure		1				1
Social life		1				1
Access to labour after Brexit	1					1

4.2.4 Perceived institutional challenges in the case studies

Table 11. Frequency of institutional issues in farming systems from the 11 case studies of SURE-Farm

Perceived institutional challenges	Frequency					
	Crop	**Livestock**	**Horticulture**	**Perennials**	**Mixed farms**	**Total**
Subsidies & subsidized insurance premiums		2				2
Environmental policies and regulations (CAP)		1				1
Limits to the way farmers can use permits		1				1
Positive change towards formal cooperation	1					1
Continuous changes into legal framework	1					1
Lack of stability	1					1
Job creation related to beef cattle farming		1				1
RDP related to landscape preservation		1				1
Protests against intensive pig farm odour pollution	1					1
Change in food safety regulations				1		1
Local innovation, learning and research initiatives	1					1
Regional projects aiming to integrate arable and livestock farming	1					1
New EU regulations on biofuels			1			1
Challenges towards emissions and animal welfare			1			1
EU regulations regarding the use of neonicotinoids					1	1
Lack of clear land operation code for small farms					1	1
National park regulations limit construction and waste treatment		1				1
Depopulation		1				1
Different standards for domestic and imported goods		1				1
Policy changes	1					1

Institutional issue related to subsidies had a highest score of frequency in the institutional dimension. Furthermore, table 11 shows that subsidy and subsidized insurance are mainly present in the livestock farming systems. However, drawing a conclusion from that might be misleading as there might be many other factors that would influence the outcome. For example, within the livestock farming systems in the case studies, there are some cases with extensive farming of broilers, extensive farming of beef cattle, dairy farming, etc. These differences may all play a role and the subsidies and insurance premiums needed in these different cases may vary also significantly. Furthermore, other factors like farm size, market orientation (local, regional, global) may all play a role in determining to what extent subsidies and insurances are needed.

All other issues might have a low score of frequency, yet their effects play an import role in the system's ability to fulfil its core function.

4.3 Evaluating key actors in Farming systems of the case studies

The evaluation of key actors in farming systems consisted of reviewing the 11 case studies of SURE-Farm project, listing all the actors based on the assumption of mutual dependence, and then the frequency of number of counts was assigned to each actor in terms of how many times the actor is mentioned in the case studies. However, during the review of case studies, there were some key actors who did not fulfil the mutual dependence assumption, yet they who still played an important role in the farming system. Therefore, these actors who did not fulfil the mutual dependence criteria were also listed, first in each case study, then in the five main farming systems of the 11 case studies.

Table 12 presents an overview of key actors in farming systems based on the outcome from case studies. Actors of category A were actors who aligned with the assumption the mutual dependence assumption and the illustration in figure 5. Whereas of category B were important for delivery of the system's core function without mutual dependence.

Table 12. Overview of key actors in farming systems from the 11 case studies of SURE-Farm

Case study Region, Country	Category A[2]	Category B[3]
Dairy farming in **Flanders, Belgium**	• Farms of other sectors • Neighbors • Consumers	• Processors • Contract workers • Farm household
Crop farming **(Cereals and industrial crops) North East, Bulgaria**	• Policy makers • Financial institutions • Consumers	• Local governments • NGOs • Land owners • Knowledge providers • Farm household
Cow calf producer and beef finisher **Bourbonnais - Allier, France**	• Producer organization	• Breeding industry • Feed and fertilizer supplier • Slaughter houses • Advisory & Veterinary
Large scale corporate farms **Altmark, Germany**	• Agric. Policy makers • Financial institutions	
Hazelnut farms **Virtebo, Italy**	• Producers organizations • Farm household	• Processors

[2] *Key actors within the FS boundaries in figure 5*
[3] *Key actors beyond the FS boundaries in figure 5*

Arable crops **(potato, cereals, sugar beet), possibly in combination with livestock farming Old Ambt region, Netherlands**	• Farms of other sectors	• Processors • Farm households
Horticulture **(Fruits and vegetables) Mazovian region, Poland**	•Agric. Policy makers •Financial institutions	
Mixed cropping and livestock **North -East region, Romania**	•Farm household •Neighbours •Consumers	• •Land owners •Mechanical service suppliers
Extensive beef farming **Sierra de Guadarrama, Spain**	•	•Feedlots •Dealers •Slaughters •Suppliers (fodder, animal health services) •Other farms •Land owners • Public administration
Eggs and Broiler production **Southern Sweden, Sweden**	• Farms	• Processors
Arable crops **(potatoes, cereals, industrial crops, sugar beet) East of England, UK**	•Policy makers •Financial institutions •Neighbours	• •Agronomists •Social media

Although some actors are recurrent almost in all the case studies, the importance of the actor's role is somehow embedded in the context of each single case. It is also possible that none of the actors fulfils the mutual dependence criteria. In the ''Extensive beef farming'' case in Sierra de Guadarrama (Spain), it was found that none of the key actors has a mutual dependence with the farm. Whereas, ''Fruits and vegetables'' case study in Mazovian region (Poland), showed quite the opposite, whereby all the farming system actors had mutual dependence with the farm.

After reviewing the case studies and listing key actors, the 11 case studies were divided into 5 farming systems namely; livestock, crop, mixed farms, horticulture and perennial farming systems. Thereafter, actors from both categories were listed in each of the farming systems, and a count of how many times they were listed in each case (frequency) was written down as a score of 0 to 4. 0 was given when the actor is not mentioned in the case study and the farming system, and 1 if the actor is mentioned in a single case of the farming system and so on. 4 was the highest score and it could only be possible for a farming system with at least 4 case studies. Table 13 shows an overview of counts of each actor from category A and category B, in the 5 farming systems.

Table 13. Frequency of counts of key actors in farming systems of the 11 case studies of SURE-Farm

Farming systems	Category A key actors	Frequency	Category B key actors	Frequency
Livestock	Farm(s)	2	Processors	2

(4 cases)	Neighbours	2	Contract workers	1
	Consumers	2	Farm household	1
	Producer organizations	1	Breeding companies	1
	Policy makers	0	Feeds and fertilizer suppliers	1
	Financial institutions	0	Advisory & Veterinary	1
			Land owners	1
			Dealers	1
			Feedlots	1
Crop **(4 cases)**				
	Farm(s)	0	Farm household	2
	Neighbours	1	NGOs	1
	Consumers	1	Local government	1
	Producer organizations	0	Knowledge providers	1
	Policy makers	3	Land owners	1
	Financial institutions	3	Processors	1
			Agronomists	1
			Social media	1
Mixed farms **(1 case)**				
	Farm(s)	0	Farm household	1
	Neighbours	1	Land owners	1
	Consumers	1	Mechanical service providers	1
	Producer organizations	0		
	Policy makers	0		
	Financial institutions	0		
Horticulture **(1 case)**				
	Farm(s)	0	Farm household	0
	Neighbours	0	Land owners	0
	Consumers	0	Mechanical service providers	0
	Producer organizations	0		
	Policy makers	1		
	Financial institutions	1		
Perennials **(1 case)**				
	Farm(s)	0	Farm household	1
	Neighbours	0	Land owners	0
	Consumers	0	Mechanical service providers	1
	Producer organizations	1		0
	Policy makers	0		0
	Financial institutions	0		0

In the first place, table 13 shows that the level at which a single actor plays a key role varies from one farming system to another. For example, financial institutions had 0 counts in the livestock farming systems in crops systems financial institutions had 3 counts, a much high score of frequency. However, there might be other reasons such as type of farming practices, are they intensive or extensive, are they corporate or family farms, which play a role in determining which actor is key for the system to deliver its core function or which one is not.

Although the insights in table 13 might not a completely accurate picture of who is a key actor in a farming system, an aggregate count of how frequent an actor is mentioned in either category A or category B may give a more focused picture of who are key actors in farming systems.

Table 14. Aggregate counts of key actors in farming systems

Actor	**Livestock**	**Crop**	**Mixed farms**	**Horticulture**	**Perennial**	**Aggregate counts**

Farm(s)	2	0	0	0	0	**2**
Neighbours	2	1	1	0	0	**4**
Consumers	2	1	1	0	0	**4**
Producer organizations	1	0	0	0	1	**2**
Policy makers	0	3	0	1	0	**4**
Financial institutions	0	3	0	1	0	**4**
Processors	2	1	0	0	0	**4**
Contract workers	1	0	0	0	0	**1**
Farm household	1	0	1	0	1	**3**
Breeding companies	1	0	0	0	0	**1**
Feeds and fertilizer suppliers	1	0	0	0	0	**1**
Advisory & Veterinary	1	0	0	0	0	**1**
Land owners	1	0	1	0	0	**2**
Dealers	1	0	0	0	0	**1**
Feedlots	1	0	0	0	0	**1**
NGOs	0	1	0	0	0	**1**
Mechanical service providers	0	0	1	0	0	**1**
Local government	0	1	0	0	0	**1**
Knowledge providers	0	1	0	0	0	**1**
Agronomists	0	1	0	0	0	**1**
Social media	0	1	0	0	0	**1**

If key actors are only those with an aggregate count of at least 3 aggregate counts, key actors in farming systems will be in this case neighbours or farm neighbourhood, consumers, policy makers, financial institutions, processors and the farm household. On one hand this might be a limited way of determining who are key actors of a farming system and who are not. However, on the other hand, the combination of the selected key actors is a representation of the embeddedness of farming systems in EESi dimensions.

Chapter five: Discussion and conclusions

5.1 Discussion

Resilience and SD issues in farming, food and agricultural systems have been studied for over a decade although the focus remained mainly on a single unit of the FS, mostly the farm. For example, Milestad et al. (2003) and Darnhofer (2006), Darnhofer et al. (2010) had started working on the resilience in the farming context and their focus was mainly on how to strengthen the resilience of farms, and more specifically family farms. Thus, although studies about resilience in farming have been done for over a decade, the extent to which the focus extended beyond a single unit of an FS is relatively smaller based on findings from literature review.

In relation to resilience and SD issues identified beyond the farm, the extent to which these issues fit into the FS's context differs. Especially when the criteria of being 'beyond the farm' is related to how many actors within an FS find an issue important in order to ensure the delivery of the system's core function. For example 4 actors out of 6 in an FS in France indicated that increasing food price volatility had a negative effect on their resilience (Prosperi et al., 2016) yet in another case in the USA 2 out of 4 actors of a farming system indicated volatile food prices as a resilience issue (Bowman & Zilberman, 2013). Looking into the two cases, the extent to which fluctuating food prices fit into 'beyond the farm' in the first case is higher than it is in the second case. Thus, an issue may have effects on the resilience and/or SD of an FS but the extent remains case dependant. This resonates with Quinlan et al. (2015) who argued that resilience is context dependent.

In relation to the EESi dimensions of resilience and SD issues in FS, it was shown that irrespective of geographical region, and sectors of farming, there are more economic and social issues than ecological and institutional issues. Most of environmental issues are related to climate change and declining biodiversity. Institutional issues were mainly related to changing policies in areas such as quality assurance and land tenure. However, although economic and social issues were more frequent, the effect of environmental and institutional issues, cannot be undermined, as they are embedded into the social and economic aspects of actors in an FS. For example, changing land tenure policies will change the dynamics in land ownership which is a social aspect and it may influence the ability of actors such as farm/farm household, cooperatives, rural communities to supply food and food product which has an economic component.

Although associating resilience and SD issues with a number of FS actors provided insights on finding to what extent an issue can be considered as an FS or beyond the farm level issue, the validity of that association in the literature review is somehow questionable because of the following; in a study in Austria (Darnhofer et al., 2010), commodity price volatility was identified as a resilience issue in both crops and livestock sectors but only associated with the farm/farm household. In practice, consumers and the rural community who are other actors in this particular case must have been affected with this issue. However, if this point is restricted to the confines of 'resilience' as the system's ability to maintain its essential functions of in the face of increasingly complex and volatile economic, social, environmental, and institutional challenges (Meuwissen 2018), then it seems rational that this issue affects the farmer's ability to produce and supply enough food as his core function in the agroecosystem. Therefore, this association of resilience and /or SD issues and actors was to a great extent based on assumptions. One of the ways to increase the validity of this approach of associating an issue with corresponding actors in the FS would have been through the case studies where interviews would have purposely seek to find out for each issue that is identified as being 'beyond the farm level' which actors associate with it in the pursuit of the delivery of the system's core function. However, given the large scope of case studies evaluated in this thesis, and the scarcity of in-depth information in case studies, it was not possible to establish this clearly in the case studies. Although evaluating resilience and SD issues in 11 case studies seemed logical after assessing resilience and SD issues beyond farm level, a better formulation of the evaluation should have included resilience and SD issues beyond farm level in the case studies in order to remain consistent in purpose and also in focus.

5.2 Conclusions

- The extent to which resilience and SD issues have been studied beyond the farm is quite smaller than the studies on resilience in farming, agricultural and food systems in general. This could be because when the resilience concept was introduced into farming and agricultural context the focus was restricted to the farm or farm household. Irrespective of the farming sector and regional location, issues on the economic and social dimensions are more and diverse than issues in ecological and institutional dimensions. Resilience and SD economic issues that were reported/ mentioned or associated with at least three FS actors include; persistent financial crisis, increasing food price fluctuation, changing technological innovation and cost efficiency and variability in supply. One of the outstanding social issues was the increasing need for collaborative capacity amongst actors.

- The assessment of resilience and SD issues in the 11 case studies of the SURE-Farm project did not establish a direct 'issue – actor' association, leaving all issues as system's issue without further explanations. However, designing and constantly updating policy instruments that address issues such as price volatility, water pollution and scarcity, land ownership and aging will help FSs maintain their essential functions. Although the focus in the case studies somewhat revolved around the farm and/or the farm household.

- Although who the actors of an FS are mostly case specific, key actors FS in the 11 case studies include neighbours or farm neighbourhood, consumers, policy makers, financial institutions, processors and the farm household. Therefore, to strengthen the resilience and SD of EU FS, it is important to address challenges that are common to the key actors, and find ways to increase the collaborative capabilities of these actors.

5.3 Recommendation for future research

For future research, it would be much more insightful to make a step further and find out which actors are affected by which issue and to what extent, so that the credibility of resilience issues is more representative of the reality in the farming system. Furthermore, it would be interesting in the future to consider the time dimension in the study of resilience and SD issues in farming systems. For example, a few issues that are found very key in a farming system are thoroughly studied within a certain time frame to see how they might change in intensity or frequency over time. This would be important given that farming systems have changing neds and reality within a time frame, and different issues may be important due to long-term or short-term perturbations of the system's functioning.

Additionally, a future study on how some resilience issues affect actors in within a farming system over time would be maybe much more insightful, to show how the issue's importance moved from being a single actor's issue to a system's issue. For example, Prosperi et al. (2016) identified changes in consumption pattern as a social issue with effects on the farm, processors, distributors and retail in farming systems in France. However, it was known how thus issue moved from affecting upstream to the downstream actors in the farming systems. Yet it could be that some actors were affected until a certain point and then the issue spread its effects to other actors.

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